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Communicating Science in Social Contexts

New models, new practices

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Foreword

José Manuel Silva Rodríguez

I am pleased to introduce this book, which I am sure will enhance the dialogue between science and society—nowadays an important element of the scientific and technical landscape.

The European Commission is deeply committed to facilitating the dialogue between science and society and has taken numerous recent initiatives in this context. Promoting dialogue between science and society or, more precisely, putting science back into society is one of the priorities of the European Union's Seventh Framework Programme, which runs from 2007 to 2013. There are specific budgets allocated to these activities. In addition, the contracts the Commission signs for projects of the Seventh Framework Programme require beneficiaries to 'take appropriate measures to engage with the public and the media about the project aims and results'. In February 2007, the European Commission adopted a communication entitled *Scientific information in the digital age: Access, dissemination and preservation* with the aim of starting a political debate on the scientific publication system, which everyone says should be reformed from top to bottom.

All of these initiatives are designed to provide wider public access to scientific knowledge and ongoing research. The objective is to develop a genuine 'scientific communication culture' in Europe. The 'scientist in his ivory tower' is still a reality, and this contributes to the current wary atmosphere, at least in Europe. This is why the present book has an important role to play.

However, although information and communication are necessary, they are not sufficient. There is no magic wand that will make all the existing resistance and scepticism go away. Scientists should also accept that there are some scientific developments that people do not want. Researchers should remain aware that better dialogue with the public could have prevented much of the friction and lost potential innovations in several research fields, such as nuclear energy, genetically modified organisms, pesticides, and others. They should keep in mind that they operate in a public context.

Paying attention to this reality will allow the scientific community worldwide to improve and enhance the science and society dialogue.

Director-General,
Research Directorate-General,
European Commission

Foreword

Deng Nan

I am very pleased to see this new book of public communication of science and technology published, and feel pleased and honoured to be invited to write this foreword.

The constant innovation of science and technology has continued to produce outcomes to the benefit of mankind, driving human society into prosperity while giving rise to all sorts of new social demands. Prosperity demonstrates the contribution of science and technology to human society and is understandable as part of social progress. In the world today, society demands further advances in many fields, including the protection of the ecological environment, the appropriate utilization of resources, the beneficial coexistence of humans and nature, and the sustainable development of society.

The public and the science and technology community share a need to develop the public communication of science and technology, to engage the public in science, to encourage dialogue and interaction between science and the public, and to mobilize all sectors of society to join us in the common pursuit.

All these factors show the significance of the impact of science and technology on society. Based on this understanding, the China Association for Science and Technology (CAST) will strengthen its effort, as it has in the past, to promote the public communication of science and technology.

Public science and technology communication has grown into a prosperous enterprise, accommodating the harmonious development of science with society. As an enterprise, it is already well beyond discussions within academic circles or the science communication community. It now attracts broad attention from various social sectors, and penetrates into the daily life of the public.

Playing active roles in communicating science to the public, science communicators make it their responsibility to nurture and optimize the relationship between science and society. In carrying out that responsibility, they keep asking themselves questions, diagnosing problems and trying to solve them by developing new practices. Their work deserves respect. This book is a record of their dedication to the task. The editors and authors are from many different countries. Based on their perspectives on current social contexts, they consider issues of outstanding importance in science communication from many angles, and propound possible ways, means and solutions. Their goal is to bridge science and society, to get the public connected with science, and to reinforce the harmonious development of human society.

To write and compile a manuscript of high academic merit is not easy, but it is a significant contribution to the field. The value of the effort lies in the powerful and effective exchange of experiences and the communication of ideas. In its own right, this book will be a specific, value-added contribution, a valuable resource, and a medium for sharing in the international science communication domain. As an accessible reference, it will be a positive benefit for practitioners world-wide in their field work.

Since its foundation, the Public Communication of Science and Technology Network has devoted much effort to science communication and made profound contributions to the field. The network runs a website, holds international conferences and publishes books—all of which have greatly advanced global science communication. This book is a fresh outcome of the network's endeavours, and I hope it will be widely shared and exploited.

CAST takes great pleasure in knowing that the China Research Institute for Science Popularization (CRISP) has been involved in such international academic exchanges, and firmly supports CRISP's further efforts in the science communication field.

Executive Vice President,
Chief Executive Secretary,
China Association for Science and Technology

Foreword

Shane Huntington

Over the past decade, I have fulfilled three key roles that bring balance to understanding the practical nature of science communication. First, I work as a senior researcher at the University of Melbourne. I have published many papers and have personally acquired about A$6 million in grants in the past five years. Second, I am co-director and founder of a company that initially consulted on commercialization and is now a premier supplier of scientific equipment in Australia and New Zealand. And finally, I have been a broadcaster for a Melbourne-based science radio show for the past 12 years. This combination allows me to view the problems and opportunities for science communication from three perspectives: academia, industry and the media.

The technological and environmental challenges of the 21st century will not be accepting of the current state of play in science communication. All indications seem to be that we have a community that is inherently interested in science and technology, but unable to properly engage with it. Science communication is about bridging the gap between various sectors. A good science communicator should be able to facilitate a scientist's engagement with industry, government, other scientists and the community. Science communicators need to be extraordinary intermediaries.

Is it any surprise therefore, that with such heavy requirements on this sector we seem to be failing to achieve the level of engagement that we would like? When I teach scientists to interact with other sectors, the primary point that permeates our discussion is always 'what drives people in that sector?' In order to communicate with other sectors we all need to have a solid understanding of what gets the audience out of bed in the morning.

As science communicators, it is therefore incumbent on us to start this philosophy at home. The key player for us is the scientist, and we need to listen to what drives them to achieve. Sadly, in most cases, the communication of science to other sectors is not a key driving force. This is unfortunate, but in no way restrictive. When I teach scientists to engage with other sectors, I make it clear that the skills they learn will be directly applicable to their core activities of research, grant writing and teaching.

Now comes the part where you need to think like a scientist to communicate this message to them. Scientists hate vague statements. They need something that resists falsification to some degree, meaning they need to hear solid examples of the benefits of science communication skills. The ability to communicate needs to be seen as an important tool in their intellectual arsenal. And, as for any tool, they will require a set of well-established rules and guidelines for implementation. Such a system needs to be developed.

Scientists to me are tough customers. But anyone who has worked in retail or marketing will know that, once converted, these ‘customers’ become your most vocal supporters. Understanding where the message is coming from is just as important as how we deliver the message.

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Abbreviations and Acronyms

AAAS	American Association for the Advancement of Science
BA	British Association for the Advancement of Science
BBSRC	Biotechnology and Biological Sciences Research Council (UK)
BSE	Bovine Spongiform Encephalopathy
CAST	China Association for Science and Technology
CCME	Canadian Council of Ministers of the Environment
CHASS	Council for the Humanities, Arts and Social Sciences (Australia)
CMSD	Canonical Model of Sustainable Development
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
CST	Conseil de la Science et de la Technologie (Québec, Canada)
CVD	Congressional Visits Day (US)
DEFRA	Department for Environment, Food and Rural Affairs (UK)
EC	European Commission, Environment Canada
EU	European Union
EUSCEA	European Science Events Association
FASTS	Federation of Australian Scientific and Technological Societies
GDP	Gross Domestic Product
GM	Genetic Modification, Genetically Modified
HASS	Humanities, Arts and Social Sciences
LWA	Land & Water Australia
NCST	National Coalition for Science and Technology (US)
NESTA	National Endowment for Science, Technology and the Arts (UK)
NGO	Non-Government Organization
NRA	National Rifle Association (US)
NWRI	National Water Research Institute (Canada)
OECD	Organisation for Economic Co-operation and Development
OMD	Orchestral Manoeuvres in the Dark (UK band)

PCST	Public Communication of Science and Technology
POST	Parliamentary Office of Science and Technology (UK)
PR	Public Relations
PUS	Public Understanding of Science
S&T	Science and Technology
SBS	Save British Science
SCP	Sustainable Consumption and Production
SLB	Science Liaison Branch (NWRI)
SmP	Science Meets Parliament (Australia)
STC	Science and Technology Council (Quebec, Canada)
STEM	Science, Technology, Engineering and Medicine
UK	United Kingdom
UNESCO	United Nations Educational, Scientific and Cultural Organization
US	United States

Introduction: Science Communication — A Multidisciplinary and Social Science

Cheng Donghong, Michel Claessens, Toss Gascoigne, Jenni Metcalfe, Bernard Schiele, and Shi Shunke

This book is the fruit of a lengthy gestation and equally lengthy work. The editors first conceived of this project in June 2005 at a workshop in Beijing organized by the Public Communication of Science and Technology (PCST) Network. Then, at a January 2006 working seminar in Venice, the main topics and issues were broached with some 30 experts in science communication from around the world. The richness of the Venice contributions and exchanges convinced us of the need for a volume to crystallize the state of the art and to advance knowledge further.

The book is also the product of equally lengthy work that owes a debt to the research and expertise of the PCST Network, which includes the editors. For nearly 20 years, this informal, international network has been organizing events and forums for discussion of the public communication of science (see Appendix).

As a multidisciplinary field, science communication has developed remarkably in recent years. It is now a distinct and exceedingly dynamic science that melds theoretical approaches with practical experience. Formerly well-established theoretical models now seem out of step with the social reality of the sciences, and the previously clear-cut delineations and interacting domains between cultural fields have blurred. This work examines that shift, which itself depicts a profound recomposition of knowledge fields, activities and dissemination practices, and the value accorded to science and technology.

Simply put, theories about the public communication of science have until now focused essentially on two aspects: the incapability of the actors and the inadequacy of the means.

First, the actors: scientists were reproached for remaining enclosed within a universe of concepts and formalisms that kept them distant from the concerns of society—which, paradoxically, was being transformed by the discoveries of those same researchers. This sparked a genuine proselytism to 'reform' scientists, so they would finally learn to communicate with the public in its own language. The rise of communications as a field naturally impelled many science communicators to become trainer–educators, teaching communication skills to scientists.

At the same time, the burgeoning multimedia field spurred a new profession of science media practitioners. They proclaimed themselves as the natural intermediaries between the enclosed world of the sciences and a public desperately seeking answers to questions and concerns. They took it upon themselves to bring science

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and society closer, to narrow an ever-widening gap between scientists' knowledge, with its inherent power, and public knowledge implicitly subject to it. In this context, the public communication of science deemed itself necessary to re-establish a balance and restore a right to speak. But science mediators have not yet received the full recognition they desire or the proper means they demand.

Every coin has a flipside. On the one hand, science communication is a distinct research field, with an international researcher and practitioner community that, among other things, brings together two-yearly PCST conferences. On the other hand, we observe that the scientific community, while increasingly interested in communication, nevertheless holds to simplistic ideas, as evidenced in its often outmoded approaches. Many researchers still feel that promoting science communication should enhance the public's scientific knowledge and lead to more generous budgets for research. The industrial promoters and research managers generally feel that knowledge invites development support.

Implicit in that view is the notion that well-informed citizens will be more receptive and positive towards new technologies. The reality, we know, is much more complex. Communication policies and actions remain important but, in certain key areas, the information is insufficient to convince or rally—which seems healthy on the whole. Perhaps, in all modesty, those attempting the difficult art of science communication and popularization aspire to participate more in an evolution than a revolution of opinions, by enriching the democratic debate and developing the culture. As one of us has written: 'Strictly from the viewpoint of learning scientific knowledge, if popularization fails, it still makes a huge contribution to its socialization'.[1] In the present context, achieving such an objective would certainly represent success.

Obviously, adequate means are required to fill the knowledge gap and develop communication skills. So mediators and educators have for a long time—and with some success—mobilized governments, foundations and associations to disseminate science as a collective effort, and to garner resources in order to share knowledge effectively. But there's the rub—because the knowledge gap continues to grow, the public still has no say in the matter.

Of course, this timeworn discourse has received ample criticism. For example, there was the attempt to replace the *deficit model* (which that discourse originally defined) with a *contextual model* that incorporates the operativity of knowledge associated with interests, concerns or lay expertise, so that the relationship to scientific knowledge is constructed on that basis. But the contextual model, while more nuanced than the deficit model, shares the same premises: first, science and society are conceived as two autonomous spheres, distinct from one another, and with one prevailing over the other; second, only a mastery of techniques and communication enable a rapprochement and the regaining of equilibrium.

In other words, it's necessary to break with linear conceptions of science–society relationships. Such conceptions postulate the existence of a knowledge situated

[1] Schiele, B. (1983). Enjeux cachés de la vulgarisation scientifique. *Communication-Information*, *V* (2–3).

elsewhere, but demand dissemination if that knowledge is to be shared with the greatest number and is to benefit society as a whole.

The editors of this work see this rupture taking place. Today, communication is seen as a necessary (but insufficient) contribution to science and society's dialogue to reintegrate science within culture. The social role of science goes well beyond scientific knowledge and its intrinsic merit; it resonates in the forms and functions of contemporary organization. Their importance in our modern life means scientific thinking and activities are not outside culture, but well within it. Science is not another culture, alien to society. It should be considered as a substratum, a *déjà-là*, a base from which meanings elaborate and evolve, in turn yielding a coherent vision of our actions and our situation, but also our will to understand, to communicate and to act.

Moving away from the linear deficit model, communication practices and models are increasingly integrating the diversity of social contexts, the multiplicity of actors involved and the spectrum of objectives pursued. Witness the multitude of science events with numerous geographic and social contexts reaching the many 'general public' subgroups. Witness the richness of communication models and experiences, which this work partly reflects. Witness also the scientific community today becoming aware of the appeal expressed by one of us in 1983: 'A science policy depends first and foremost on the policy of scientific communication'.

By way of introduction, these brief words sketch how particular knowledge relationships form and interact within different situations in the science–society dialogue, in turn influencing the models and practices of science communication that are variously explored and applied. Reciprocally, the abundance and flourishing of science communication models and practices, directly interacting, stimulate this vital dialogue between the community of researchers and civil society. This is the guiding theme of this work.

December 2007

Chapter 1
Paradigm Change for Science Communication: Commercial Science Needs a Critical Public

Martin W. Bauer(✉)

Abstract With private patronage, the pressure grows to commercialize scientific research and its results. The business model extends into the laboratory, and applies also to communication. The author explores potential risks for science communication in this changing context. In product marketing and public relations, hyperbole and sensationalism are normal modes of operation. 'Innocent fraud' (Galbraith) and more 'bullshit' (Frankfurt) are likely risks with this communication practice, and those risks call for increased vigilance by knowledge consumers. The author points to some indicators of the growth of critical publics for science: the long-term waves of mass media coverage, the cycles of hype and disappointed expectations, increased scientific literacy, and the displacement of scientific ideology by sceptical and utilitarian attitudes in high-tech knowledge societies. In this context, the paradigm of science communication is no longer to deliver public acceptance, but to enhance public scrutiny of private scientific developments.

Keywords Commercialisation of science, knowledge marketing, public relations, science attitudes, science communication, scientific ideology

> Long live the accomplishments of Enlightenment, Modernity and Globalisation! Thanks to their outcomes—innovation, science and technology—all citizens in our global city make use of the information that was once only available to the West and to other advanced nations. Thanks to the worldwide expansion of Western ideals of democracy and capitalism, every citizen in our global city has the potential to have access to the vital utilities of modern life. Yet, some controversies remain to be answered by the theory of modernity. *Do the promises of these developments fully live up to their expectations?* Is the potential realized for all people? Do the developments of science and technology come hand in hand with perfection of human lives and closing disparities among peoples?
>
> —*A young Turkish woman in a postgraduate course essay, January 2006*

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I will make my argument in four steps, starting with a short exposé of the shift from public to private patronage of science and the commercialization of scientific research that follows from this. It will be shown that this accentuates some risks of science communication: maybe more fraud, likely more hype. This trend requires us to recognise that a public critical of science and technology (S&T) is an asset and not a problem. The paper ends with some observations on the social location and trends in sceptical attitudes to science across Europe to make this asset somewhat more tangible.[1]

1.1 The Knowledge Economy and the Commercialization of Science

Over the past 30 years, the striking trend in the science–society relationship is the increasing private patronage of scientific research. Private patronage of science is historically nothing new (on the contrary, it was probably the normal state of affairs before World War II). After 1945, generous state funding streams concentrated research activities in the public research universities of the developed world and established an ideal of science as a 'common good' in the tradition of the 18th century Enlightenment.

That state of affairs has been reversed since the 1970s. OECD figures for research and development (R&D) report that industrial R&D is financed by public, private or charitable sources, including organizations such as the Rockefeller Foundation (US) and the Wellcome Trust (UK). R&D is performed by industry, universities or governments. The latter two might be considered 'public', although the status of universities is becoming more hybrid. Most funding for R&D now comes from private sources and most R&D is also performed by private actors. The world leaders here are the US and Japan, where respectively 63% and 74% of R&D is industry funded and 69% and 74% is industry performed. This is also the reality across the EU 25, where 55% was industry funded and 64% was industry performed in 2002, albeit with some variation among EU countries. Things have changed. Since 1981, overall public funding in the OECD shrank from 44% to 29%, while private funds increased from 52% to 65%; research funded by charitable sources grew from 4% to 7% by 2000.

These observations support my first claim: *scientific research is increasingly in private patronage*. Many people now talk convincingly about the 'knowledge economy'—an economy that is dominated by a transformed, high-tech, R&D-intensive industry and service sector employing highly educated and creative people in private research laboratories.

[1] Earlier versions of this argument have been presented at the CNR and British Council meeting in Rome, February 2006; PCST-9, Seoul, May 2006; INNOVACTION, Udine, February 2007; and the Institut für Wissenschafts und Technikforschung, University of Bielefeld, May 2007. I am thankful for many helpful comments received on those occasions.

What for most of the post-war period was considered a ‘public good’—the universally accessible and valid knowledge about nature and society produced under state patronage (albeit largely for security needs; Mirowski and Sent 2005), is increasingly becoming a ‘private good’.

Privatization might have an upper limit (indeed, by 2000 the trend appears to halt), but an inevitable consequence of private patronage is the commercialization of science. The managerial model becomes pervasive for both private and public science. A literature is already emerging that maps the unintended consequences of this ‘Mode 2’ science (Nowotny et al. 2003). Commercialization of science boosts knowledge production, but also redirects research in favour of short-term projects with immediate pay-offs; product innovation and improvement displace ‘blue sky’ curiosity. It turns the remaining public institutions into public–private hybrids, such as academies with a commercial spin-offs culture, reduces the dominant actor’s contributions to the open literature, and a policy of secrecy to protect potential patents sets in (Tijssen 2004). It exerts ‘corrupting’ influences in academic research and erodes independent capacities in public interest areas like occupational health (see Krimsky 2003, Greenberg 2007).

Most of these observations on the production of knowledge remain preliminary and controversial. What seems to be uncontroversial, even taken for granted, is the universal acceptance of the business model for the communication of ideas. It is even suggested that business schools are a model of production and marketing of ideas (Woolgar 2004): ‘knowledge is co-constructed’ in the act of marketing and networking; and the only bottom line is ‘profit = income exceeds costs’ at the end of day.

I would like to explore some potentially undesirable consequences of normalizing this logic of marketing and public relations in the realm of science.

1.1.1 The Implication: Knowledge Marketing

We might ask ourselves: does the commercialization of scientific research have any implications for science communication? Vacuum cleaners, furniture, carpets, cars, toothpastes, washing powders and perfumes are very different consumer products but have one thing in common: they are all commodities subject to the powerful logic of consumer marketing, a professional expertise that has been in the making for most of the 20th century. The logic of marketing goods to target groups, by using advertising and public relations, is extended to knowledge and ideas—the realm of science. This creates new challenges for science communication.

An example of this trend towards the marketing of knowledge is the recent image campaign of DuPont, a global biochemical company, under the trademark title ‘The miracle of science’. Science is not a hidden backdrop to products but at the forefront of corporate image making. National and international corporations compete to be associated with the ‘magical’ powers and achievements of science (see Box 1.1). Never mind the tensions between magic, myth, miracles

Box 1.1 An example of advertising of commercialized science: DuPont 2006

'The miracle of science: science at work'
- Nourished by science—food
- Structured by science—materials
- Protected by science—health
- Enhanced by science—colours
- Connected by science—communication

(seen at Geneva Airport, August 2006)

and science—the image maker simply ignores the Enlightenment tradition of demystification of nature, and happily mystifies science with the 'miracle'.

Economists consider 'intangible assets and investments' and refer to the efforts on R&D and the management of markets. An increasing amount of expertise and effort is spent to decode market signals and to inform and guide the demand for new knowledge products.

Under the 'principle of relative constancy', advertising expenditure closely follows the economic cycle, but expands faster in good times and contracts faster in bad times. Overall, it remains a relatively constant national parameter over longer periods of time, although there is faster growth of advertising than of gross domestic product (GDP) in Asian countries (see Chang and Chan-Olmsted 2005). If the claims about the 'knowledge economy' with increasing proportions of high-tech industry and services are true, and if the principle of relative constancy of advertising is valid, it follows that the relative and absolute amount of advertising spent on knowledge-intensive products will increase with economic growth.

Increasing amounts of advertising money will go into the marketing of ideas and products and the image making of ideas producers. Global advertising expenditure is already about half the size of R&D expenditure. In 2005, when the world's advertising spending was US$385 billion, OECD countries spent about US$650 billion on R&D. US advertising per head is about three times that of EU countries. In the UK, overall advertising expenditure is 1.4% of GDP, while R&D is just under 2%; in the US, 2.4% of GDP goes into marketing and 2.8% into R&D (OECD 2004); Japan spends 1.2% of its GDP on advertising and over 3% on R&D. Much of this expenditure will shift from mass to high-tech products and services as the sectors become more knowledge intensive. In the 1980s, Italian high-tech industries spent between one tenth and one third as much as they spent on R&D to market their products (see OECD 1992: 114 ff). Even if this proportion stays the same (and it is likely to increase with competition), the total amount of knowledge advertising will expand with the expanding high-tech sector. The internet hype and stock market bubble of the late 1990s is just a recent example of more to come.

The ever closer association of markets and scientific research is likely to lead to a clash of ethos. Scientific activity is normatively oriented towards ‘objective truth claims’, while entrepreneurialism and its marketing logic are oriented towards market attention and the bottom line of returns—‘true’ is what pays off. The public intellectual and the private entrepreneur, who both might be scientists, each follow a different logic.

The logic of the market calls for professional marketing, public relations and image management. This poses a challenge to science communication, which increasingly turns itself into ‘science public relations’ (see Bauer and Bucchi 2007). This is not an entirely novel observation (Nelkin 1987), but the transition has gained a critical mass in the past 20 years.

For the marketers of ideas, the hype and sensationalism deplored by traditional science communicators are not disqualifications but normal tools to market a product. Hyperbole is a calculated trope to manage the attention and expectations of a market; building sustainable customer relations is a way of designing the hearts and minds of the public and bringing about the right conditions for new ideas to diffuse in a context of global competition (some academics invent here a sociology of expectations; see Brown and Michael 2002).

I recently came across two small pamphlets, which I made compulsory reading for my students. They explore some implications of the extension of a market logic to everything under the sun. The titles speak for themselves: *Innocent fraud* and *On bullshit*. The pamphlets pinpoint potential risks also for science communication.

1.1.2 Risk 1: Innocent Fraud

The last pen-stroke of Galbraith (2004), the American economist and commentator on public affairs, goes by the title *Innocent fraud*. Galbraith is uneasy over the fact that corporate power has become overwhelming and politically uncontrollable, and this manifests itself in an Orwellian newspeak (e.g. ‘market system’ for ‘capitalism’) and the erosion of the critical powers of language. In a culture that celebrates the pursuit of self-interest over everything else, this trend leads to a loss of clarity about what constitutes ‘fraud’ and a loss of public control. Without moral boundaries, enterprising fraud is ‘innocent’, the fraudster cannot be called to account, and impunity reigns. The only responsibility of marketers is to themselves, as long as shareholders and stock investments are being served in the short run.

Galbraith did not have scientific research in mind when he made these observations. More likely, he was thinking of the creative accounting at ENRON and other recent scandals of high-octane capitalism. But some recent scientific frauds might suggest a similar dynamic. Is there a pernicious influence of commercial interests undermining the integrity of the scientific research?

However, there is little evidence of increased fraud in scientific research beyond the high profile of a few cases, which might exaggerate the problem.[2] The problem of defining misconduct (faking, withholding data, plagiarizing, hiding methods, chopping up research into the smallest publishable units, and so on) and the tendency of institutions to avoid complex investigations complicate the collection of reliable statistics.[3] However, in a survey of US National Institutes of Health researchers, one in six admitted to having changed their research design or methodology in response to pressure from their funding source.[4] Scientific fraud is rare, probably underreported, and most prevalent in the biomedical sciences because of their high stakes in private money, public hope and personal glory.

1.1.3 Risk 2: More Bullshit

The second pamphlet of interest was written by Frankfurt (2005), a moral philosopher, who titled it *On bullshit*. 'Bullshit' is a rather rude English word, which Frankfurt uses purposefully to underline a serious problem. The text reprints a lecture given to a student society back in 1986, but which resonates more clearly with the current Zeitgeist. The pamphlet is an example of what scientometricians call a 'sleeping beauty': no impact when published, huge impact years later.

Frankfurt's argument distinguishes 'bullshitting' from 'lying' on the basis of the care for truth-value. The act of lying, morally dubious as it is, remains intricately tied up with the 'truth' which the liar tries to hide from an interlocutor, either for good reasons (a 'white lie') or for bad or selfish reasons. The liar consciously misrepresents the truth. By contrast the bullshitter ignores the value of truth; they do not care about truth, perhaps because they never did. The bullshitter is cynical to the extent that they have given up any belief in truth as a regulatory social idea.

Frankfurt distinguishes the lie from bullshit like this: '[T]he motive guiding and controlling it [the bullshit] is unconcerned with how the things about which he speaks truly are' (Frankfurt 2005: 55). He then identifies social trends that favour bullshitting in modern societies:

- The multiplication of situations that oblige people to speak about topics beyond their knowledge, for example in politics and in professional communication
- The need to opine on everything
- The inflation of knowledge claims, which engenders forms of unspecific scepticism that undermine a residual belief in 'an objective reality'
- The shift in the evaluation of public speech from an ideal of 'correctness' to one of 'authenticity' (no matter whether a claim is true, if only it is believed sincerely)

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[2] See *Nature Biotechnology*, 24(7), July 2006, 745 ff.

[3] See *Nature*, 445, 25 January 2007, 240 ff.

[4] See *Nature*, 445, 25 January 2007, 245.

Privatized knowledge production will necessitate professional marketing, and this is already changing the way science is publicly communicated globally. First signs in this direction are difficult to ignore. Box 1.2 lists the range of activities that make science into public events and displays and go beyond the traditional activities of science writing. While the evidence for fraud as a consequence of commercialization is inconclusive, the evidence for increasing 'bullshit' is more convincing (Box 1.3).

This is a slow trend and difficult to detect. Public patronage of science favours the 're-feudalization' (Habermas 1962) of the public of science: 'representation' and show in the arena rather than argumentation at the forum; global empires rather than republics of science. This will affect scientific information by accumulating small shifts in activity and ethos, slowly but decisively.

Public vigilance and debate are urgently required. How will the public sustain a critical conversation when scientific information is leaning heavily towards

Box 1.2 Trends in science communication activities

1. Knowledge product marketing via corporate image and myth making
2. Rehearsal of conflict between 'tool makers' and 'salesmen'
3. Professionalization and differentiation: media journalism, public relations (PR), dialogue experts
4. Conferences and congresses become trade shows for sponsors
5. Product placement with doctors and researchers (presents and perks for doctors)
6. Scientific event making: AAAS, British Association for the Advancement of Science, science festivals as annual events
7. Defence secrecy replaced by corporate secrecy (pre-patent)
8. New developments as event management (e.g. Human Genome Project)
9. Centralized PR in scientific institutions: 'everybody goes on message'
10. Professional media officers at every research laboratory
11. Newsmaking for stock market: conflicts over 'hype' between PR and the lab
12. Truth-by-press-conference to short-cut peer review: not only 'cold fusion'
13. Decline of independent journalism: infotainment and precarious freelancing
14. Science writers make a lucrative career move into PR
15. Science news production increasingly depends on PR sourcing
16. Selective publication: knowledge remains 'private secret' until patented
17. Methodology becomes 'private capital' rather than public auditing
18. Universities set up 'cinema liaison officers'; high-tech by Hollywood
19. Scandalization: fraud = news value; 'bringing down a scientist' a career high

Box 1.3 From conflicts of interest to fraud

Whistleblower loses job

Consider the case of a British whistleblower who lost his job upon calling the bluff of the corporate communications officer. Andrew Millar was a laboratory bench scientist working at British Biotech, then a relatively new and striving biotechnology company. Millar told the public and thus shareholders that a particular line of drug research by his company had little chance of success. He was fired and described as 'ill-informed and irresponsible', sued for the disclosure of confidential information, and smeared in public. Later, British Biotech lost the court case and had to pay out £500,000 in damages (*Guardian*, 19 June 1999, p. 26).

The centralization of communication

The rector of the University of Hamburg has decreed that all public statements on science policy emanating from the university should go through the press office to avoid confusing the public. This policy has been considered by some academics, not least those in political science, to contravene the principle of free speech in and out of university (*FAZ*, 108, 10 May 2007, p. 10).

Do people prefer GM corn?

This is clearly a question open to test. A consumer experiment offered both conventional and genetically modified (GM) corn in a farm store. Consumers preferred the GM version, which they were 50% more likely to choose (Powell et al. 2003). After the paper was published, a controversy arose over the experimental conditions: the two varieties were apparently labelled in a way that was 'leading' the experimental results by setting up a demand characteristic. Conventional maize was apparently labelled '*Would you eat wormy sweet corn?*', while the GM variety was labelled '*Here's what went into producing quality sweet corn*' (followed by a list of chemicals). This information on product labelling was omitted from the paper and emerged only afterwards from witness accounts. Subsequent calls, for example by the British Soil Association and Professor Jennings, a research ethicist of Cambridge University, to withdraw the paper were rejected but featured in a debate in the journal that published the original material. The controversy continues (see *New Scientist*, 27 May 2006; *Private Eye*, 28 September 2007). GM activists on the case are apparently facing threats of a SLAPP action (strategic law suit against public participation). An alleged photo of the labels in the store where the experiment took place can be found at http://www.gmwatch.org/p1temp.asp?pid = 72&page = 1

The elusive stem cell lines of Professor Hwang Woo-Suk

Consider the case of the Korean stem-cell researcher Hwang Woo-Suk, whose two 'revolutionary' papers in *Science* had to be retracted in early 2000 when it became clear that most of his 'revolutionary' data were fabricated.

(continued)

Box 1.3 (continued)

Was this a case of an isolated individual failing? Or is there systemic pressure at work to take risks and fake data because the gains are very high, whereas the likelihood of being detected is very low? Are there not pressures of national and international competition to succeed at all costs and to justify the resources invested?

Failure is no longer a corrective. The system of late-modern research includes intensified competition, concentration of publication efforts on a narrow range of top journals and societal expectations of results, which might encourage misconduct (Kim 2007, Franzen et al. 2007, Greenberg 2007). Krimsky (2003) argues that biomedical research is particularly prone to 'corruption' when facing a conflict of public and private interests because of the erosion of independent public expertise.

advertising, strategic public relations and propaganda in the service of private interests? Where can we find the vestiges of a sceptical public to sustain the vigilance needed to the call the bluff on fraud and high-tech snake oil? The source of quackery is no longer outside science: it is high-octane science itself.[5]

1.2 The Social Locations of 'Critical Attitudes'

In the citation from a recent student essay at the beginning of this chapter, I recognise promising elements of an attitude we need when facing the trends and risks I have outlined. 'Do the promises of these developments fully live up to their expectations?' this young woman from Turkey asks. That science and technology automatically deliver the common good of society is no longer taken for granted.

Modernism equates S&T with 'progress' in the world. This engenders a messianism that expects S&T to deliver the solutions to all the world's problems. Hunger, misery, inequality, war, moral conflict—all the world's evils will be eradicated by the unconstrained deployment of science to increase food production, boost productivity to create income for redistribution or consumption, expand communications technologies, and even recognise the evolutionary basis of morality and ethics.

This view is that science discovers the laws of nature, technology applies them to practical ends, and the social sciences make sure that those solutions are accepted

[5] This was a very interesting side remark made by Steven and Hilary Rose during their Annual BIOS lecture given at the London School of Economics in 2007.

and replace the old ones. It is not clear whether this 'linear model' ever was a valid description or just good rhetoric for political expediency (see Krige 2005).

Modern science is bound up with technical infrastructure: there is no subatomic physics without supercollider installations, no astronomy without high-tech telescopes, no genetic engineering without gene sequencers, no nanotechnology without lasers, no brain research without magnetic visualization techniques, and probably none of these research activities without high-powered computers. Science and technology are intimately linked up at their shared frontier, which is marked by the term 'technoscience'. The technological hold on the world is hegemonic. In technology, globalization is already achieved. There are few corners of the world without electricity, telephones or motor cars. Clearly, these are achievements on a large scale, but the student's question remains: has all this lived up to expectations?

After a successful past with only ineffective challenges from the fringes of modernism (Sieferle 1984, Touraine 1995), the equation 'Science + Technology = Progress' has now become dubious. Science and technology no longer produce societal progress automatically. Several benchmarks have developed since the 1970s to assess whether scientific achievements constitute 'real' progress. Each of the benchmarks is associated with social actors and social movements who sponsor the doubts, resist developments and ask the burning questions, and thus bring S&T under public scrutiny. Individually and combined, they call into question the autonomy of science: science, like other societal activities, is accountable for its consequences. The consumer movement puts product safety on the agenda. Environmentalism brings the old idea of conservation into the mainstream and commits everybody to sustainable development. Fairness and equity are written on the banners of the antiglobalization and world development activists. Traditional religions reassert statements of human dignity, morality and ethics. Philosophical 'Kulturkritik' renews the allegation of a reification of nature, others and self. And finally, economists conclude that 'science is too important to leave to the scientists'.

These benchmarks have willy-nilly hastened private patronage and will do so in the future. The loss of autonomy in scientific practice is both a part of the problem and part of the solution. There is a loop of mutual reinforcement: critical publics demand accountability; this challenges the autonomy of science, undermines public patronage and strengthens private patronage and the commercialization of science communication; in turn, this requires increased public vigilance to mitigate the risks of fraud and bullshit.

1.2.1 Historical Variation in Public Attitudes

My research on long-term trends in science communication in the UK (and also by colleagues in Bulgaria and Italy) shows that annual science reportage can be taken as an index of the changing public discourse of S&T. We observed that

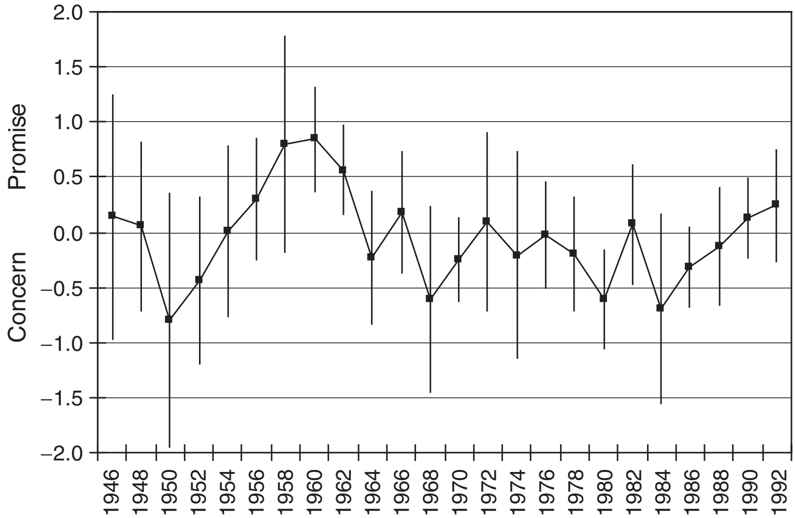

Fig. 1.1 The evaluation of science in the UK press, 1946 to 1992: The figure shows the fluctuations of annual averages, (+/–1 SD). The discourse of individual articles is rated on a 5-point scale between 'overwhelming promise' and 'serious concerns' (N = 6,083). The data source is Bauer et al. (1995)

between 1946 and 1992 the intensity of science coverage and its slant varied (see Fig. 1.1). The intensity of the public conversation about science peaked in the early 1960s in the UK and probably elsewhere; it declined into the 1970s but has picked up again since then. This cycle has been evident in the elite as well as the popular press, but has been clearer in the former (see Bauer et al. 2006, Bucchi and Mazzolini 2007).

The evaluation of science in this public conversation is tied to an intensity cycle (not shown here): science coverage increased until 1962, then declined into the mid-1970s, and recovered through the 1980s and into the 1990s. Depending on whether one weights the absolute intensity in relation to overall news space, which increased considerably since the 1950s, the peak of 1962 is regained in the 1990s or it is not, but the phases remain (Bauer et al. 2006).

Figure 1.1 shows the 'evaluation' of science in the UK press. The line of moving averages shows two phases of something close to an irregular cycle: more negative coverage into the 1950s, recovering positive coverage in the later 1950s and into the 1960s, more negative coverage again into the 1970s until the early 1980s (although with erratic ups and downs in the 1970s). Positive coverage expands in the 1980s to reach the levels of 1946 again (the data stream ends in 1992—an issue of funding). The critical climate for science in the semiosphere, which the mass media create around us, is clearly a variable, and this should be an invitation to think about what makes and breaks the climate of mass mediation.

1.2.2 Public Attitudes and the Life Cycle of New Ideas

Haldane, an eminent British biologist of the interwar years, made a suggestion that is widely echoed in recent discussions and which one might call the 'Haldane Principle': 'Biological invention… tends to begin as a perversion and end as a ritual supported by unquestioned beliefs and prejudices' (Haldane 1925: 49). Haldane sees a natural cycle in public controversies over biological innovations: what starts with an initial outcry of disgust (the 'yuk' factor) ends as taken-for-granted common sense, with no questions asked.

My research on biotechnology and public opinion and debate sits uneasily with such a model. Figure 1.2 shows three data streams of public opinion in the UK since the early 1970s: the intensity of coverage reached a peak in 1999, with over 1,600 references to 'biotechnology' in a single news outlet. The evaluation of biotechnology shows the initial hype in the early 1980s. The tone sobered in the 1990s, and became erratic after the 'watershed' years of 1996 and 1997, with the controversies over GM crops and foods and the cloning of animals leading into the stem-cell debates. The poll responses express a general optimism about biotechnology

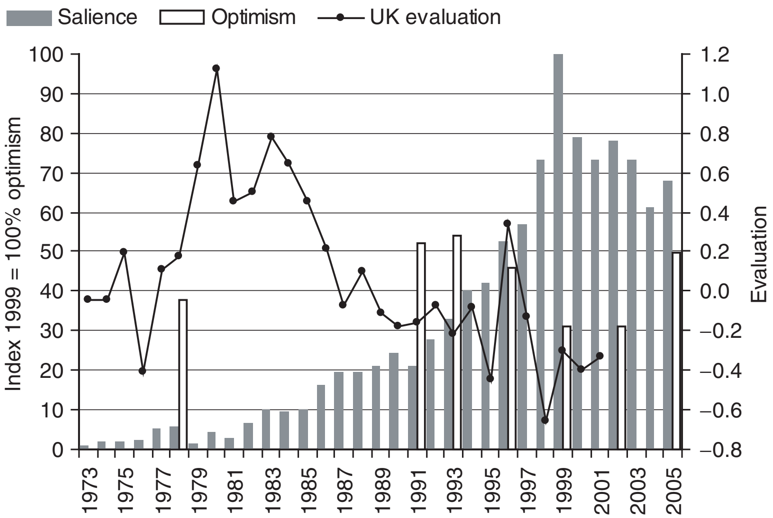

Fig. 1.2 Biotechnology and the British public, 1973 to 2002: The figure shows the rise and later fall in salience, the cycle of evaluation in the press, and changing public optimism about biotechnology in opinion surveys for the UK. Salience (the dark bars) is indexed to 100 in 1999, when 1,666 articles on biotechnology were published in a single quality newspaper source (left scale). The index of evaluation (the line) shows the deviation from the long-term slightly positive average: low figures indicate evaluations more negative, positive figures indicate evaluations more positive than average (right scale: mean = 0; SD = 1). The white bars give the percentage of UK respondents who declared optimistic expectations about biotechnology when asked in 1978, 1991, 1993, 1996, 1999, 2002 and 2005 (left scale). The graphic is updated from Bauer (2007)

('Biotechnology will improve our lives in the next 25 years', as in Eurobarometer; see Bauer 2007). Public optimism increased into the 1990s and later declined amid the public controversy over GM food and human cloning in the late 1990s. These data streams suggest that, in contrast to a cycle from initial disgust to everyday acceptance, nowadays the initial hype is followed by controversy and more sober public attitudes.

1.2.3 The Latest Evidence: a Mature Scientific Culture

The European Community has for some years conducted representative surveys of the populations of EU Member States on the public understanding of science. The surveys ask adults questions about scientific literacy, their interest in science, and various items expressing attitudes to science.

For example, respondents' 'agree' or 'disagree' answers to the statement 'Science and technology can sort out any problem' are a good indicator of an attitude that invests science with confidence and the power to solve the world's problems. In January 2005, 500 people in 32 European countries (including Turkey) were asked this question, and the result shows wide variations between countries. In Turkey 12% and in Italy 31% disagreed with this claim, while in Sweden, Switzerland and the Netherlands disagreement reached 80%. Disagreement is taken as an expression of a 'sceptical attitude'. By combining several claims about science, we create an index of the scientific 'ideology' that is normally distributed: the omnipotence of science, the control of side effects, the provision of a complete world picture, and the rejection of any constraints (see Appendix 1.1 at the end of this chapter). These claims amount to a modernist myth of science (see Ziman 1995), a confident worldview that grants science a privileged epistemic and moral status that affords no constraints outside itself.

Most surveys of the public understanding of science are designed to track science literacy, and to demonstrate that knowledge is a driver of positive attitudes. This has come to be known as the 'deficit model' of public understanding of science: the more you know of science, the more you love it. My analysis, however, shows that the real story is different—a nice case of falsification of a widely held belief.

Equally knowledgeable and interested, women tend to be more sceptical than men, and so are people who are generally more knowledgeable and the older population. Those who are very interested in science tend to be less sceptical. Curiously (and seemingly contradictory), people who see a role for science in the economy, for technological innovation to develop industry and to improve the environment, are more sceptical on the ideological tenets of science.

Plotting belief in ideology and the perception of the societal relevance of science (Fig. 1.3) allows us to profile different 'scientific cultures' among European countries (at least in a very preliminary terms) into:

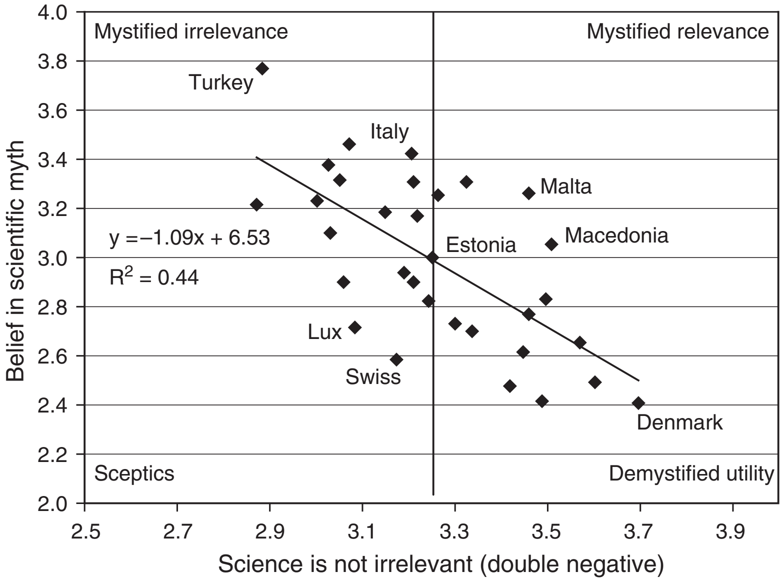

Fig. 1.3 Scientific ideology and the societal relevance of science: The figure plots the values for 32 European countries on two dimensions. The Y-axis shows the average score on 'scientific ideology', the expressed belief in the modern scientific myth. The X-axis shows the average disagreement on several items, such as 'Science and technology does not play an important role in industrial development'. The data source is Eurobarometer 63.1 of 2005 (data analysis by myself)

- *Sceptics* who are critical on both accounts (such as the Swiss and the Luxembourgeois)
- Those who mainly see science in a '*mystical*' light, far removed from real-world issues (such as the Turkish and to some extent the Italians)
- Those for whom science is highly *relevant* but who are also *mystified* by ideological claims (such as the Macedonians or the Maltese)
- Those who mainly see science as a *demystified utility* (such as the Danes)
- This pattern of correlations shows that different types of attitudes, ideological and utilitarian, combine into cultural patterns that deserve a closer examination.

Third, we must consider public attitudes a part of the 'general climate of opinion'—the scientific culture of a country. Patent applications and scientific publications are indicators of countries' scientific productivity. My data show that scientific literacy increases with national scientific productivity (Fig. 1.4): the more patents a country produces (on a logarithmic scale), the higher is its scientific literacy. The correlation across Europe is high ($r = 0.75$; $n = 32$). However, belief in the scientific ideology declines with higher knowledge and higher scientific productivity. Respondents in scientifically more productive countries distance themselves from the idea that

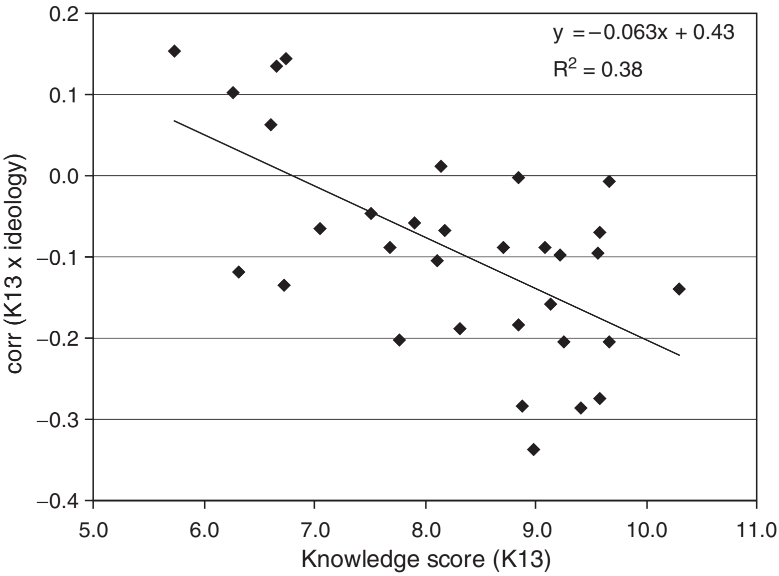

Fig. 1.4 Aggregate level of literacy and the association between individual literacy and scientific ideology: The X-axis shows the aggregate level of literacy; the Y-axis shows the correlation between individual literacy and scientific ideology. Literacy is measured on the basis of 13 quiz items. The data source is Eurobarometer 63.1 of 2005 (analysis by the author)

'science can solve all the world's problems' or that 'science will one day produce a complete picture of nature and the cosmos'. The correlation between this belief and scientific productivity is clearly negative ($r = -0.82$; $n = 32$).

My analysis shows that literacy and scientific ideology are negatively correlated in most countries, and the higher scientific literacy and scientific productivity the more likely knowledgeable citizens will reject a scientific ideology. Only in a small number of countries at the lower end of the literacy scale do knowledge and ideology have a positive correlation. In all other contexts, this relationship is negative, and the more negative, the more scientifically literate the society has become. The 'deficit concept' of public understanding of science is falsified: the more we know the science, the less we love it (at least in the terms of the modernist ideology). Higher science literacy and a sceptical atmosphere come with higher scientific productivity. Note that this observation is only of an association; any causal claim requires further analysis.

This analysis suggests that a highly productive scientific culture does away with some ideological tenets of science. The coexistence of public scepticism and productive research is not only desirable, but already the reality in some places. We must celebrate this as an asset and not deplore it as a liability or a deficit. A critical public opinion is not suffering a 'deficit of literacy or appreciation', and a critical public is not a problem but an asset, the value of which remains to be determined.

These observations on knowledge, interest and attitudes have implications for a concept of ‘scientific culture’. We need to consider the changing empirical relationship between variables, and go beyond normative assumptions like those of the deficit model of public understanding of science. It seems that late-modern scientific culture might well be a complex of high knowledge, sceptical attitudes and moderate interest (see Shukla and Bauer 2007), and that these are part and parcel of a productive knowledge society.

1.3 Conclusion

I have argued that science communication faces new challenges, which arise from the commercialization of research under private patronage. This trend leads us away from science writing and journalism and into public relations. Science reportage turns increasingly into public event making for science. This entails specific risks of fraud and ‘bullshit’ in public communication. While the evidence on scientific misconduct is not conclusive, the proliferation of hype and ‘bullshit’ in science communication is evident and worrying.

In this changing context, a sceptical public is highly desirable. This is, however, contrary to the traditional missions of science communication, which are to promote public scientific literacy and a positive image of science and to generate public acceptance of new technology. But a sceptical public is necessary to compensate for the proliferation of exaggerated claims, hype and ‘bullshit’ on high-tech ideas and products, so the traditional mission statement seems out of date. The knowledge society needs a public with critical attitudes, as the consumer society needs consumers with a consumer consciousness. This attitude is necessary but not sufficient to increase vigilance. It needs to be cultivated, maintained, mobilized, invested, amplified and made to resonate by competent social actors. The various social movements that set the benchmarks for societal progress have an eminent role to play here.

Sceptical attitudes to science are more likely among literate women, the older, and the more knowledgeable in general, while strong interest in S&T news ‘immunizes’ against a healthy scepticism. I have demonstrated that attitudes to science are not a historical constant; nor are they following a ‘natural’ cycle from initial disgust to subsequent acceptance. The real path is rather one of initial hype that gives way to a more sober assessment.

The rejection of the tenets of a modernist ideology of science varies across Europe as a function of economic development, scientific literacy and scientific productivity. On a continuum of levels of scientific literacy, the association between high knowledge and ideological attitudes is increasingly negative. The idea that ‘the more you know, the more you love it’ is no longer valid. In scientifically highly productive contexts, familiarity might well breed contempt, or at least discontent. Sceptical attitudes towards science go hand in hand with a utilitarian assessment of its importance for society. A mature science culture is a complex of high literacy, sceptical but utilitarian attitudes, and moderate interest. Patterns of attitudes allow us to characterise diverse cultures of science in Europe.

A sceptical public that is not awestruck by the new displays of science is a necessity for knowledge societies. A sceptical public is, after all, the democratized scientific attitude, the ethos of organized scepticism vested in a literate public (Merton 1973). Sceptical public attitudes counteract social pressures towards conformity and obedience to authority, including that of the technological fait accompli (Bauer 2008). Scientific knowledge is different from toothpaste, perfumes and washing powder, and the public communication of science ought not, but nevertheless increasingly does, follow the same logic as washing powder marketing and image making.

By cultivating public conversations that are highly scientifically literate, but also highly sceptical of the hyperbolic claims of professional knowledge marketers, we might end up with the kind of S&T that is universally desirable: a 'common good' that is safe, distributed justly, morally sound and dignifying, and environmentally sustainable. However, on the way to this desirable world of 'motherhood and apple pie', we might have to face some dilemmas and controversies. The community of science communicators might recognise here its new mission: to empower public opinion to recognise the exaggerated claims of private knowledge marketing.

Appendix 1.1

Eurobarometer A survey instrument of the EU. In January 2005, conducted a representative survey of public perceptions of science in all EU countries and candidate countries, including Turkey ($n = 32{,}000$). I chaired the expert group that constructed the survey instrument in 2004.

TRIAD Patent Families Per Million Population Patents filed in 2000 in the US, the EU and Japan. Patents have a close but not perfect link to innovation (some patents are of no use and many innovations are not patented). The natural logarithm (Ln) of TRIAD patents per million population is closely related to GDP per capita ($r = 0.80$), meaning that increased patenting is associated with decreasing returns in GDP per head. TRIAD also correlates highly with scientific production measured as publications per million population ($r = 0.86$).

Level of Knowledge (K13) A set of items on factual knowledge, the knowledge quiz. They are in the 'yes/no/ don't know' format, and have been used for many years to measure literacy in national sample surveys: 13 items in Eurobarometer 63.1 of 2005.

Ideology of Science A set of Likert type items (5-point scale; 1 = agree, 5 = disagree) using statements that indicate elements of an ideological view of science—a view that is idealistic and mythical. The original responses to these items were recoded so that high scores indicate agreement to the statements: Index = (a + b + c + d)/4: (M = 2.97, SD = 0.823; $n = 15{,}595$; Cronbach's alpha = 0.58).

- Omnipotence: ‘Science and technology can sort out any problem’.
- Control of side-effects: ‘New inventions will always be found to counteract any harmful consequences of scientific and technological developments’.
- World picture: ‘One day science will be able to give a complete picture of how nature and the universe work’.
- No constraints: ‘There should be no limits to what science is allowed to investigate’.

Interest in Science Respondents declaring that they are ‘very’ or ‘moderately’ interested in either new medical discoveries, environmental pollution, new inventions or new scientific discoveries.

References

Bauer, M. W. (2007). The public career of ‘genes’—Trends in public sentiment from 1946 to 2002. *New Genetics and Society*, *26(1)*, 29–46.

Bauer, M. W. (2008). The fait accompli and its social influence. *DIOGENE* (UNESCO), *217*, 68–83.

Bauer, M. W. & Bucchi, M. (Eds.) (2007). *Journalism, science and society: Science communication between news and public relations*. London: Routledge.

Bauer, M. W., Petkova, K., Boyadjieva, P. & Gornev, G. (2006). Long-term trends in the representations of science across the Iron Curtain: Britain and Bulgaria, 1946–95. *Social Studies of Science*, *36(1)*, 97–129.

Bauer, M.W. Ragnarsdottir, A., Rudolfsdottir, A. & Durant, J. (1995). *Science and technology in the British press, 1946–1992. A systematic content analysis*. London: Science Museum and Wellcome Trust.

Brown, N. & Michael, M. (2002). A sociology of expectations: Retrospecting prospects and prospecting retrospects. Retrieved on 8 October 2007 from http://www.york.ac.uk/org/satsu/OnLinePapers/NB/Brown,%20N.PDF.

Bucchi, M. & Mazzolini, R. G. (2007). Big science, little news: Science coverage in the Italian daily press, 1946–2007. In M. W. Bauer & M. Bucchi (Eds.), *Journalism, science and society: Science communication between news and public relations*. London: Routledge, 53–70.

Chang, B. H. & Chan-Olmsted, S. M. (2005). Relative constancy of advertising spending. A cross-national examination of advertising expenditure and their determinants. *Gazette: The International Journal for Communication Studies*, *67(4)*, 339–357.

Eurobarometer 63.1 (2005). Europeans, Science and Technology, Brussels, DG Research.

Frankfurt, H. G. (2005). *On bullshit*. Princeton: Princeton University Press.

Franzen, M., Roedder, S. & Weingart, P. (2007). Fraud: Causes and culprits as perceived by science and the media. *EMBO Reports*, *8(1)*, 3–7.

Galbraith, J. K. (2004). *The economics of innocent fraud*. London: Penguin Books.

Greenberg, D. S. (2007). *Science for sale: The perils, rewards and delusions of campus capitalism*. Chicago: University of Chicago Press.

Habermas, J. (1962). *Strukturwandel der Oeffentlichkeit*. Frankfurt: Suhrkamp.

Haldane, J. B. S. (1925). *Daedalus, or science and the future*. London: Kegan & Co.

Kim, D.L. (2007). A study of Korea’s response to the prospect of stem cell technology: with reference to Hwang’s scandal. Unpublished graduate thesis, Department of Sociology, Yonsei University, July.

Krige, J. (2005). Critical reflections on the science–technology relationship. *Transactions of the Newcomen Society*, *76*, 259–269.

Krimsky, S. (2003). *Science in the private interest: How the lure of profits corrupted biomedical research*. Lanham: Rowman & Littlefield Publishers.
Merton, R. K. (1973). *The sociology of science: Theoretical and empirical investigations*. Chicago: Chicago University Press.
Mirowski, P. & Sent, E. M. (2005). The commercialization of science, and the response of STS. Draft version of chapter to appear in the *New Handbook of STS*. Cambridge MA, MIT Press.
Nelkin, D. (1987). *Selling science: How the press covers science and technology*. New York: W. H. Freeman.
Nowotny, H., Scott, P. & Gibbons, M. (2003). Mode 2 revisited. *Minerva*, *41*, 179–194.
OECD (Organisation for Economic Co-operation and Development) (1992). *Technology and the economy: The key relationships*. Paris: OECD.
OECD (Organisation for Economic Co-operation and Development) (2004). *Basic R&D statistics*. Paris: OECD.
Powell, D. A., Blaine, K., Morris, S. & Wilson, J. (2003). Agronomic and consumer considerations for Bt and conventional sweet-corn. *British Food Journal*, *105(10)*, 700–713.
Shukla, R. & Bauer, M. W. (2007). *The Science Culture Index (SCI)—Construction, validation and benchmarking across Europe and India*. London and Delhi: LSE and National Council of Applied Economic Research (.pdf available from authors).
Sieferle, R. P. (1984). *Fortschittsfeinde—Opposition gegen Technik und Industrie von der Romantik bis zur Gegenwart*. Munichen, Verlag C.H. Beck.
Tijssen, R. J. W. (2004). Is the commercialisation of scientific research affecting the production of public knowledge? *Research Policy*, 33, 709–733.
Touraine, A. (1995). The crisis of 'Progress'. In M. Bauer (Ed.), *Resistance to new technology—Nuclear power, information technology, biotechnology*. Cambridge: Cambridge University Press, 45–56.
Woolgar, S. (2004). Marketing ideas. *Economy and Society*, *33(4)*, 448–462.
Ziman, J. (1995). *Of one mind: The collectivisation of science*. Washington DC: American Institute of Physics.

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Chapter 2
European Trends in Science Communication

Michel Claessens(✉)

Abstract This chapter reports on current trends in science communication in Europe in the light of several recent studies by the European Commission. The author investigates why the European public's scientific knowledge, as measured by the surveys, has increased substantially over the past few years. He then reviews coverage of science in the European media and analyses the relationships between European scientists and journalists and recent trends in reportage. Noting that it has become harder to gain public acceptance of scientific and technological innovations in Europe, the author argues that the science–society dialogue is insufficiently developed because a genuine communication culture is lacking in the science and technology sector. This lack may hamper the advancement of the sector.

Keywords Science communication, science journalism, science and the media

2.1 Introduction

In Europe, recent scientific and technological developments in such areas as nuclear energy, GM (genetically modified) food and cloning have generated a lot of media coverage, public debates, political decisions—and even fights. This may create a general impression that the European public is losing confidence in science and technology (S&T). Some media have published reports about growing anti-science opinion in Europe.

Against this background, public opinion surveys (Eurobarometers) are carried out by the European Commission on a regular basis, with the most recent published in December 2007 (EC 2007a). Dedicated reports published in 1992, 2001 and 2005 show that science and technology are still valued positively in Europe. Citizens expect a lot from scientific progress. For example, more than 80% of Europeans are confident that scientific and technological progress will help to cure

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diseases such as AIDS, cancer and so on. Europeans put great trust in S&T: 87% agree that scientific and technological advances have improved their quality of life, and 77% believe that they will continue to do so for future generations. Europeans also want political decisions to rely more on experts' advice. Interest in S&T remains high (78% of citizens are very or moderately interested in new scientific discoveries), although it has decreased since 1992. The proportion of people who are 'very interested' in S&T issues has dropped significantly since then.

The S&T Eurobarometers include the following questions on S&T issues:

Here is a little quiz. For each of the following statements, please tell me if it is true or false. If you don't know, say so, and we will go on to the next one.

The Sun goes around the Earth
The centre of the Earth is very hot
The oxygen we breathe comes from plants
Radioactive milk can be made safe by boiling it
Electrons are smaller than atoms
The continents on which we live have been moving for millions of years and will continue to move in the future
It is the mother's genes that decide whether the baby is a boy or a girl
The earliest humans lived at the same time as the dinosaurs
Antibiotics kill viruses as well as bacteria
Lasers work by focusing sound waves
All radioactivity is man-made
Human beings, as we know them today, developed from earlier species of animals
It takes 1 month for the Earth to go around the Sun

Results of this knowledge quiz show that, for most statements, a majority answered correctly (see Fig. 2.1). The average proportion of correct answers reaches 66%, while that of wrong answers is quite low at 21%. However, one should not conclude from this that Europeans have a fairly good knowledge of scientific topics, as answering the quiz at random would give an average proportion of correct answers of 50%.

More interestingly, national averages show that there has been a clear rise in the number of correct answers to the quiz since 1992. This is the case in practically all countries surveyed.

This increase is one of the most stunning developments related to science in Europe. Since the previous surveys in 1992, 2001 and 2002, scientific knowledge, as measured by the surveys, has increased substantially in most European countries. Increases of over 15% have been observed in Luxembourg, Belgium, Greece, the Netherlands and Germany (see Fig. 2.2); among the new EU Member States, the Czech Republic and Slovenia show a 10% increase in only three years. Sweden achieved the highest rates of correct answers.

Further analysis of the Eurobarometer data confirms the overall trend towards higher scientific literacy in all European countries.[1]

[1] M. Bauer, London School of Economics, pers. comm., November 2007.

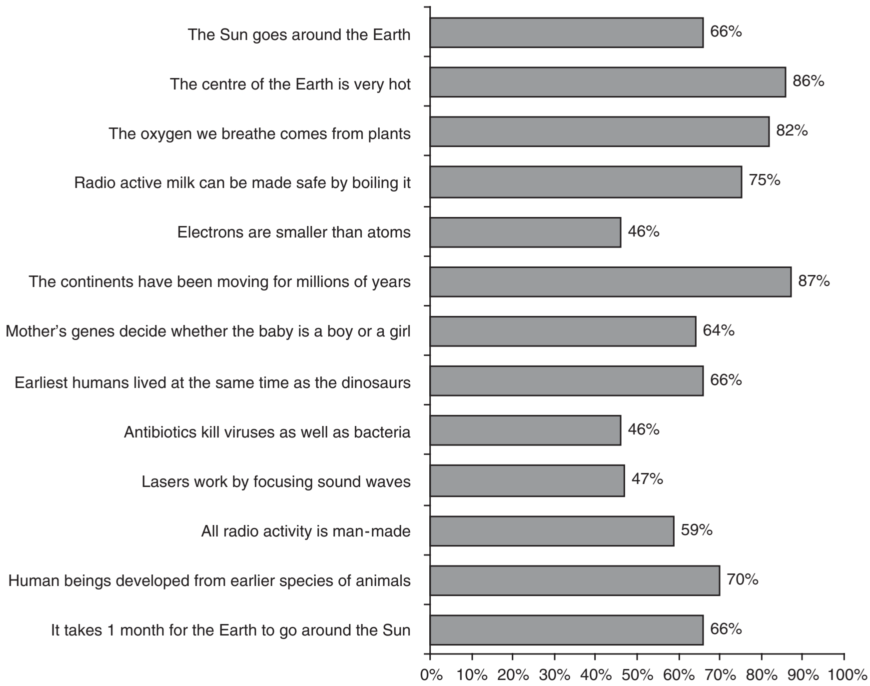

Fig. 2.1 Percentage of correct answers to the 13 questions in the Eurobarometer scientific quiz

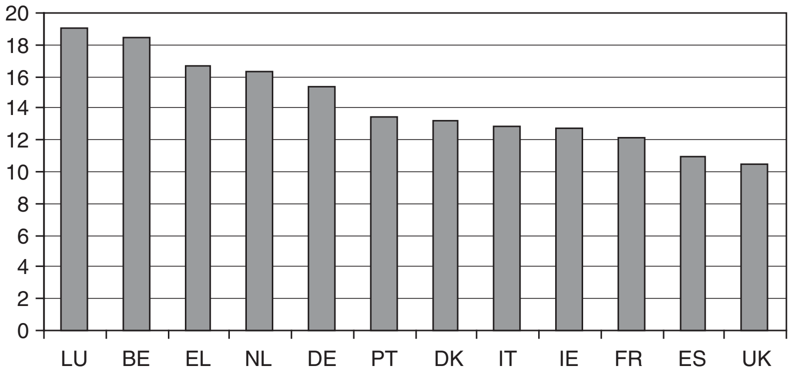

Fig. 2.2 Improvement in the percentage of correct answers to the Eurobarometer scientific quiz in 12 European countries, 1992 to 2005

There seems to be a contradiction here. While interest in S&T among Europeans is declining and Europeans claim to be poorly informed on the subject, their answers to a basic scientific knowledge test show improved results.

After the tsunami in 2005, the percentage of people who understand the movement of continents and tectonic plates seems to have risen by 20%. Analysing the slight improvement of the Japanese understanding of science between 1991 and 2001, Shimizu (2007) argues that the 1995 Kobe earthquake contributed to the public understanding of plate tectonics, but more so among non-college-educated people than among the college educated. On the same basis, one may argue that media coverage of recent crises in Europe (Chernobyl, mad cow disease, contaminated blood, avian flu, SARS, nuclear energy, GMOs, etc.) has brought many scientific and technological concepts and issues onto the public radar and has subsequently raised the overall public understanding of science in the EU countries.

For those who have left school, newspapers and magazines are an important source of information about S&T. It is therefore important to gain a better understanding of the role of the media as the public's sources of information about S&T.

2.2 Europeans and Science Information

The Directorate-General for Research of the European Commission launched a special Eurobarometer survey to explore the role that the media is playing as an interface in the science domain, helping to increase public support and understanding about the need to create a knowledge-based society. Face-to-face interviews were conducted in people's homes, in their national languages, between 10 April and 15 May 2007. The countries surveyed were the 27 EU Member States. The methodology used was that of the standard Eurobarometer polls managed by the European Commission's Directorate-General for Communication.

This recent poll (EC 2007a) shows that television is still the most popular medium for information. It also has the widest reach. Figure 2.3 shows aggregated percentages for sources of information about scientific research cited among either the first or second preferred sources. Traditional TV channels lead, with a total of 47% saying they would like to receive information about scientific research through that medium. Around a quarter of Europeans prefer thematic TV channels (27%), the specialized written press (26%) and the general written press (23%), while radio and the internet share about the same level of importance.

In 26 of the 27 countries, most people's first choice for information about scientific research is television. Only in the Netherlands would citizens turn to the specialized press first. Thematic TV channels are outstandingly more popular in Sweden than elsewhere in the EU, with a rating of 42% in the aggregated table. The specialized written press is not only the most preferred medium in the Netherlands (35%), but it also reaches high aggregated percentages in France (37%), Finland and Sweden (both 35%). As expected, the youngest respondents have the most favourable views about the internet.

The data show very clearly that there is a link between people's use and trust of different media sources. The ranking of media sources by usage and by the level of trust in them is the same.

Generally speaking, EU citizens are satisfied with the way the media provide information about scientific research (56%). Almost a quarter express dissatisfaction (24%), and exactly a fifth have no opinion on this matter (20%).

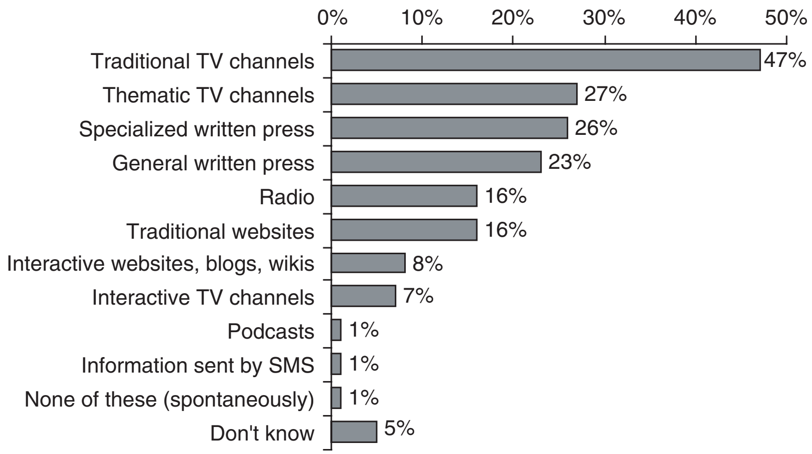

Fig. 2.3 Europeans' preferred sources of information about scientific research

The only country where the majority of respondents declare they are dissatisfied with the way the media treats this topic is Greece (53%). The 'don't know' rate is very high in several countries, reaching a maximum of 47% in Bulgaria.

The majority (50%) say that the space the media devotes to scientific research is sufficient. Around a third (31%) believe that the media does not give research enough importance. Only a few (4%) of respondents as a whole feel that the topic gets too much prominence.

Asked about content, most citizens across the EU have a generally positive view of the way news on scientific research is presented and consider it to be reliable (65%), objective (63%), useful (60%), varied (57%) and sufficiently visual (57%). At the same time, they also say it is difficult to understand (49%), far from their concerns (45%) and not entertaining (51%).

Questioned about what they wanted most in news on scientific research, a large proportion opt for ease of understanding (38%), information on the actual topic (37%) and usefulness. Reliability (29%), relevance to citizens' concerns and objectivity (both 20%) are ranked fourth to sixth. There is a need to improve the ease of understanding of scientific information in the media, as this aspect is the most important for people. Virtually one in every two respondents says scientific news is difficult to understand.

Most prefer that scientists (52%) rather than journalists (14%) present scientific information (Fig. 2.4). A striking finding of the survey is that one in five respondents replies spontaneously that they would like scientists and journalists to present scientific information together (20%). Europeans who prefer scientists as presenters argue that this approach is more trustworthy (61%) and results in more precise information being made available (60%). Objectivity is cited in third place (39%).

Europeans who prefer journalists to present scientific information mention most often the assumption that people would understand the content more easily (70%). Other reasons, such as objectivity (23%), usefulness in citizens' everyday life (19%) and diversity (18%), are cited significantly less often in this context.

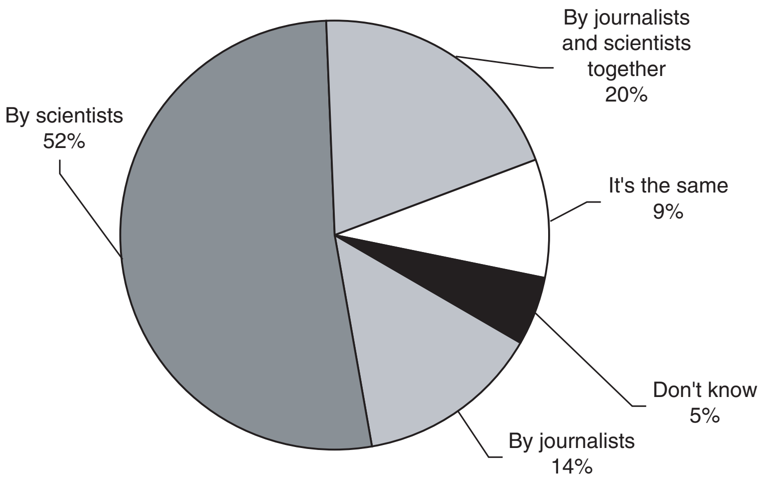

Fig. 2.4 Scientists vs. journalists as sources of information about scientific research

2.3 European Scientists and Communication

The increasing impact that science has come to have in society has paved the way in recent years for a more fluent dialogue between the scientific community and the general public. Because the EU is providing increasing funding to research and innovation, the Directorate-General for Research has decided to gain a detailed understanding of the issues, variables and constraints faced by European researchers when communicating with wider audiences (EC 2007b,c). To this end, in-depth telephone interviews were carried out with a sample of 100 researchers who have participated in projects funded by the European Commission's Research Framework Programme, based on the excellence of their scientific work. Researchers from all Member States and representing a broad spectrum of scientific fields were interviewed in order to adequately reflect different subgroups. The field work and data reporting were undertaken between the end of April and mid-June 2007.

Only 20% of scientists interviewed have an active relationship with the media, although most have been sporadically or very occasionally involved in some way in communicating to a wider audience. Those scientists who currently take an active role believe that it is their moral duty to do so. There appears to be a significant willingness to create dialogue and partnership with the media to achieve better coverage of science as the key to improving the public's perception of scientific culture and its benefits. Despite these good intentions, it is worrying that so few senior scientists are involved in explaining topics that are vital to everyday life, because the scientific community depends on outside support to allow it to continue to make significant advances that benefit society.

The survey shows that there is a clear misunderstanding between the media and the scientists. The great majority of scientists interviewed (just over 90%) recognise an obvious mismatch between what scientists want covered in the media and what media people regard as newsworthy. It seems that, for many scientists, explaining science in general and the scientific method are more important than the short-term dissemination of the results of their work. Although groundbreaking research results are likely to interest the media, there is great potential for scientists to be the interpreters of the day-to-day events that affect people's everyday lives, but that potential does not seem to have been fully harnessed by either side.

For a scientist to feel comfortable in the science–media dialogue, there is a need for trust between the scientist and the media contact. However, scientists believe that this trust is best achieved through face-to-face contact, which means that establishing it remains difficult. This suggests that to improve communication between scientists and the media there is a need to find a more immediate and feasible mechanism to allow trust to be established.

Scientists understand that the media have the power to influence the public, but also believe that the media have a responsibility to educate the public rather than simply respond to popular interest areas. Thus, according to scientists, the way to improve the coverage of science and the public's perception of science is for the media to be provided with the 'right' scientific messages and commit to disseminating them. The scientists show a lack of realism in their view that the media can perform a purely didactic role and are not driven by the need to attract viewers, readers and listeners by being responsive to their interests.

Scientists report that they are often discouraged by the barriers they face in their efforts to disseminate the results of their work more widely. According to a survey published in June 2006 by the Royal Society, 70% of UK scientists believe that 'funders of scientific research should help scientists to communicate with the non-specialist public' and 46% of them do not 'feel well equipped to engage with the non-specialist public' (Royal Society 2006). The goodwill shown by many is pushed to its limits by difficulties that to some extent stem from the lack of professional recognition for those scientists who are successful at communicating their work to the public. In a community that rewards specialist publications and does not emphasise the need for general communication, it is obvious that scientists lack funding to support specific communication measures and lack time to communicate. To compound these systemic barriers, there is a skills gap: scientists often find it difficult to find the right language to communicate to the wider audience.

Many scientists recognise that there is a fundamental difference of approach in media reporting and scientific reporting, and suggest that this leads to frustrations on both sides. A key issue is that the media are thought not to understand the basis of the scientific method or its culture, including the timescales required to achieve results and the fact that the results are then only valid until proved otherwise. If the focus of media interest were on scientists interpreting everyday occurrences, rather than purely on the release of research results, this would not be a barrier. However, it may be that some scientists are not reaching their potential because they believe that the public is not really interested in science.

It also seems that many researchers feel intimidated by TV broadcasting and are more comfortable with written media. If this apprehension is not dealt with through specific training, it will reduce the potential of science to reach wider audiences: TV has mass audiences, and visual images significantly aid comprehension.

Many researchers, particularly those from the 15 ‘old’ EU Member States, report that the fact that their work is funded by the EU generates little media interest, so they do not try hard to include the source of their funding in their communications. This situation is different in some of the smaller and newer Member States (in Eastern and Central Europe), where EU research funding is perceived as more newsworthy. In the older Member States, it is vital to adapt messages to the national context, for example by highlighting national benefits.

It is important to note that there are no significant differences in the views of scientists by nationality, but that there can be differences where scientists were previously working under a communist regime. In addition, age seems to be a factor. Scientists who have been working in former communist countries, as well as the older generation of scientists (those around the age of 60 + years), seem to be more distrustful of the media because they are very aware of sensation-seeking behaviour. In contrast, younger generations seem to be more open and are particularly aware of the force of the internet.

2.4 The Communication of Science: Born of Fashion?

Public understanding of science, science communication and the science–society dialogue are today major issues in Europe. They are on the agenda of virtually every meeting of the EU’s research ministers in Brussels. This prominence originates, at least in part, from reported low levels of scientific literacy and highly publicized resistance to S&T developments such as nuclear energy, stem cell research, cloning, GMOs and nanotechnology.

As a result, European scientists are now encouraged, urged and even obliged by research funders to communicate their research more effectively. Science communicators are now recognized and acknowledged by most research organizations as professionals and are expected to bridge the gap between the scientific community and the public, as summarized in the so-called ‘gradient model’ put forward by Hans-Peter Peters.[2] The model (see Fig. 2.5) assumes that, while there is a continuity of activities between scientific production and science popularization, there are also various constraints and obstacles (institutional, cultural, and so on) that make science communication difficult. As an example, when an astrophysicist refers to the ‘Big Bang’, he or she does not have in mind the same thing as the layperson.

Nevertheless, the gradient model implies that improving both the scientists’ communication skills and the public’s scientific literacy should allow a better science–society dialogue in Europe.

However, there are two sides to every coin. According to the study carried out by the Royal Society (2006), a quarter of the British scientists surveyed considered that popularizing science and engaging with the public had a negative impact on

[2] Pers. comm., January 2007.

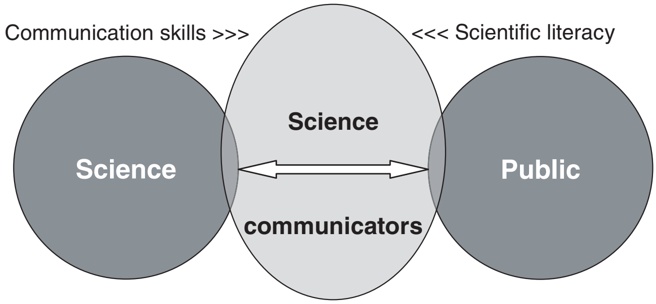

Fig. 2.5 The gradient model: bridging the gap between the scientific community and the public?

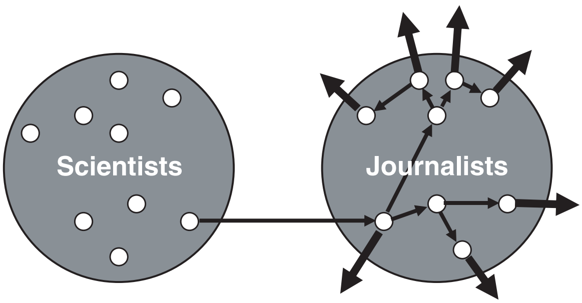

Fig. 2.6 The stellar model: a chain reaction develops in the media and 'enlightens' the public

their professional evolution. Moreover, as reported from the European Commission survey of researchers (EC 2007b), scientists too often see journalists as mere 'spokespersons'. They expect the media to just 'cut and paste' their words. As a result, scientists are keen to train themselves in science communication; they believe that this will enable them to 'package' their work in a form immediately digestible by journalists, hence discouraging detailed, in-depth investigations.

The real relationships between scientists and journalists are better described by a 'stellar model' (see Fig. 2.6). According to this model, a scientist responsible for a breakthrough will inform a few journalists, who will subsequently report on the achievements and, it is hoped, trigger a sort of chain reaction (journalists are keen to follow up each other's stories). In turn, this will send a lot of information to the public, who at the end of the process are expected to be 'enlightened'.

However, scientists should acknowledge the fact that the media follow their own rules on how to communicate, including on how to communicate science. For example, it is difficult to avoid the 'star' system in media coverage of science. On the other hand, one should expect to see at least as much reporting in the media on scientific 'stars' as on stars in football or in popular music.

Despite a growing interest among European scientists in science communication and media reporting, Europe still lacks a genuine communication culture between the scientific community and the public. While communication of every kind is on everyone's lips, we are still far from the genuinely 'intelligent' communication promised by the advent of the 'knowledge society'. Technologies—first and foremost the internet and the mobile phone—may be partly responsible for this paradox. Having pervasive 'means' of accessing and exchanging information creates the feeling that we are communicating better. While this is no doubt true in so far as society is spontaneously generating new and creative initiatives, much remains to be done when it comes to the various levels in established institutions and organizations.

Rather late in the day, the world of science is now also in the grip of this communication fever. If nothing else, there is certainly a demand for S&T information! The 2005 Eurobarometer established that very clearly: Europeans want information on S&T, they want to be involved and they want to participate in decisions. The information supply is growing, albeit timidly and not without ulterior motives coming into play. However, many scientists wrongly view communication as the magic wand that will remove at a stroke all the doubts people have about new S&T. Also, but in this case with good reason, effective science communication is seen as a means of attracting extra funding for research. Of course, the danger is that funds will go to the most effective communicators rather than to the most excellent researchers.

Scientists are encouraged or even obliged to inform audiences about what they are doing, but they also have an imperative to listen. Researchers these days must understand the social context within which they operate: what people worry about, what they expect or need from science, what they do not want in their lives. In short, the ivory tower is no longer an option.

Communicating is truly an imperative in a democracy, if one is to build trust and legitimacy for activities funded in great part by the public. It is also a simple question of common sense: there are so many exciting developments and the public should be informed about them.

In a report published in June 2007, EURAB, the research advisory body of the European Commission, encourages researchers to interact more with civil society and communicate science (EURAB 2007):

> Researchers should remain aware of how the actions of the past have generated negative public perceptions of research today (as in issues arising from nuclear energy, GMOs, pesticides) and that better dialogue with the public either directly or via the societal actors could have prevented much of the friction and lost potential innovative developments in these research fields.

To avoid lost opportunities and suspicion about R&D in the future, the report urges more societal engagement and open dialogue on emerging research fields, such as nanotechnology and therapeutic food additives.

As stated in the report:

> European publics are not questioning the scientific information as much as they are actually questioning the institutions generating it (a lost confidence in business, government and academia). Research is seen to be good when it solves problems and is relevant to people's lives—when research is useful to society, and not just in an economic sense. Too often though, researchers are perceived to be addressing issues that the public may not necessarily consider as beneficial to society. Researchers work in systems that are rational and instrumental, and have a tendency to assume that society behaves likewise. But society does not always behave rationally, and in certain sensitive areas, researchers should keep in mind that their systems operate in a public context.

References

EC (European Commission) (2007a). *Special Eurobarometer report: Scientific research in the media*. Brussels: European Commission.

EC (European Commission) (2007b). *European research in the media: The researcher's point of view*. Brussels: European Commission.

EC (European Commission) (2007c). *European research in the media: What do media professionals think?* Brussels: European Commission.

EURAB (European Research Advisory Board) (2007). *Research and societal engagement, final report*, 07.013, Brussels: EURAB.

Royal Society (2006). *Science communication—Survey of factors affecting science communication by scientists and engineers*. London: Royal Society. Retrieved from http://www.royalsoc.ac.uk/downloaddoc.asp?id = 3074

Shimizu, K. (2007). Japanese survey of the public understanding of science and technology: Review of results, impact and recent secondary analysis. Communication at the International Indicators of Science and the Public meeting organized by the Royal Society, 5–6 November 2007, London.

Further Reading

Bauer, M., Allum, N. & Miller, S. (2007). What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda. *Public Understanding of Science*, *16(1)*, 79–96.

Bodmer, W. (1985). *The public understanding of science*. London: The Royal Society.

Cheng, D., Metcalfe, J. & Schiele, B. (Eds.) in collaboration with Claessens, M., Gascoigne, T. & Shi, S. (2006). *At the human scale: International practices in science communication*. Beijing: Science Press.

Claessens, M. (Ed.) (2007). *Communicating European research 2005*. Utrecht: Springer.

EC (European Commission) (2002). *Report of the expert group benchmarking the promotion of RTD culture and the public understanding of science*. Brussels: European Commission.

EC (European Commission) (2005a). *Europeans, science and technology*. EUR 21722, Brussels: European Commission.

EC (European Commission) (2005b). *Social values, science and technology*. EUR 21721, Brussels: European Commission.

Okamoto, S., Niwa, F., Shimizu, K. & Sugiman, T. (2001). *The 2001 survey for public attitudes towards and understanding of science and technology in Japan, NISTEP report no. 72*, Tokyo: National Institute of Science and Technology Policy.

Stocklmayer, S., Gore, M. & Bryant, M. (Eds.) (2001). *Science communication in theory and practice*. Dordrecht: Kluwer, Academic.

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Chapter 3
Words and Figures of the Public: the Misunderstanding in Scientific Communication

Joëlle Le Marec[a](✉) and Igor Babou[b]

Abstract With the development of museums and centres of scientific and technological culture, research on their audiences and on visitors to exhibitions have multiplied. Studies of audiences' acceptance of science museums have long questioned the importance of prior scientific education, of the level of knowledge gained, of relative representations of a given subject, and of the visitor's familiarity with a particular area of science. However, there has never been any questioning of levels of knowledge of social, institutional and media models of communication, although that knowledge is constantly used by visitors. Visitors continue to give credit to science museums for being able to put them in contact with scientific spaces, even when a large part of what is being displayed evokes a space of advertising rhetoric and media communication. At the heart of popularization discourses and public debates about science and the different forms that its media coverage can take, the authors notice the recurring mobilization of an argument, or rather of a figure: that of the audience. They briefly present the three main forms this mobilization can take, show that public debate can itself be represented as a figure of discourse, and then draw out all the possible consequences of these invocations of the audience and question their meaning.

Keywords Debate and discourse on science, figures of the public, media, museums, popularization, public, television

In France, the 1980s were the starting point for an uninterrupted series of creations and renovations in the fields of museology and technological and scientific

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exhibitions.[1] Those transformations are of course deeply linked to the strengthening and the diversification of actors and structures involved in the transmission of science.[2] They also go hand in glove with the rise of a 'debate' about socio-scientific questions and the relationships between science and society (political debates, debates and controversies organized by the conventional media, calls for action, and protests by militant groups on many issues).

However, even if synthetic overviews of this open and complex 'milieu' of social communications about general sciences is extremely useful, we advance the idea that understanding the phenomenon of the audience for science requires us first and foremost to take an interest in the heterogeneous and differentiated character of that milieu. The institutional space of the museology of sciences is itself socially heterogeneous, and its heterogeneity is growing. We could choose to see in this space a positive dynamic process—a general encouragement of opening up, development and exchange. However, if we examine closely on the one hand the way the public reacts to this heterogeneity and on the other the expectations different actors in media productions about science have about the audience, we have no choice but to note a great misunderstanding.

There is a misunderstanding by visitors who want to play their role as the audience of science, and more generally of knowledge-transmitting institutions (it is imperative to know how to be a 'good' audience of the bodies producing science and views on science in order to develop a distinctive relationship to science). This misunderstanding concerns the many bodies which in their discourse on science invoke figures of the general public that have no basis in empirical reality, and more fundamentally are not based on a model that could be shared by those who are in a position to be an audience and those who are in a position to address the audience.

Our objective in this chapter is to discuss the tension between audiences' development of competence in criticizing the media, and the reinforcement of instrumentalization of communication by the media professionals: a naive conception inspired by the old model of communication as a transmission process proposed by Shannon and Weather in 1948.

Certainly, the borders marking social spaces are very porous; and current tendencies lean towards contesting differentiation principles on all spatial scales, both in

[1] Among these renovations and creations can be noted the opening of the first regional science and technology cultural centres; in 1986, the inauguration of the Cité des Sciences et de l'Industrie (the Science and Industry Centre); the renovation and opening of the Grande Galerie du Muséum (the Great Gallery of the Natural History Museum); the renovation of the national museum of technology; the renovation of some of the exhibition spaces of the Palais de la Découverte (science and industry museum in Paris); and, currently, the progressive renovation of some of the regional natural history museums.

[2] These include new statutory obligations for academic researchers; professional networks of scientific mediation; the mobilization of mainstream education movements through the actions of the Petits Débrouillards (Kids who know the ropes); the creation of scientific discussion groups; the Fête de la Science; and the creation of the Université de tous les savoirs (University of all knowledge).

the academic world and in the modes of organization and social action.[3] But 30 years of research into the practices and representations of visitors to science centres and museums has shown that audiences are constituted through the perception of the differences between social spaces—through strong awareness of the specificity of spaces (physical or symbolic) in which they exist as a 'public'. The more professionals attempting to organize social communications on science try to deny or to open frontiers by de-differentiating political, media or academic spaces, to 'break down barriers' and open up to a larger public, the more the invited audiences must use all their energy and skill to understand which space they find themselves in, who is speaking, who is acting, and in which temporal frame.

What empirical elements can we use to assert the reality of this phenomenon? What are its extent and its importance in the ensemble of observations on the changing relationships between science and society?

3.1 The Audience in Speech

With the development of museums and centres of scientific and technological culture, studies and research on the audiences of those centres and on the visitors to exhibitions have multiplied. The results observed within this framework were compared to work carried out on the cultural practices of the French,[4] on people's attitudes and opinions in regard to science,[5] on the production and reception of media discourses about science,[6] and on the social practices and communication linked to science.[7] We will not repeat here the numerous results that have been published and discussed; we will, however, take the time to recall a few, with the aid of which it will be possible to reflect on the importance of the effects of borders and of a

[3] With regard to the principles of distinction and division that structure French social space, Bourdieu has commented on the tendency to deny the existence of social classes while somewhat paradoxically affirming the existence of a very large middle class, and has shown that wherever homogenization is offered, while differences are present, they rest on a redistribution of the principles of division and distinction. In a completely different register, and with an opposite goal in mind, Laplantine tried to challenge the representation of cultures as greatly differentiated entities linked to physical territories, in order to focus more closely on the phenomena of crossbreeding, circulation and networking. This current in academic research, the seductive qualities of which are felt well beyond the field of anthropology and which claims an anti-conformist character, is nonetheless perfectly in sync with the promotion of de-differentiation principles held by actors of the construction of a globalized economic space.

[4] See further the surveys conducted by the Département Etudes et Prospective (the Department of Prospective Studies) of the Ministère de la Culture (Ministry of Culture): Donnat (1998, 2003).

[5] See Europeans, Science and Technology (2005, June). See also Boy, de Cheveigné and Galloux (2002).

[6] Babou (2004); see also de Cheveigné (2005).

[7] Schiele (2005); see also Royal Society (2006).

communication and media culture in the relationship of audiences to science and to cultural institutes of science and technology.

Visitors to scientific and technological exhibitions feel a sense of belonging to the audience in different ways. Here, we are not saying merely that there are not *one* but *several* audiences; in other words, that there is a diversity of different audiences. The academic and professional communities have reached consensus on that point. However, this concern to recognize the diversity of audiences misses an essential phenomenon: it reduces the complexity of the 'audience' element to a series of categories. Speaking of 'audiences' often amounts to designating a variety of categories, which obviously do not necessarily coincide with the sociodemographic categories of the census. For example, we can talk of audiences of young people, tourists, regular visitors, families, schoolchildren, workers, and so on.

Here the case is entirely different: there are several ways for visitors to feel that they are really members of an audience.

For example, in an exhibition on so-called 'socio-scientific' topics—in other words topics that essentially concern problems and debates that mobilize scientific arguments with important social consequences (such as environmental issues)—the visitor can undoubtedly feel that he belongs to the audience of the visited establishment, but can especially perceive himself as the audience of discourses that are widely dealt with in many social spaces, particularly in the classical media, such as the press and television. He is then confronted as a member of the audience not with his ignorance of science, but with his helplessness as a witness to all the standpoints and views displayed in all public speaking spaces.

But in an exhibition on topics that are obviously categories created by the scientists (a discipline, for example, or a truly scientific discovery or event), more than anything one can feel unscientific, an ignorant beneficiary of the act of transmission from those who know to one who does not know.[8] The visitor feels himself being in the institutional space of learned knowledge.

Depending on circumstances, the space identified by the visitor and in respect to which he situates himself is the general space of discourse, the place of the debate about sensitive socio-scientific topics (including the media), or the venue of popularization where she comes into contact with the scholarly world. What the visitor expects and the manner in which he takes a stand as a member of the audience vary greatly according to the space where he believes himself to be.

Thus, while visitors feel they are incompetent and have difficulty understanding a scientific exhibition at too difficult a level, it is rare for them to criticize the exhibition, saying rather that it was 'not for them' or that they did not 'feel at home' with it. Yet at an exhibition with a scientific theme which presents works of contemporary artists that they do not understand, visitors can express criticism and irritability, because in this case it is the works of art that are out of place ('We are not at Pompidou Centre here!').

[8] See Fouquier and Véron (1985).

Criticism is also expressed when other elements of the exhibition are manifestly out of place, as is the case in certain exhibitions co-produced with commercial partners that use the museum-related space to present products that are or will be on the market (technological innovations, for example). Conversely, criticism is not voiced about spaces expressly dedicated to commercial partners, no more than it is about clearly identifiable shops inside museums: the places can be adjacent under the same roof, but they nonetheless constitute very different spaces. It is the visibility of the boundary that makes this proximity acceptable. However, what is intolerable to visitors is the confusion when the exhibition space, as a cultural and institutional place, is taken over by outside agencies.

The importance of these boundaries is played down or even denied by many professional practitioners of institutional and cultural activities who would like to develop the opening up of scientific spaces, using intermingling and hybridization of genres when drawing up museographic discourses. Thus a growing number of communication professionals coming from different sectors play a part in the design teams and bring with them conceptions of culture, communication and audience that are in conflict with cultural, scientific or patrimonial principles. The logic behind opening up and hybridization also plays a role in production (there are numerous partners and a sharing of institutional territories) and in communication (different communication 'functions', such as reception, being subcontracted to professionals and companies).

Consequently, we are faced with a highly paradoxical situation: in the name of a policy of opening up and mixing genres that is thought to benefit the greater public, one develop productions that demand of visitors the increased mobilization of media culture and institutions, of a culture of communication and enunciative logic.

Studies on audiences' acceptance of science museums have long questioned the importance of prior scientific education, of the level of knowledge gained, of relative representations of a given subject, and of the visitor's familiarity with a particular area of science. This concern is especially obvious in the care taken to organize different levels of readings in exhibitions to take into account visitors' existing knowledge and representations. However, there has never been any question of levels of knowledge of social, institutional and media models of communication, although this knowledge is constantly used by visitors to situate themselves within heterogeneous enunciative *dispositifs*,[9] and visitors continue to give credit to science museums for their capacity to put them in contact with scientific spaces, even when a large part of what is being displayed evokes a space of advertising rhetoric

[9] An adequate English translation of this term, or rather concept, does not yet exist. When we talk about 'communication devices' or 'discursive devices', we are bearing in mind the Foucauldian idea of the communicational/discursive 'dispositif'. Quite frequently, however, we have either joined the term dispositif to the expression, or used it on its own, as it is the only word available that can encompass and convey all that we intend it to express. For a detailed explanation, see Foucault (1975).

and media communication. For visitors this knowledge is a requirement; their need for it is greater than their need to master actual scientific knowledge, because it conditions the possibility of existing as an audience.

For example, an exhibition on economics at the Cité des Sciences included a game, designed by financial partners, in which visitors made choices in their management of a budget. Some visitors identified a rhetoric imitating the didactic register, but clearly intended to promote behaviour favourable to banks and insurance companies. To maintain the credibility and trust they have in museums as institutions of legitimate scientific knowledge, visitors interpreted the presence of these elements in the exhibition as a concession made to the financial partners, since the development of a discourse in which these partners so overtly promoted themselves clearly showed that the museum could not be suspected of having 'hidden' it in the exhibition. This made it possible within the exhibition to distinguish a promotional space, about which the visitors did not feel concerned, from the institutional space they wished to continue to trust at all costs.

The effects of borders also play a role, not only in visits to the exhibition, but also in the surveys themselves. If visitors very willingly answer sociologists who ask them questions in museums, it is because the space where they find themselfs when answering is the same as the one in which they exist as the audience of an institution of scientific culture: a relationship with science and knowledge is at stake. On the other hand, in certain museums, service and product providers who are sometimes external to the museum space question audiences 'lent' by the museum to external studies and research organizations that conduct surveys.[10] Once again, such museums minimize the importance of the media and institutional knowledge of the visitors surveyed, and misunderstand what it means to be a member of the audience.

Studies and research projects therefore develop very detailed descriptions of certain characteristics of the public of science museums (attendance figures, structure of attendance, knowledge and representations of people whom the museum addresses), but do so using a model in which the relationship with the audience is linear, and which is significantly more simplistic than the model visitors create in order to establish their own relationship to the museum, to science, or to institutions. The data yielded by the studies are used by the museums to develop 'personalization' strategies; in this way, offers and services for very specific categories of the public are developed. Visitors also develop ideas of personalization, but from a reverse viewpoint. This means that personalization becomes the opposite of what it means in marketing—an adaptation of products and services to highly differentiated targets. What we refer to as *personalization* from the visitors' point of view, even if they never use the term, is rather the great attention paid to intentionality and the enunciative dimensions of

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[10] At the Cité des Sciences et de l'Industrie (City of Science and Industry), the LUTIN laboratory (UTC, Paris VII, Cité des Sciences, CNRS) carries out surveys on people recruited among the public in order to test technological innovations (concerning neither museums nor scientific culture) originating in research and development.

communication. Great effort is made to understand who is speaking and what they are saying, and this effort is an answer to the enunciators' supposed commitment to the intention of saying something to 'someone', who can be the population as a whole.

What causes us to assert so strongly the importance of visitors' sensitivity to the enunciative dimensions of the discourse? Mainly two elements:

- On the one hand, as the exhibition is a communicational device in a public institution, visitors do not make a 'custom' of it in the sense of a personal appropriation, but they place themselves in a situation of communication. We have detailed this communicational dimension of visits extensively in other papers.[11]
- On the other hand, visitors feel very directly, in their own bodies, the bond between commitment and discourse: in the case of exhibitions, they go to the place of the exhibition and move around inside it. The idea of a construction of meaning through the act of physical movement within an exhibition has been extensively commented upon.[12] But these attempts often focus on movement as the operator of a combinatorial analysis of signs. We have developed elsewhere the hypothesis of an equivalence between the commitment in a practice through movement and its expression in discourse, basing ourselves on the comparison between expographic and televised discourses.[13] Until now, we have focused on the production of discourses. We noted that a television crew going to a laboratory is not the same thing as a researcher from that laboratory going to a television studio: the movement is not the same, and it reveals legitimacy relationships that give rise to the presence of the laboratory space on the television screen in the one case, and the television studio in the other. For the expographic discourse, the movement to the museum of objects belonging to the laboratory is also not the same thing as the exhibition of a substitute (photograph, model) made by the museum. Once again, we have reversed legitimacy relationships that in the exhibition are visible through the presence of elements belonging to other spaces, in the case of objects brought to the museum, or from the museographic media space in the case of museum-made substitutes.

We can extend this model of analysis to the movements of the audience, bearing in mind that its members define themselves as relinquishing any writing activity.[14] Audiences inscribe nothing or, if they do, this activity takes place in spaces that are carefully identified or circumscribed as such (visitors books, forums, etc.). Control over the conditions of enunciation and of the place of inscription of the public's voice in the discourse is felt to be infinitely stricter

11 See in particular Le Marec (2005).

12 See the introduction by Eliseo Veron in Veron and Levasseur (1983).

13 Babou and Le Marec (2003); see also Babou (2004).

14 See Le Marec (2006).

than the control of the conditions of enunciation and inscription space of exhibition partners from outside the museum (financial partners, communication professionals, etc.). But the audience's action of inscribing nothing is part of the construction of the scientific discourse: there is a cultural consensus often expressed by visitors around a vision of the scientific discourse as legitimate, ratified ('We can't just say anything'), that implies adhering to mechanisms of exclusion of non-legitimate speech. The feeling of 'non-authorship' experienced by the audience places it in the position of receiver, but also in the position of an active witness of speech control, experiencing trust and being in the position of delegating competence to the institution. Although the audience's act of going to the place of the exhibition does not appear to inscribe anything, it effectively concretizes the specific place of the audience in the discourse. Therefore, for the public there is a true physical commitment to inscribe nothing and, because of this, also a great attention to commitments perceptible in the discourse through enunciative heterogeneity.

It is this sensitivity to commitments in the discourse, where the commitment is physically felt by the visitor, that is expressed by the attention to symbolic spaces in which he is located as an audience, and by an intense mobilization of media and institutional culture that helps him understand where he is and in front of whom. Among adolescents and young adults, we have noticed serious dangers of misunderstanding: while there is an obsession with attendance and learning things with scientific content, these visitors develop a culture of criticism of mediations, rhetorical and communicational processes, because the mobilization of that culture is made necessary by the proliferation of actors and bodies taking part in cultural and media productions about science.

In regard to this, one might worry about the professional communication sector taking over the aesthetics of enunciation widely exploited by the commercial communication sector.[15] Going back to personalization, we underlined that visitors sought to learn who was involved in the discourse and with what intentions: the institution (be it cultural or scientific) and its representatives, individuals, partners, etc. But we can expect communication professionals who play a part in the museum to seize on the idea of highlighting interpersonal relations between potential visitors and identified 'representatives' of science or scientific culture. However, visitors can then decode such staging as advertising strategies that reveal the fact that the real enunciator who is addressing them is a publicity agent.

[15] For example, advertisement posters for banks frequently show close-up shots of faces of individuals looking the passer-by in the eye and saying to them: 'Christine Dubois, 35 years old, counsellor'. This type of advertising mimics the designation of personalized communication relations between bank counsellors and passers-by considered as potential clients. But obviously no one is fooled: everyone knows that it is not Christine Dubois who wants to address passers-by in this way, but that an advertising firm is staging a type of personalized communication. We can guess that the communication is either promoted by the bank as a customer service, or is a guarantee for the people that the bank wishes to attract.

3.2 Audience in the Text

At the heart of popularization discourses and public debates about science and the different forms that its media coverage can take, we notice the recurring mobilization of an argument, or rather of a figure: that of the audience. We will briefly present the three main forms this mobilization can take, and then we will see that public debate can itself be represented as a figure of discourse. We will then draw out all the possible consequences of these invocations of the audience and question their meaning.

First and foremost, the audience can be directly present, and therefore represented as a discursive actor in media communication and discursive devices (televised debates between audience representatives and researchers, interviews of medical system users or representatives of associations, street interviews, and so on).

Second, whether the audience is or is not directly present in media communication devices, the actors who play a role can address the audience by presenting it as a real or imaginary interlocutor. Consider this example, taken from the introduction of a televised popularization news magazine hosted by a well-known 1980s French scientific journalist: 'Just like me, you are probably asking yourself this simple question: "Why does matter exist?"'[16] Despite the absence of a studio audience, the presenter's use of the pronoun 'you' designates the audience he is addressing. Fictitiously, he creates a place for it in his opening remarks. Meanwhile, this simple 'you' has a very important rhetorical role, in so far as it legitimizes the communication relationship that the programme will then set up between the journalist, the spectator, science, and the world: there are questions that 'everybody' asks, and which it is important to answer. These questions receive contradictory answers, provided by different bodies—scientific and religious. The role that the journalist takes on, for the good of the public and to help develop its representations, is to distinguish between rationality and dogmatism or obscurantism.[17] This type of questioning of the audience, of the materialization of its presence in media discourse, can appear in different forms: pronominal forms, looking at the camera, the journalist's body language and gestures, camera movement, etc. Thus designated, the audience can be an individual subject or a collective subject, these two possible bodies of 'the audience' being indistinctly linked by the pronominal form or by looking at the camera.

Finally, we can observe the audience being mobilized by verbal statements made in its name, thus transforming it not into an actor or media discourse recipient, but rather into a 'reason' legitimizing the discourse or the action. For example, this is the introduction to a website linked to the French Ministry of Research and which deals with radioactivity:

[16] Laurent Broomhead in 'Objectif demain: les anti-mondes existent-ils?' [Objective tomorrow: Anti-worlds—do they exist?], news magazine broadcast on 12 December 1979 on television channel Antenne 2.

[17] Babou (2004).

> To the physician radioactivity is indissociable from the adventure of atom exploration. For the engineer it constitutes an unlimited source of energy; for the researcher, as for the doctor it is an extraordinary diagnosis tool. But for Mr. or Ms Everybody (the man or the woman in the street) it is above all a source of fears, some legitimate, others unfounded. The objective of the site www.laradioactivite.com is to reveal the real nature of radioactivity to Mr. and Ms Everybody… Mr Everybody, lost in a torrent of contradictory information, has difficulty separating the wheat from the chaff, legitimate worries from irrational apprehensions. It is this website's ambition to bring him the true and accessible information he needs. It is with this in mind that its authors have tried to objectively describe existing problems, dangers of radioactivity, and the solutions put forward by engineers and physicians.[18]

In this example, the expression 'Mr. or Ms Everybody' legitimizes the existence of the website and the popularizer's project. It allows them to qualify the type of problem allegedly encountered by the audience. This drafting of a fictitious actor-recipient authorizes them to construct a situation of mediation between audience perception of radioactivity presented as erroneous, and the reality supposedly known thanks to the engineers' objectivity and answers. Never mind the fact that the sociology of public opinion in regard to science has abundantly shown that in industrialized societies with high levels of education, such as French society, people's opinions about science are not led by irrational fears but by critical demand:[19] there is no need to refer to the scientific knowledge of society. In fact, speaking in the name of the audience quite often means expressing an opinion or common sense supported by nothing.

To these three possible statuses of audience mobilization in media discourse should be added the complete absence of reference to the latter, or the different status combinations that complexify the discourses and *dispositifs* that can be observed and described. We should also clarify the manner in which portrayals of the audience figure evolve with time, what the physical places or institutional positions that accompany those evolutions are, and how media supports play a role in this process.[20]

The staging of the public debate—the last possible configuration in the mobilization of audience figures in media discourses about science—is particularly interesting. On the one hand, it can elucidate for us how different media structures conceive public debate, while public debate itself constitutes a historical construction which structured the birth of the media (particularly the press) and one of its important social functions: to allow the expression of different actors and the confrontation of

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[18] Retrieved on 14 September 2007 from http://www.laradioactivite.com/fr/site/pages/PresentationSite.htm. This website has been realized through the contributions of several researchers and spokespersons of the CNRS (National Centre of Scientific Research), the CEA (Atomic Energy Commission) and the IN2P3 (National Institute of Nuclear Physics and Particle Physics), following support received from the Museum National d'Histoire Naturelle (National Museum of Natural History). It has benefited from a grant from the Ministère de la Recherche et des Nouvelles Technologies (French Ministry of Research and New Technologies).

[19] Boy (1999); see also Boy (2001).

[20] We conducted research on these processes in different media. See Babou (2004), Le Marec and Babou (2004) and Babou and Le Marec (2003).

their ideas. On the other hand, debate is a form of social discourse brought forward by another social discourse: media discourse. Therefore, staging the public debate on science in the media operates with a double *mise en abyme*, which imposes attentiveness simultaneously on the actors called on to be present and on the types of mobilized discourses, particularly the forms of legitimation of the argument.

Without going into details of the different results of the analyses conducted on exhibitions, in the press or on television in regard to this, we can nonetheless outline the general tendencies.

Our first observation is that controversy or debate between scientists is rare, especially on television, where the dialectical basis of the production of scientific knowledge is only rarely shown. The second noteworthy aspect is that scientific exhibitions, when they deal with socially sensitive topics (genetically modified organisms, radioactivity, etc.), do not directly refer to opposing figures; references to social debates on these subjects are generally 'enclosed' in spaces exterior to the actual exhibition, and take the form of a 'press review' that is parallel or preliminary to the exhibition. In a nearly symmetrical manner, these two types of media confirm an idea of opposition between science and society: science being a space of certainties and society a space of debate, the two do not meet in their discursive methods. The press seems to constitute an intermediary communication device (*dispositif*) in so far as arguments between scientists or questioning of scientists by some civil society actor or other are frequent. Let us remember, however, that 'the' press (just like 'the' television, in fact) is not a uniform communication device (far from it), and that we observe that each media institution possesses specific 'reading contracts', privileged ways of presenting the different relationships possible between the universes of journalism, science, the audience and such and such a theme.

If we leave the sphere of controversy to look more specifically at representations of the audience in the media, we observe yet again an opposition between television and exhibitions. In scientific and technological exhibitions it is very rare to find members of the audience identified as such, in contrast to television, where representatives of civil society are regularly invited to appear or ordinary citizens are filmed. Some exceptions exist, however, and we will be able to see that the modes of argument legitimation they mobilize are very comparable to those of television.

In 'Le train du génome',[21] shortly before the exhibition's opening, a video monitor showed images of a series of individuals (professional actors), presumably cast to represent the diversity of the French population. They showed a young man, a grandfather, a North African, a woman, and so on. Each one of them, filmed in a medium shot against a neutral background, asks a question of the type: 'Is it right to create identical human beings?' and 'Will we have cloned babies in the future?'. These questions are clearly meant to incarnate questions on people's minds. Just as with street interviews produced by television channels, or the choice of actors 'representative' of the audience appearing on the set of a programme of debates about

[21] Travelling exhibition in a train that travelled through 20 cities in France from 18 October to 23 November 2001.

science and medicine, there is still no mention of the conditions in which these questions were collected, analysed and selected. We are dealing here with sociological common sense, illustrated through a screened sample of individuals, visually as varied as possible in order to represent the ‘mass audience’. While television can call on representatives of associations (the sick, opponents, etc.), we notice that exhibitions generally exclude all actors, including groups, who speak on behalf of a profession, a commitment or a responsibility. In the case of the genome train, this sociological common sense is equally at work in the sample of questions claiming to represent the diversity and generality of the public debate. The simulated position of the audience is that of a questioning addressed to experts by laypersons animated by a pure need for information, and not by the assertion of values or scientific concepts.

The two registers (the ‘sociological’ sample and the range of questions) are not referenced in any attested empirical reality. If an inquiry was indeed made, it was not used to enrich the information presented in the exhibition.[22]

This pretence of sociology and interest in public debate is paradoxical on two levels. On the one hand, it operates within the universe of representations of science as the accepted space and reference necessary to truth. On the other hand, it addresses real visitors in the flesh—actual members of an audience that is locally personified in the exhibition. It is surprising that the communication contract implicit in the exhibition as a cultural genre is not taken into account, as here it functions as a double system of values: the truth of assembled knowledge (the museum is an institution of knowledge) and the authenticity of objects (their status is specified on cards designating their link to the reference universe of their origin). Other museographic devices—*dispositifs*—considered as ‘participative’ stage an action of the visitor and allegedly include in the debate process.[23] In almost all the exhibitions visited, public debate is valued: it is presented as very open and involving every citizen. There is a sort of positive injunction to participate that addresses visitors directly. Yet, in most of the cases observed, no sociological knowledge is called on to do so. When the social sciences are mobilized, for example in the framework of a survey conducted by a CNRS research laboratory at the end of an exhibition at the Cité des Sciences,[24] the visitor gives information that will really be cultivated and analysed, but in the framework of a *dispositif* that has not been problematized in the expographic discourse. The form of the ‘debate’, as well as of suggested questions, has a significance which belongs to a space other than that of

[22] After the exhibition ended, the producers (Aventis and the Pasteur Institute) had *Le Monde* newspaper publish a full page of advertisements highlighting the number of visits and some results of an exit survey of visitors.

[23] In ‘Genes and ethics’, an exhibition at the Parc d’Aventures Scientifique de Mons, we find a fictional *dispositif* called ‘The theatre of controversies’, which shows filmed actors playing roles that illustrate a typology of ethical positions described in a work by Dominique Mehl. The audience is invited to vote by moving over sensitive surfaces. Dominique Mehl was not, however, a member of the exhibition scientific committee.

[24] The exhibition was titled ‘Des gènes et des hommes’ [Of genes and man].

the exhibition. It is not a question of exchanging arguments, at the risk (for members of the audience and opposing experts) of having to travel or to change their positions, or even at the risk of seeing a complete disagreement. The social sciences and humanities are explicitly present here at the level of the actual conception of the exhibition and thus they intervene, but in a minor role, to exploit the visitor in their turn as he completes the survey on an interactive terminal.

Through these different examples, we can see that the call for public debates as a figure of media discourse on science is not based on scientifically constructed sociological or communicational knowledge. Everything happens as if common sense were sufficient to take up public debate as a means of recognition. If this is not surprising in the case of television, we can only be concerned when this common sense recurrently plays a role in scientific exhibitions. On the other hand, in the end it is fictional forms that stage the public debate. This is all the more paradoxical in the case of exhibitions, in so far as the audience is physically present but is not involved as an actor.

Many other examples and observations could be given to illustrate the different methods of representing the audience and public debate in media discourse on science. It would also be necessary to look for other incarnations of this figure of the audience in political discourse or that of scientists. Daily contact with the issue and actors in the field of 'science and society' gives information about how the audience is mobilized as a figure of the discourse legitimizing action. Often presented as the pole of irrationality, the audience is what justifies taking a stand and action; however, it does not require a scientific approach to be known and understood. With the exception of some researchers in social sciences who work on public opinion about science, most of the time the incantatory mobilization of the audience is based on a simple discourse of opinion. Perhaps it is precisely the absence of precise knowledge of the audience on the part of most actors that makes it such a source of legitimacy.

The research we have been able to conduct on figures of the audience in media discourse about science has the advantage of pinpointing legitimacy relationships that exist either between actors within media space, or between the media and its exteriority. When studying discourses about science on television or in museums—and we can no doubt generalise to other media types—we notice that the mobilization (or lack of mobilization) of the audience as figure of discourse is far from uniform over time. For example, French television in the 1970s was able to dispense with references to the spectator when presenting scientific themes. At the time, it was considered that science spoke for itself or at least that it was fully legitimate in regard to television, so journalists and hosts of popularization programmes did not need to stage their own mediatization operations. Discreet on the screen, humble in front of researchers, they could not mobilize their 'instruments' of privileged contact with the spectator: at that time, eyes were rarely trained on the camera, just as the pronoun 'you' was sparingly used to address the audience. The audience was simply not staged in the media discourse.

On the other hand, when science began to no longer be the object of a consensus as plainly as it had been, or at least when it was no longer considered by television a faraway and unreachable space that one must respect, television journalists and hosts began to assert their legitimacy by appearing on the screen, either in the framework of interviews with scientists or alone on the set. They could then be seen designating the spectator as the recipient of their discourse.

This change in the most common forms of enunciation corresponds to the beginning of the 1980s in the context of the arrival in power of the left—a time when French government was mobilizing on the theme of the dangers of 'anti-science'. Whether the anti-science arguments were real or manipulated by the political power is of little consequence. What matters is that at that time the state implemented a vast policy of action in favour of communication on science, and that scientists, universities and the field of scientific and technological culture rallied in this direction. Training programmes in scientific communication were established, 'the little shops of science' were replaced by 'CCSTIs' (centres of scientific, technological and industrial culture), the Cité des Sciences opened its doors, and so on. At the same time, the professions of journalism evolved, especially in the television industry, and the balance of legitimacy was tipped over. We moved from a television mainly filmed by former producers of the ORTF (the French radio and television broadcasting office) who trained in cinema and documentary production, to a generation of journalists–hosts–producers of their own programmes. Popularization, which had been until then mostly the field of documentary reports, followed this trend and became a scientific performance accepted as such, often produced on the set by celebrity hosts. All this seems to have created a favourable context for the staging of the audience on television.[25]

In exhibitions, the process of staging the audience differs, even if in its enunciative forms we can see 'mechanisms' that imply legitimacy fields comparable to those that operate in television.

All of these observations help us understand that the presence of the audience in discourse does not necessarily correspond to a particular interest in its positions, its expectations, its questions, or the ways it conceives relationships with the media or scientific institutions. If we can link the legitimacies of the actors that play a role in the process of communication about science and in the enunciative forms of media discourses, this does not necessarily mean that the presence of figures of the audience in those discourses would signify that those audiences, or even public opinion about science, were being taken into account. First of all, as we have seen, this is because the actors of popularization or of discourse about science in the media do not display a particular interest in those human and social sciences that draw up knowledge of the audience, the public debate or public opinion. Finally, we can legitimately interpret the existence of figures of the audience in media discourse about science not as the mark of legitimacy of its consideration but, on the contrary, as proof of its existence as a category of discourse called up by actors when they wish to dismiss all public debate: a simple rhetoric of democratic debate would work as a functional substitute for taking it into consideration.

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[25] For a synthesis of this entire movement, and a bibliographic review, see Babou (2004). See also Veron and Fouquier (1985).

The recurrent presence of figures of the audience in public debate, and the insistent injunctions to civic debate, are no doubt a sign of a loss, of a failure of democracy to organize a public dialectic on science. Roland Barthes explained that every time a social practice emerged, it then turned into a sign. Today, he would say perhaps that every time a social practice disappears, it turns into a sign.

3.3 Conclusion

We hypothesize that the phenomena we observe as much in the case of the audience (growth of cultural criticism in regard to media and communication) as in that of discourses (staging of the audience and of public debate) proceed from the same trend—the field of professionalized communication's progressive gain in autonomy. No doubt, although it was initially thought of as a means of connecting an audience to scientific content in the paradigm of popularization and transmission, this now autonomous communication builds its own spaces, organizes symbolic relationships and arranges its actors. It is part of an increasing number of mediations and of a heterogeneity of frames of discourse and cultural productions about science.

One of the consequences of this process of becoming autonomous is the importation of norms and values that are exogenous to both scientific and cultural institutions. It is decidedly even more necessary and topical, on a theoretical plan, to relinquish the paradigm of popularization and transmission. At the same time, it is advisable to question the social and epistemological significance of such shifts in boundaries, actors and languages.

References

Babou, I. (2004). *Le cerveau vu par la télévision* [The brain seen thorough television]. Paris: PUF, 198.

Babou, I. & Le Marec, J. (2003). Science, musée et télévision: Discours sur le cerveau [Science, museum and television: A discourse on the brain]. *Communication et Langages*, *138*, 69–88.

Boy, D. (1999). *Le progrès en procès* [Progress on trial]. Paris: Presses de la Renaissance.

Boy, D. (2001). *Les attitudes des Européens à l'égard de la science* [Europeans' attitudes in regard to science]. Report for the European Opinion Research Group, INRA, Direction Générale de la Recherche, Brussels.

Boy, D., de Cheveigné, S. & Galloux, J.-C. (2002). *Les biotechnologies en débat* [Biotechnologies debated]. Paris: Balland.

de Cheveigné, S. (2005). Le discours des médias sur le thème de l'environnement [Media discourse on the topic of the environment]. In M.-C. Smouts (Ed.), *Le développement durable, valeurs et pratiques*. Paris: Dalloz/Armand Colin.

Donnat, O. (1998). *Pratiques culturelles des Français Enquête 1997* [Cultural practices of the French Survey 1997]. Paris: La documentation Française.

Donnat, O. (Ed.) (2003). *Regards croisés sur les pratiques culturelles* [Mixed views on cultural practices]. Paris: La documentation Française.

Europeans, Science and Technology, 224 Special Eurobarometer, 63.1 (2005, June). Retrieved 29 October 2007 from http://ec.europa.eu/public_opinion/archives/ebs/ebs_224_report_en.pdf.

Foucault, M. (1975). *Surveiller et punir* [Discipline and punish]. Paris: Gallimard.

Fouquier, E. & Véron, E. (1985). *Les spectacles scientifiques télévisés—Figures de la production et de la réception* [Televised science shows—figures of production and reception]. Paris: La Documentation Française.

Le Marec, J. (2005). La relation entre l'institution muséale et les publics: Confrontation de modèle [The relation between the museal institution and the public: Confrontation of models]. In *Musées, connaissance et développement des publics* [Museums, knowledge and development of audiences]. Paris: Ministry of Culture and Communication, 103–121.

Le Marec, J. (2006). Public, inscription, écriture [Public, inscription, writing], *Sciences de la société*, *67*, 145–161.

Le Marec, J. & Babou, I. (2004). La génétique au musée: Figures et figurants du débat public [Genetics in the museum: Figures and extras of the public debate]. *Recherches en Communication*, *20*. Louvain-la-Neuve: Presses de l'Université catholique de Louvain.

Royal Society (2006). Science communication: A survey of factors affecting science communication by scientists and engineers. Retrieved 29 October 2007 from http://www.royalsoc.ac.uk/downloaddoc.asp?id = 3074

Schiele, B. (2005). Publiciser la science! Pour quoi faire? [Publicizing science! Why do it?]. In I. Paillart (Ed.), *La publicisation de la science: Exposer, communiquer, débattre, publier, vulgariser*. Grenoble: PUG.

Veron, E. & Fouquier, E. (1985). *Les spectacles scientifiques télévisés* [Televised scientific programmes]. Paris: La Documentation Française.

Veron, E. & Levasseur, M. (1983). *Ethnographie d'une exposition* [Ethnography of an exhibit]. Paris: Georges Pompidou Centre.

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Chapter 4
Representation and Deliberation: New Perspectives on Communication Among Actors in Science and Technology Innovation

Giuseppe Pellegrini(✉)

Abstract Since the 1980s, a large body of analysis in communication and political science has emphasized the importance of activating spaces for public discussion, not only on political issues but also on themes of strong public impact, such as the effects of techno-scientific innovations. Challenge for political transformation is crucial for the concurrent changeover from representation to deliberation in the realm of techno-scientific innovation. In the traditional decision-making processes of representative democracy, all the points of view and interests of civil society are not necessarily—indeed, almost never—represented and considered. This means that representation is always partial, and the arguments of those who will be affected by particular innovations are not part of the debate serving to orient decisions. By contrast, the deliberative model of democracy is founded upon public discussion and the exchange of arguments. Representative and deliberative democracy are strictly interdependent, and it is misleading to consider the two terms as being in opposition to each other. Rather, considering them as terms in the same equation is much more conducive to effective management of the relationship between techno-science and society.

Keywords Communication, deliberative democracy, representation, techno-scientific innovation

The pace of techno-scientific innovation and the pervasiveness of its products raise new issues for policy, especially in a period when it is increasingly difficult for a small elite of decision makers and experts in the Western democracies to take decisions affecting the lives of citizens. Today the public is more aware and expert at formulating questions on issues of strong public impact and areas on which the products of techno-scientific innovation have major effects.

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In the face of the challenges raised by innovations such as biotechnologies, nanotechnologies and communications technologies, it seems necessary to find new methods for their governance. It is consequently important to investigate how the need to take decisions on highly complex issues in the area of science and technology (S&T) can be reconciled with the demands for public involvement increasingly typical of the democratic societies, especially in Europe and the US. Given that this challenge has been taken up by a number of countries in recent years, a lively dialectic has arisen between democratic systems that privilege representative procedures and systems that introduce various forms of public discussion typical of deliberative democracy to involve the non-expert public.

In this chapter, I argue that this challenge for political transformation is crucial for the concurrent changeover from representation to deliberation in the realm of techno-scientific innovation. At the same time, it is misleading to consider the two terms 'representative' and 'deliberative' as being in opposition to each other.

The argument advanced and explored in this chapter is that deliberation is particularly worthwhile in dealing with uncertain techno-scientific innovation impacts because it tends to improve the outcomes of decision making. If deliberation is successfully handled, it will also lead to better knowledge and to confidence in discussions for future decisions, but at the same time it is also important to place appropriate emphasis on representative democracy, legitimacy and responsibility.

4.1 Representation and Techno-Scientific Innovation

Historically, processes of techno-scientific innovation since the middle of the last century have been governed within so-called representative democracies through close relationships between the political decision-making system, techno-scientific experts (particularly scientists) and business. The instruments with which to undertake scientific research and to develop the products of innovation have long been discussed in these three domains in relation to more or less shared concerns, but with rising tensions due to power relations that change according to events and the evolution of knowledge.

From a functional point of view, representative democracy uses the mechanism of delegation, whereby voters transfer decision-making power to their elected representatives. The latter, as a rule, have managed research policies and the governance of innovation mainly by relying on the opinions of experts. For example, after World War II decisions about the mature phase of so-called 'big science', such as the construction of colossal nuclear physics laboratories, were taken with no need to consult local communities or civil society organizations. Such decisions were considered legitimate, in that they were useful and necessary for the progress of science and were based on a mandate received from the electorate.

This type of innovation governance was characterized by a so-called 'technocratic drift'—a political orientation in which the power of experts in matters of great public importance decisively conditioned public decisions. That orientation was based on the conviction that experts possess an objective knowledge able to solve not only specifically technical problems but social, political and economic ones as well. The technocrat, therefore, is suspicious of transparency and democratic discussion, and considers political conflict to be a 'consequence of ignorance' (Radaelli 1999). At the same time, because techno-scientific issues of public importance had increased in number and complexity, the experts and the public decision-makers expressing this technocratic orientation acquired considerable power in determining responses, but also in formulating society's demands for innovation. This orientation long characterized the governance of techno-scientific innovations. And today it is still apparent in various countries where it is inconceivable that other forms of knowledge expressed by citizens or civil society organizations could stand on the public stage as points of view alternative or complementary to those of scientists and experts. Again, from the point of view of knowledge and power, this relationship between science and democracy lays bare two systems: a self-referential system based on the possession of certain and 'true' knowledge, and a system centred on the aggregation of preferences and on the principle of participation by citizens via the vote, which is often more important than the decision to be taken. In recent years, there have been many situations in which these two attitudes have strongly opposed each other.

The proponents of the technocratic option grant remarkable authoritativeness to expert systems and the truths of S&T. In his book *The descent of Icarus*, Jaron Ezrahi describes the phenomenon well, stressing that contemporary democracies have used science as a cultural resource to establish mechanisms considered scientific by society (Ezrahi 1990). The reference is to the so-called 'scientificity of political life'. In this view, the scientific community has furnished a method for the functioning of science and at the same time for the functioning of society. The community of scientists, it is argued, is an idealized political collective founded upon internal consensus, and in which common agreement arises on scientific truths. Historically, this view has even deeper roots in the origins of modern society, and it is based on the need to ensure social integration by means of a method grounded, not on authority, but on intersubjectively constructed and validated knowledge, on an expertise still today considered more objective than others. Polanyi (1962) also depicted the community of scientists as an ideal and democratic collective, a sort of perfect republic. Likewise, in an article from the same period ('Science and democratic social structure'), Merton (1968) maintained that the manner in which science is conducted is what makes scientists ethically credible, so that today scientists are idealized above all by the media.

This idealized view of science is one of the bases of the research policies developed since the end of World War II. One famous document testifying to the doctrine is *Science, the endless frontier*, a report submitted by Vannevar Bush to President Roosevelt with the precise intention of emphasizing that the alliance between scientists and governments had brought great benefits during the world war (Bush 1945). Great discoveries and inventions had been achieved in that period, and at the end of the war there should be no return to a model of autonomous science released from a relationship that involved financing but at the same time government control.

In other words, Bush wanted to create and to maintain a stable relationship, inspired by a liberal conception of science as a privileged community financed by public resources, so that scientists could advance knowledge towards unknown ends always legitimated by an implicit mechanism of delegation. All this would involve a tacit accord among society, decision makers, scientists and enterprises.

It is evident that the system of techno-scientific knowledge represented a stable form of power able to condition the choices of numerous nation-states and orient their processes of technological transfer. But from the 1970s onwards this stable and diffused consensus weakened, and the alliance between scientists and decision makers entered crisis following many emergencies, most notably alarms concerning the bio-life sciences and the climate. Moreover, the growth of movements to protect the environment, human rights, women and medical patients, driven no longer by the political elites but from the bottom up, expanded the spaces for participation in political life.

To a large extent, techno-scientific innovations and their impact have revealed the difficulties of contemporary Western democracy in securing public trust in science, and the breakdown of cohesion among the social actors that must take important decisions in this area. Bearing witness to this are the results produced by disciplines that have made democracy one of their main objects of analysis: political science, international relations, political philosophy and the philosophy of law.

Put extremely briefly, for some time a theoretical clash has been in progress. On the one hand are conceptions and models of democracy informed by radical versions of representative democracy based on the thought of Schumpeter (1942). These emphasize the importance of competition among political–economic elites and the action of stakeholder lobbies. On the other hand are democratic forms founded upon participation and deliberation with the active contribution of citizens. These derive from the thought of Kelsen (1966). The concept of representative democracy has been strongly criticized by several commentators, and for various reasons has revealed all its shortcomings in the area of techno-scientific innovation. I now discuss those reasons with a view to making a dialectical comparison with recent developments in deliberative democracy.

4.1.1 Rapidity of Change, Progress, Communication

The speed and complexity of technological change in recent decades has prevented science from developing a coherent and complete explanation of it, and from furnishing certain answers to applied problems: What will happen if we use these antenna masts for mobile telephony? If we use such and such medicine? If we construct a high-speed railway line? If we modify the genetic make-up of this species? Our ability to induce enduring and sometimes irreversible changes is more advanced than our ability to foresee the effects of our actions. Moreover, the relationship between laboratory and market has grown increasingly close. And from the communicative point of view as well, science and technology have become so closely interconnected that they are beginning to form an indissoluble whole. These various factors have led to the birth and development of so-called techno-science (Longo 2001).

The idea of technical and scientific progress that will solve humanity's problems of hunger, unhappiness and so on has entered grave crisis. Slowly, but evidently, the idea of meliorative progress has declined as we have witnessed ever more problematic situations in the rich and industrialized West. For example, the ability to modify life, to solve health problems and to discover new medicines has not prevented increases in depression, addiction and the stress-related illnesses typical of Western societies. And environmental emergencies such as global warming due to the industrialization of almost the entire planet are among the negative effects of the careless use of the products of S&T. Therefore, science and technology no longer embody the myth of beneficent progress. Instead, an ambiguous, double-faced image of science emerges, in which the dark side consists of negative effects that often involve broad segments of the population and are manifested in unexpected ways.

Globalization has afforded unprecedented access to communications. However, while it is true that a hitherto inconceivable number of individuals and groups can not only access information but also communicate their opinions or reach others across the world in real time, is also true that the large majority of the world's population does not yet have daily access to a telephone or even to electricity (Held 1995, Giddens 1999). Therefore, although the potentialities of communication are badly distributed, they allow access to, and therefore assessment of, the activity and knowledge of others, and the consultation of materials that in the past were only accessible on printed paper or through personal contacts. And all this without the intermediation of governmental authorities. From the point of view of democracy, we live in an increasingly global world which has modified the values and norms that traditionally unified entire social groups within the nation-states. For this reason, it is not easy to confine certain choices about innovations within national boundaries; research on stem cells, cloning for therapeutic purposes and the use of nuclear energy are cases in point. It follows that these and other techno-scientific innovations throw into crisis the democracies founded on the idea and law of the nation-state, whose range of action is restricted, as a rule, to a delimited territory from which it draws the necessary legitimation (Habermas 1998).

The globalization of the past decade, however, has not produced an economically, culturally and politically homogeneous society. Rather, it has reawakened a sense of local identity that had long lain dormant. Consequently, globalization has produced and exacerbated unexpected phenomena of diversity and inequality.

The globalized world comprises various levels—local, regional, national and continental—which often generate disputes and complicate decision making, given that some innovations extend beyond such levels. Decisions on the use of stem cells for research may be taken at national level but be in conflict with those taken by neighbouring states in which the citizens can freely state their preferences. Likewise, a refusal to adopt a nuclear-based energy programme for safety reasons clashes with the presence of potentially dangerous nuclear power stations in an adjoining country.

In the past 50 years, the function of representative democracy—understood as the system of principles, values, rules and procedures that arose from the formation of the European states after the wars of religion in the 17th century and from the great bourgeois revolutions, with their social pacts on welfare—has diminished to such an extent that it is now largely symbolic. The causes of its decline are well known: the globalization of production and investments; the dependence of governments on global financial markets, with a consequent loss of control over the levers of economic policy; the cancellation of the social contract between capital and labour; the exponential growth of migratory flows and the formation of an enormous mass of human beings devoid of rights because they have no citizenship status; and the fragmentation of societies that only regain unity through images in the media, which are now the most real locus of politics and trigger processes of spectacularization and personalization.

Amid all these changes, citizens have scant chance of affecting decisive choices about the products of innovation.

4.1.2 The Role of Scientists and Uncertainty

The ideals put forward in the literature of the 1960s, which extolled the qualities of an independent class of scientists extraneous to economic interests, have rapidly dissolved now that so many scientists have become outright economic operators, with partisan interests and public stances in which they resemble more entrepreneurs than experts motivated by the pure search for knowledge. A celebrated case is that of Craig Venter, promoter of one of the most important research programmes in genetics as the scientist/entrepreneur heading Celera Genomics. The history of the past 40 years has dramatically cast doubt on the neutrality of science, highlighting that the choice is not just between its beneficial and harmful uses, but also between acceptance and rejection of a scientific discovery or a technological innovation. The image of science as a two-faced Janus, the bringer of good or evil according to the intentions of those who use it and the contexts in which it is used, and therefore in itself neutral, is thus no longer current.

The problem of the limits of science does not arise only in the fields of biology and genetics. In the case of information and communication technologies, too, it is increasingly permissible to wonder whether everything that is technically feasible is also socially and politically acceptable, ethically admissible and legally legitimate. It is clear that the role of independent experts in exerting constructive influence for the public good is no longer guaranteed by the principles of a representative democracy, which founds its decision-making on the certain opinions gathered by those who make choices on behalf of voters. Obviously, decision makers can no longer respond to these demands in close accord with industry and the advice of scientists. The renewal of policy is therefore crucial and urgent, especially when one enquires as to which actors can or must contribute to the public debate on techno-scientific issues.

Although science warrants special interest in modern democratic societies, it evidently cannot be released from the guarantees that the rule of law has imposed on all the democratic powers—especially in this contemporary age, when science and knowledge exercise a power able to condition the rights of citizens and profoundly alter economic equilibria. If the notion of an independent science conducted in pursuit of the public good has broken down, the myth of a harmonious scientific community is also disintegrating, given that one frequently hears differing and sometimes contradictory opinions from scientists on issues of significant public impact.

Another major change concerns the uncertainty acquired by scientific knowledge—uncertainty that has become radical and constitutive for two main reasons. The first is that the laboratory of science is today somehow represented by the world as a whole (Latour 1987), and therefore by society at large. This is due to the 'amplification' of science's products and procedures brought about by its alliance with the market. The extension of innovations therefore reduces the capacity (which was always limited) to predict their effects. In this situation, facts are increasingly uncertain, the scientific community often seems divided, and the values under discussion substantially differ. The other reason is that, despite the importance of these issues, the system of norms lags behind the accelerated techno-scientific developments: a further factor that generates uncertainty.

What is proposed as an alternative? The turning point in recent years has been the advent of a broader participatory model. Attempts have been made to encourage broader dialogue among the scientific community, the institutions and citizens in order to bring out their opinions so that constructive discussion can be possible and diverse discourses can merge. This therefore requires a new definition of democracy, whereby the challenges raised by techno-scientific innovations can be managed. Democracy today cannot be founded solely on the prevalence of a majority, for there is a risk that only one language will predominate. This would be the language of techno-science, from which we would objectively draw the consequences for our civil and democratic life, without the uncertainties contained in the black boxes of science, and without different positions being confronted and discussed effectively.

In other words, it is essential to seek to understand how science and democracy can be reconciled today. What meanings and what possible actions are available to policymakers in the democratic states when innovations increasingly invasive of health and the environment must be managed?

4.2 Deliberation

When investigating the reasons for the crisis of contemporary representative democracy in managing techno-scientific innovation, and with particular regard to communication among the actors concerned, one soon encounters developments in so-called deliberative democracy. Since the 1980s in the US, and subsequently in Europe, a large body of analysis in political science has emphasized the importance of activating spaces for public discussion not only on political issues but also on themes of strong public impact, such as the effects of techno-scientific innovations. In the traditional decision-making processes of representative democracy, all the points of view and interests of civil society are not necessarily—indeed, almost never—represented and considered. This means that representation is always partial, and the arguments of those who will be affected by particular innovations are not part of the debate serving to orient decisions. By contrast, the deliberative model of democracy is founded upon public discussion and the exchange of arguments. The deliberative process therefore proceeds through rational and impartial discussion, and it is democratic in that it is grounded on the principle of giving voice to the interests of the citizens and actors affected by the certain and uncertain consequences of techno-scientific innovations.[1]

Deliberation therefore consists of a complex set of processes (Held 1995, Giddens 1999) that are bound to alter the structural configuration and institutional arrangements of existing political systems. I consider in this chapter, in particular, the discussion-based and inclusive nature of the deliberative approach, dealing with its strengths and weaknesses but not going into details on individual procedures experimented with around the world in recent years.

The main purpose of 'deliberative arenas' is not to decide, but rather to encourage open discussion among actors with important interests in the subject being discussed. These practices are deliberative in that they emphasise the importance of superseding elitist forms of decision making and the democratic mechanisms founded upon majorities obtained by aggregating preferences. It is therefore a paradigmatic form of democracy that disputes the legitimacy and effectiveness of decision-making processes based on representation of the electorate. Implicit within it is a denunciation of the weakness of traditional democratic systems when complex decisions must be taken on controversial issues. And this objection also applies in cases where policymakers, together with scientists and enterprises, have taken decisions strongly resisted by the entire population at the moment of their implementation. Environmental conflicts over the construction of dangerous waste disposal sites and protests over the construction of infrastructure such as high-speed railway lines are two well-known examples.

Deliberative practices are mainly processes of communication used to activate relational links that extend beyond the normal mechanisms of power between elected and electors, decision makers and scientists, to address new controversies of great public concern, such as cloning, GMOs and the patenting of genetic material. The discussion in this chapter refers to deliberative democracy in the strong sense given to it by Elster (1998), Cohen (1997) and Habermas (1998), for whom the exchange is based on arguments put forward with criteria of validity. In this case, comparisons among arguments may also produce a change in the actors' attitudes during the deliberative process, as has been apparent on several occasions (Bobbio 2002).

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[1] I refer to the group of deliberative procedures which, in various forms, and with the varying involvement of experts, non-experts and decision makers, have been used in recent years to manage phenomena of techno-scientific innovation. For a classification of these procedures, see Rowe and Frewer (2005).

The discussion thus far has shown that, in a more general sense, deliberative democracy is intended to deal with the crisis in institutions and democratic practices by introducing new dialectical forms to evince the reasons for particular choices, and to extend as far as possible the array of objections concerning the effects of decisions. In regard to techno-scientific innovation, I believe that there are two areas of particular importance in which procedures of deliberative democracy have contributed significantly to resolving decision-making deadlocks: governance for the citizens, and communication.

4.2.1 Governance and Citizenship

The challenges raised by the products of techno-scientific innovation cannot be countered in the absence a model of enlarged regulation predicated upon governance. This is a system that associates the conventional state/market binomial with the role and participation of a civil society organized at national level, and eventually at global level as well. From this perspective, the theorists of deliberation propose the adoption of inclusive and pluralist models of citizenship able to manage, through negotiation, the diverse cultural and normative attitudes expressed by the members of an increasingly diversified and complex society.

Given the new and growing demands that severely test the decision-making autonomy of the traditional democratic systems, the proposal is to promote a techno-scientific citizenship characterized by the enforceability of rights and the creation of opportunities to participate in the discussion phase with a view to decision making (Frankenfeld 1990). The most characteristic examples concern the role of patients' associations in decisions about the allocation of research funding and the selection of priorities, and the broad movement of computer users who collaborate with software producers in the production of new IT tools.

Those most critical of these processes stress the difficulty, for the modern democracies, of responding appropriately to an increasing number of demands. For the proponents of deliberative practices, this is instead an assumption of responsibility that, vis-à-vis a particular problem, also involves broad strata of society in identifying possible solutions and in finding the necessary resources.

4.2.2 Communication and Deliberation

If the relationship of governance with citizenship raises many interesting topics for reflection, its relationship with communication is no less important. Communication, in fact, is one of the bases of a democratic state: communication among institutions, political associations and citizens; communication among the various institutions themselves.

In the perspective of deliberative democracy, it is vital that the sphere of the political institutions should not be perceived by citizens as a separate body behaving incomprehensibly and unpredictably. On this conception, communication is a *res publica*, a good of public interest. It must be possible to communicate and to interact with the state through effective tools accessible to all, especially when issues of great public concern are involved. This is the case for questions such as whether GM foods should be placed on the market; where it is best to process radioactive waste; what measures should be taken to combat global warming; or whether research on embryonic stem cells for therapeutic purposes is ethically admissible. These are some of the issues on the media and political agenda, and on which important decisions are taken by means of the mechanism of political delegation.

And the same applies to the relationships between citizens and the mediatory associations of representation, which in democratic countries take the form of political parties. Only transparent communication ensures that citizens can select their representatives in a conscious and informed way, control and direct their activities, and, in general, freely and responsibly exercise their rights to participate in the formation of the general will.

The form of deliberation described here takes place on the public stage through the use of the many instruments, with almost limitless potential, which today enable exchanges in real time. This mode, characterized by easy access, concerns the practices of 'discursive democracy' described by Dryzek (1990) as increasing the opportunities for connection among various actors while respecting their roles as decision makers and citizens—as those who must somehow control and promote sensible demands. Besides these potentialities, one must also consider the forms of control that the communication media may produce through their invasion of the private sphere and their conditioning of social and commercial relations and of learning processes.

The facile optimism apparent in the claims of the theorists of deliberative democracy has been harshly criticized on grounds that have a certain cogency. Although deliberative democracy, by relying on dialogue and participation more than on mediation and political representation, may give rise to a different relationship among the actors of techno-scientific innovation, between governors and governed, at the same time it may create some general problems, which I now briefly discuss.

The first problem concerns effects. Deliberative procedures have at times been disappointing in their outcomes: that is, in their capacity to enable real influence to be exerted on the choices of decision makers. The empowerment activated by deliberative arenas, in fact, provokes frustration in participants when their opinion is not considered during the public debate. While it is true that the procedures typical of deliberative democracy are not necessarily intended to produce decisions, they may nevertheless generate expectations in the individuals and associations involved (Einsiedel and Eastlick 2000).

A second problematic area is resources. The correct organization of deliberative procedures, whether local or national, requires a wide array of capabilities, large amounts of funding, third-party bodies and experts on participation. On summing these resources, there are those who argue that the costs exceed the benefits. Moreover, only recently have governments or local public administrations begun to invest in the management of controversies by means of deliberative procedures.

Third, there is the question of participation. Citizens generally tend to delegate to politicians and experts the task of taking decisions on complex techno-scientific issues, often claiming that their involvement is pointless because they lack the necessary knowledge. The concern of citizens is normally aroused when problematic and controversial situations occur. In these cases, typified by the NIMBY (not in my back yard) syndrome, deliberative procedures are able to activate participation only in regard to specific and localized issues. It is more difficult to attract the attention of civil society actors to more general issues of a national or supranational character.

A fourth problem is the weakness of deliberation procedures. Given the difficulty of organizing occasions for participation that aggregate all actors representative of the general public, it may happen that the discussions and the instruments used are not neutral in the sense that they permit open and frank debate. Moreover, there is a serious risk that such procedures may involve only citizens, organizations and institutions already experienced in public debate, sidelining a silent majority of subjects who do not normally have access to public discussion. In other words, the procedures may become manipulatory and instrumental to undeclared purposes, or they may produce unwanted effects. All of this confirms that the management, control and evaluation of effective public arenas are complex undertakings that require the deployment of various skills and the impartial conduct of the process and contents.

A final problem concerns the pertinence of deliberative practices. Can these forms of discussion be used to resolve conflicts and disputes, especially those concerning the most controversial issues? For critical commentators, there is no certainty of success in this regard. They stress that some issues require a different form of communication among actors. More institutional means must be found, lest conflicts degenerate and deadlocks arise, with the consequence that processes of techno-scientific innovation are no longer manageable. It is not by means of open debate that situations of impasse can be resolved. Rather, recourse must be made to third-party bodies or to superordinate institutions credible to the contenders. This is the case in debates about the adoption of infrastructures with a strong impact on local communities, where intransigency and paralysis often arise. Deliberative procedures are not a panacea.

4.3 Conclusions: Beyond a Useless Dualism

The critical aspects I have discussed derive principally from the widespread perception of representation and deliberation as elements in a dualism—if not, indeed, as two entirely antithetical processes. After briefly discussing the strengths and weaknesses of the two approaches in democratic regimes, I shall stress that they should be regarded as strictly interdependent. I argue, in fact, that it is misleading to sustain the representation/deliberation dualism, because it strengthens the idea that science and society are separate worlds—that society is some sort of inconvenient interloper between politics and science. To insist on this polarization, maintaining the terms on different planes, prevents valorization on the one hand of the responsibility of the decision makers and the institutions, and on the other of civil society's vivacity and ability to raise pertinent issues and to contribute to the public debate. Considering them as terms in the same equation is much more conducive to effective management of the relationship between technoscience and society.

In a representative democracy, citizens periodically elect representatives who exercise power on their behalf through the institutions of parliament and government, with no constraints on their mandate. While citizens dissatisfied with their representatives' action on techno-scientific innovations may decide to change them at the next elections, citizens have scant real power to affect their representatives' choices and are not empowered to revoke their mandate. Hence, in order to complete this democratic system, deliberative procedures can be used to implement relational systems. Those procedures are important in so far as they are able to provide a reference framework for the action, identities, and individual and collective interests activated by problematic situations and controversies. The problem of deciding whether to use the procedures and who should promote them remains. At present, they are most often sustained by civil society organizations and to a lesser extent by the institutions.

Again in regard to deliberation, the processes of conflictual action produced by citizens and organizations should not be assessed negatively. They are deemed useful by scholars because they constitute a field of tensions and contrasts in civil society that enables the inclusion of new sectors of the population in citizenship, and they stimulate institutional innovation (Geuna 1998). Mention has frequently been made of a democratic deficit in innovative techno-scientific processes, but the problem is instead a lack of harmonization between the representative and deliberative dimensions. For example, in a regime of representative democracy, the state should act as the regulator of public goods and the protector of collective interests. In theory, the state's task is to regulate the market, seeking to moderate the increasing power that it has wielded in recent decades. It is evident, however, that economic interests have much greater power than the regulatory and protective function performed by the public administration. This is why a vigilant civil society—also thanks to deliberative procedures such as citizens' juries or consensus conferences focused on issues of great public impact—can curb the influence of powerful economic and political actors. Obviously, not all citizens are willing to take up the challenge of participation and involvement, but current experiences in various parts of the world testify that the commitment of civil society organizations is able to foster these processes of involvement—even if they are restricted to forms of consultation—and activate virtuous processes that are repeatable over time.

Three factors are crucial in sustaining the fruitful relationship that can be established between representative and deliberative democracy. The first is the definition of objectives. If, as I mentioned at the outset, one of the shortcomings of institutional relationships within representative democracy is that questions are formulated that do not match the interests and needs of citizens, it is difficult to avoid fierce conflicts if there are no spaces for consultation, discussion and deliberation. Certain techno-scientific innovations, given their powerful influence over collective life, cannot be managed without the attentive involvement of significant stakeholders. This space of involvement and participation in which to clarify the goals to pursue will be more effective, the more it is possible to forestall the frequent attempts of politicians to delegate the responsibility to decide, relieving themselves of the burden of awkward decisions and relying on the opinions of experts or on forms of direct democracy such as referendums, which shift the problem onto citizens without an appropriate process of discussion and opinion formation. In this sense, the exercise of deliberative democracy allows the involvement of citizens in the definition of public policies and, ultimately, heightens their awareness of problems of far-reaching importance.

Under what conditions can close integration between representation and deliberation be achieved? The first requirement is a democratic context where there are opportunities to listen and to conduct institutional and informal discussion, where the issues to be treated are consequently selected by general consensus, and where deliberative processes take place with the contribution of effectively neutral bodies, whether public or private. For these conditions to come about, it is above all necessary that the public institutions do not resort to normative solutions, but instead work on the framing and discussion of problems. For example, the proposal to install an incinerator for urban waste cannot be put forward on legal grounds alone; rather, it should be accompanied by a process of communication that considers, besides the legitimate interests involved, the level of public debate in a particular area—the purpose being to foster appropriate discussion and decision making.

Finally, what actors should be involved? Who decides, and how, the subjects to be included in discussions about techno-scientific innovations? Such matters obviously cannot be decided by technicians and scientists alone, or by firms. It is the duty of the political system to mediate among the parties to protect the public interest, extending participation to other actors as well. But which other actors? Obviously, there is no single answer, but rather a set of criteria that enables a correct balance to be struck between making a utopian attempt to involve all citizens on all issues and restricting discussion to a few powerful experts. When selecting the actors, it should be expressly recognized that new technologies must be used to construct a more mature relationship among the state, citizens, firms and civil service organizations, privileging the direct beneficiaries and placing the citizen at the centre—as envisaged, for that matter, by numerous democratic constitutions.

In this manner, more effective use can be made of the places of representation that generally constitute the first level of the political mediation, where different demands and interests, normally particularistic and corporative, are elaborated before they are introduced into public discussion with non-experts. To resort at this point to deliberative procedures is a risky undertaking, but it is not demagogic, and does not involve the addition of even one more element in the mosaic of opinions. It should always be borne in mind, however, that the opinion of the non-expert does not stand at the same level as the opinions of experts and institutions. One cannot be so ingenuous as to ignore the different levels of information and the different capacities to influence decision-making processes. And, as powerful and authoritative scientists or the market seek to impose their points of view, the only antidote against uniformity of thinking and unilateral decisions is to strengthen channels of information and democratic consultation. In this way the credibility of the actors involved can be evaluated, and the interests that they represent made more transparent.

To conclude: there is no 'first' and 'second' between representative democracy and deliberative democracy. Rather, the deliberative approach with all its various procedures should be conceived as a historical necessity that completes representative democracy. While not every issue can be resolved through dialogue, and citizens do not have to decide everything, it is no longer possible to imagine that all communication on decisions should concern only experts and politicians.

References

Bobbio, L. (2002). Le arene deliberative. *Rivista Italiana di Politiche Pubbliche*, *3*, 5–29.

Bush, V. (1945). *Science, the endless frontier*. A report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development. Retrieved from http://www.nsf.gov/od/lpa/nsf50/vbush1945.htm.

Cohen, J. (1997). *Deliberative democracy*. Cambridge, MA: MIT Press.

Dryzek, J. S. (1990). *Discursive democracy. Politics, policy, and political science*. Cambridge: Cambridge University Press.

Einsiedel, E. & Eastlick, D. L. (2000). Consensus conferences as deliberative democracy. A communications perspective. *Science Communication*, *4*, 323–343.

Elster, J. (1998). *Deliberative democracy*. Cambridge: Cambridge University Press.

Ezrahi, Y. (1990). *The descent of Icarus*. Cambridge, MA: Harvard University Press.

Frankenfeld, P. J. (1990). Technological citizenship: A normative framework for risk studies. *Science, Technology and Human Values*, *15*, 226–243.

Geuna, M. (1998). La tradizione repubblicana e i suoi interpreti. *Filosofia politica*, *1*, 101–132.

Giddens, A. (1999). Runaway world: How globalization is reshaping our lives. London: Profile.

Habermas, J. (1998). *The inclusion of the other. Studies in political theory*. Cambridge, MA: MIT Press.

Held, D. (1995). *Democracy and the global order. From the modern state to cosmopolitan governance*. Stanford: Polity Press and Stanford University Press.

Kelsen, H. (1966). *General theory of law and state*. Cambridge, MA: Harvard University Press.

Latour, B. (1987). *Science in action*. Cambridge, MA: Harvard University Press.

Longo, G. O. (2001). *Homo technologicus*. Rome: Meltemi.

Merton, R. K. (1968). Science and democratic social structure. In R. K. Merton (Ed.), *Social theory and social structure*. New York: Free Press, 604–615.

Polanyi, M. (1962). The republic of science. *Minerva*, *I*, 54–73.

Radaelli, C. M. (1999). Idee e conoscenza nelle politiche pubbliche europee: tecnocrazia o politicizzazione? *Rivista Italiana di Scienza Politica*, *3*, 517–546.

Rowe, G. & Frewer, L. J. (2005). A typology of public engagement mechanisms. *Science, Technology and Human Values*, *30*, 251–290.

Schumpeter, J. (1942). *Capitalism, socialism and democracy*. New York: Harper and Row.

Further Reading

Abramson, J. B., Arterton, F. C. & Orren, G. R. (Eds.) (1988). *The electronic commonwealth. The impact of new technologies on democratic politics*. New York: Basic Books.

Barber, B. (1984). *Strong democracy. Participatory politics for a new age*. Berkeley: University of California Press.

Bennett, W. L., Entman, R. M. (Eds.) (2001). *Mediated politics*. Cambridge: Cambridge University Press.

Bucchi, M. (2006). Scegliere il mondo che volgiamo. Cittadini, politica, tecnoscienza. Bologna: Il Mulino.

Crane, D. (1995). Reconceptualizing the public sphere: The electronic media and the public. Paper presented at the annual Joint Congress of Swiss Societies for the Social Sciences, Berne.

Grandi, R. (2001). *La comunicazione pubblica*. Milan: Carocci.

Grossman, L. (1995). *The electronic republic*. New York: Penguin Books.

Pellegrini, G. (2005). *Biotecnologie e Cittadinanza*. Padova: Gregoriana Editrice.

Schneider, S. (2000). Political portals and democracy. Threats and promises. *iMP on-line*. Retrieved on 20 October 2007 from http://www.cisp.org/imp/may_2000/05_00schider.htm.

Thompson, J. B. (1995). The media and modernity. A social theory of the media. Cambridge: Polity Press.

Toffler, A. (1995). Creating a new civilization. The politics of the third wave. Atlanta: Turner Publishing.

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Chapter 5
Medialization of Science as a Prerequisite of Its Legitimization and Political Relevance[1]

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Abstract Sociologists have diagnosed an increasing 'medialization' of science—that is, an orientation towards the mass media, with the consequence that media criteria become relevant within science. The medialization of science is seen in this chapter as a consequence of the medialization of politics. Based on empirical surveys of German researchers, public information officers of science organizations and decision-makers in the political-administrative system, as well as a hermeneutical analysis of German press coverage, the authors analyse the manifestations and political impacts of medialization in the public communication of scientists and science organizations. Two biomedical fields—stem cell research and epidemiology—are used as case studies. Results of the empirical analyses support the hypothesis that the medialization of

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science, in so far as it guides the public communication strategies of scientific actors, increases the chances of scientific actors being noticed and taken seriously by the political-administrative system. Effects are seen in a contribution to the legitimization of science by reinforcing the perception of its social relevance and in improving the chances of scientific expertise becoming effective in policy-making.

Keywords Legitimization, media constructs of science, media contacts of scientists, medialization, political impact of science coverage, public relations of science

5.1 Introduction

The medialization of politics is regarded as one of the central changes in the political process in the modern 'media society' (Schulz 2006, Vowe 2006). A number of related developments can be understood in this context: the prevalence of media-constructed reality, the key importance of media in conveying political ideas to voters, and the orientation of political communication actors to the 'logic' of the media (Sarcinelli 1998). To begin with, medialization has consequences for the manner in which politics are presented. The political output is addressed primarily to the mass media and the central criterion for success is a positive response in media coverage. The question, however, is whether the changes brought about by medialization are limited exclusively to the way politics are depicted, or whether they also affect content. From the outset of the discussion concerning the consequences of the growing media orientation of political actors and voters, fears have been voiced that we could be moving towards a world of media-induced appearances and the dominance of symbolic politics. In short, this would be a situation in which medialization affects the substance of politics, decreasing the quality of political work (Sarcinelli 1989, Kepplinger 2002).

Imhof (2006: 201 ff) has identified, as a consequence of medialization, an increasing concentration of power in actors that use public relations (PR) strategies to affect the political arena. He links the success of media-response oriented non-governmental organizations (NGOs) to their early adaptation to the conditions of the media society. Meanwhile, however, established actors have compensated for the initial advantage gained by NGOs in terms of media response 'by adapting a successful newsworthiness-oriented manner to the media's logic in the selection, interpretation and "staging" of events'.

Weingart (2001) looks at medialization with respect to science. He sees, as a consequence of this phenomenon, an increase in the orientation of science to the media, which is due to the increasingly close connection of science to its social context. According to Weingart, in concrete terms, this is done in order to increase the legitimacy of science and influence political decisions (e.g. to support large-scale research), as well as to rally public support for claims in intrascientific disputes (e.g. disagreements about priorities).

As in the case of politics, the question arises here of whether medialization merely influences the public presentation of science and scientific knowledge, or also has repercussions on research and the knowledge it produces. The latter case would imply limitations on the autonomy of science and—also analogous to the discussion of political medialization—may threaten scientific quality. Weingart (2001: 249) makes the assumption that, in addition to the strengthening and professionalization of science PR based on corporate models, there are also influences on decisions in the research process and on the 'core of knowledge production'.

According to Imhof's thesis, as the medialization of politics increases, there is also increased pressure on institutions that are dependent on politics to follow suit with their own medialization; those institutions use the media to reach their addressees within the political system more effectively and to hold their attention. In this way, the parallel medialization of different parts of society—such as politics and science—creates a new, indirect link between those areas through their orientation to the media.

Thus, this is the central thesis of this chapter: the medialization of politics compels the medialization of science as a precondition of, first, its legitimization and, second, the political effectiveness of scientific expertise. Phenomena indicating adaptation to the expectations of the media will be shown to exist in the interface between science and the media and, as a result, this media orientation offers an opportunity for science to influence politics.

In the 'Integration of scientific expertise into media-based public discourses' (INWEDIS) project, some of the phenomena that we expected to find according to our thesis were examined more closely, using the biomedical fields of stem cell research and epidemiology as examples: first, the adaptation of science to the requirements of media communication on the part of science organizations and scientists; second, the media construct of science (especially those aspects concerning the legitimacy of scientific claims to validity as a basis for political regulation); and third, the paths of media influence that science may potentially give access to the political process. To this end, some 400 German stem cell researchers and epidemiologists were surveyed by mail, 20 interviews with heads of PR departments of scientific institutions were conducted, 240 newspaper articles about stem cell research and epidemiology were analysed hermeneutically, and some 40 representatives of the political-administrative system were interviewed.[2]

Because of their relevance to public health, the biomedical research fields of epidemiology and stem cell research both receive high levels of media attention and, for different reasons, have political relevance. While epidemiological knowledge forms the basis or legitimization for political regulation, the issue in stem cell research—in so far as stem cells from human embryos are used—is the political regulation of research itself. On the one hand, stem cell research has come into conflict with social

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[2] The surveys of both the scientists and the PR heads were carried out using international comparisons; however, for reasons of space, this article deals only with the results obtained in Germany. The survey methodology is documented thoroughly in the final report for the project, which is available online at http://hdl.handle.net/2128/2887.

values (protection of embryos); on the other hand, it is considered to be an important research field in which Germany cannot be permitted to lose its place among world leaders in the technology.

In the hermeneutic media analysis, we can see the crisis in the relationship between science and its social context in the case of stem cell research, and the difference between that research and epidemiology, which is an example of an unproblematic normal case of the science–society relationship. However, this difference is rarely visible in the PR survey, the decision-maker interviews or the scientist survey. In our assessment, this can be attributed to the fact that the ‘crisis situation’ is limited to a very specific research area. It is no longer noticeable as soon as empirical findings reconstruct the dominant pattern of media relationships (as is the case in the PR and decision-maker questionnaire) or the scientific community of stem cell researchers (only a very small part of which is composed of researchers working with human embryonic stem cells) is surveyed as a whole.

5.2 Adaptation of Science to Media Communication

5.2.1 Media Logic: Selection, Recontextualization and Framing

The media (or journalism, to which we limit ourselves in the following discussion) construct reality according to specific rules. Traditionally, those rules are described using the concept of ‘news factors’, which presumably guide journalistic selection. According to this concept, events mentioned in media reports are selected on the basis of, for example, geographical, political and cultural proximity; surprise; relatedness to a topic that has already been introduced; prominence; personalization; conflict; success; or damage (as seen in Schulz 1976, for instance).

The concept of news factors is useful as a heuristic description of the attention-criteria of journalism. But one has to agree with Imhof (2006: 204) that any description of media communication based solely on the ‘gate keeper’ model of selection criteria misses the mark with respect to the media construction of reality. However, news factors can also be interpreted in an extended sense as rules of construction—the rules according to which journalistic representations create relevance for the public, in which appropriate contexts are created or emphasized. But even in this broadened interpretation of news factors, central processes of journalistic meaning-construction escape from view. Those processes are discussed using the terms ‘recontextualization’ and ‘framing’ (see, for example, Knorr Cetina 1981 and Dahinden 2006). These concepts imply that events take on different meanings depending on the context and on the specification of the general meaning structure of which they are presented as an instance (Gamson and Modigliani 1989).

In Kohring’s (2005) variety of system-theoretical media theory, science journalism is conceptualized as an observation of science according to rules that are different from those of the system being observed. For Kohring, journalism is a socially differentiated capacity for observation from which the binding character of media constructs results (for example, for politics). The decisive rule of selection according to Kohring is multi-system relevance. In other words, scientific events selected for news coverage are those that are deemed likely to generate a response in the social context of science, such as those considered to have medical, political, legal, economic or moral implications.

One of the consequences of this conceptualization of journalism is that journalism is seen not as a transmitter of knowledge but as a producer of knowledge. Observation of society results in media constructs, which represent a specific type of knowledge about the world that is influenced by the media logic. However, journalistic 'observation' is based on interaction with actors that have authentic access to the observed system. In concrete terms, what this means is that journalists interview scientists and provoke responses that would not have occurred in the absence of the journalistic enquiry, and that journalists refer to PR materials that are targeted for use by the media.

5.2.2 Institutionalization of Media Contacts as an Element of Leadership Roles

In its observation of the science system, science journalism is highly dependent on scientists and organizational science PR. For this reason, scientists and science PR take part in the creation of media constructs, just like journalistic information sources in other fields. Of course, they are by no means objective informants; rather, they allow their interests and goals to influence their self-representation as well as their portrayal of particular problems (such as the risks of smoking, in the case of epidemiology). Both on the organizational level and on the level of the individual scientists in both research fields, a high degree of media-related communication activity can be observed. Each year, PR offices in German universities and research centres commonly issue several hundred press releases and respond to hundreds of journalistic enquiries.

More than two-thirds of the German stem cell researchers and epidemiologists surveyed had contact with journalists within the past three years (Table 5.1), mostly through interviews. About one-third of the scientists can be said to have had more

Table 5.1 Frequency of Media Contact in the Past Three Years

	All (%)	Stem Cell Researchers (%)	Epidemiologists (%)
No contact	30	34	22
1–5 contacts	38	38	39
6–10 contacts	12	10	16
More than 10 contacts	21	19	24
	100 (n = 390)	100 (n = 261)	100 (n = 129)

Note: Apparent errors in addition are due to rounding.

or less regular contact with the media (more than twice a year). Epidemiologists had somewhat more frequent contact with the media than stem cell researchers, which can be attributed to the high degree of relevance of epidemiological research both to individual health-related behaviour and to public health and risk policy. Apart from this, both groups of researchers differed surprisingly little in their views of and experience with the mass media.

Experienced (older) scientists and those with a higher level of scientific productivity were over-represented in our sample, compared with all the epidemiologists and stem cell researchers in German research facilities. This resulted in data that overestimated, to a certain extent, the average degree of experience with the media among all researchers. If one compares the frequency of media contact from our sample with an older survey taken from a broader disciplinary spectrum of scientists (Strömer 1999: 32), nothing indicates that the two research fields that we studied are extreme cases in terms of the extent of media contact. Also, considering the similarity of results in both research fields, we suspect that the basic findings of our scientist survey can be generalized, at least in the field of biomedicine, with the exception of a very limited number of topics in which a crisis exists in the relationship between science and its social context.

Scientists seldom contact journalists on their own initiative. Two previous studies sought to determine which side initiated contact—scientists or journalists. The results consistently indicated that 80% to 90% of the talks were initiated by journalists, while only a small percentage were initiated by scientists, and an even smaller percentage by third parties (Projektgruppe Risikokommunikation 1994, Peters and Heinrichs 2005). However, the circumstances of contact are somewhat more complicated than can be ascertained by the simple question of who initiates contact. Even though contact between scientists and journalists is usually initiated by journalists, it is often the case that institutionalized PR activities are involved—through press releases, presentations on websites, or referrals based on non-specific journalistic enquiries to PR offices.

The extent of media contact with scientists is not influenced primarily by subjectively perceived ‘costs’ and ‘benefits’, or by affective advocacy or rejection of such contact. Rather, it is dependent on the status of the scientist as measured by the number of scientific publications, and by whether the scientist occupies a leadership function as a project/group leader or head of an organizational unit or department. The relative independence of subjective factors indicates that willingness to have contact with the media is an institutionalized part of the leadership role within science. It is apparently expected that scientists with a leadership role will maintain contact with the media.

A surprisingly high percentage (42%) of the surveyed scientists who have had contact with the media regarded it as beneficial to their scientific careers, while only a small percentage (3%) considered it to be damaging. The rest saw either no effect (30%) or ambivalent effects (24%). If one considers this subjective estimate by those surveyed to be accurate, it follows that media visibility or expected media interest in candidates is among the implicit decision criteria for people within organizations who are responsible for selecting and promoting scientists, extending grants of support, selecting cooperation partners, and so on.

Because scientists are members both of scientific communities and of science organizations, the question arises as to which of those contexts is more important for the regulation of relationships with the media. Does the career-promoting effect arise because media contact boosts a scientist's reputation within the scientific community, or because science organizations regard that media orientation as a positive factor in addition to scientific reputation? Below, we discuss the relative relevance of the scientific and organizational contexts.

5.2.3 The Influence of Scientific Norms

Previous studies of the relationship between science and the mass media found indications that the norms of the scientific community tended to discourage media contact by scientists (for example, Dunwoody and Ryan 1985). Unlike those studies, our survey did not indicate a basic negative sanctioning of media contact by the scientific community. Only a quarter of the surveyed scientists named *'incompatibility [of media contact] with the scientific culture'* as an important concern in possible media contact (see Table 5.2).

In a question about the motivating/demotivating significance of eight possible considerations against and eight considerations for media contact, two oppositely formulated items were included that made reference to the expectation of possible reactions by colleagues: *'Possible critical reactions from peers'* and *'Enhanced personal reputation among peers'*. By combining the reactions to these two items in an index, one can make the assessment that considerations about how colleagues would react were irrelevant for nearly half (47%) of the surveyed German scientists, and that otherwise motivating/demotivating influences from the expected reactions of colleagues are basically equally represented (motivating for 18% of those surveyed, demotivating for 21%, ambivalent for 14%).

Interestingly, the expectation of a negative reaction by colleagues is only weakly associated with the extent of scientists' contact with the media (Kendall's tau-b = 0.11, $p < 0.05$)—a further indication that scientific norms are not essential barriers to media contact. However, one of the few less clear differences between the two scientific communities is evident here: among epidemiologists, the association is significantly stronger (tau-b = 0.27, $p < 0.001$) than among stem cell researchers (tau-b = 0.03, n.s.). This is probably because epidemiologists fear criticism from colleagues mainly on the basis of medical ethics and not on the basis of scientific norms, as is the case with stem cell researchers.

However, scientific norms are far from irrelevant in attitudes towards communication. Aside from the influences already mentioned, some of which are motivating and some demotivating, scientific communication norms create expectations about the ways and means of journalistic representation. In our survey, 82% of the scientists stated that the *'risk of incorrect quotation'* was a cause of serious concern in contacts with the media. The statements *'Journalists should be guided by scientific peer review standards when selecting topics and sources for their stories'* and

Table 5.2 Significance of Scientists' Motives and Considerations in Possible Contacts with the Media

	All[a] (%)	Stem Cell Researchers[a] (%)	Epidemiologists[a] (%)
Possibility of negative publicity	55	57	52
Loss of valuable research time	56	58	52
Unpredictability of journalists	80	80	80
Possible critical reactions from peers	35	38	28
Possible critical reactions from the heads of department or organization	42	44	38
Possible critical reactions from the public	47	53	35
Incompatibility with the scientific culture	25	25	27
Risk of incorrect quotation	82	82	82
Increased visibility for sponsors and funding bodies	84	86	80
A more positive public attitude towards research	97	98	95
Enhanced personal reputation among peers	32	30	35
Enhanced personal public reputation	44	42	47
Fulfilled responsibility to account for the taxpayer's money	58	61	52
Influence on public debate	89	89	90
A better educated general public	95	94	96
Enjoyment of interacting with journalists	15	14	18
	(n = 397)	(n = 266)	(n = 131)

[a] Percentage of those surveyed that considered the corresponding factor 'very important' or 'somewhat important' in the decision to make contact with the media (more than one entry possible).

'Scientists should communicate research findings to the general public only after they have been published in a scientific journal' met with emphatic agreement (mean values of 1.0 and 1.1, respectively, on a five-step rating scale of −2 'strongly disagree' to + 2 'strongly agree'). The majority of scientists would like to see journalistic science reporting held to scientific quality-control standards. The PR survey showed that scientific publications are also an important basis for organizational PR. One reason for this is that science journalists consider scientific publication (especially in well-known journals) to be an event worthy of media coverage. However, a further reason is that press offices themselves face the problem of how to assess the quality of the scientists' work within their own organizations. They do not want to risk damaging their organization's image by associating it with research of dubious quality.

As in earlier studies (see Peters 2008), our survey indicated that scientists request to check stories in which they are quoted which is rejected by journalists as an encroachment upon their autonomy. The statement, *'Journalists should permit scientists to check stories in which they are quoted prior to publication'* was received with almost unanimous strong concurrence (mean value of 1.7 on a rating scale of + 2 to −2). This demand can be understood as an attempt to instrumentalize journalism for the attainment of the communication goals of the scientist or organization cited. However, it can also be seen as a transfer of intrascientific communication scripts (that is, as an analogy to the proofreading of scientific publications). The implications are that the scientists are the authors and that they relegate journalists to the role of pure information brokers.

In summary, in both the research fields studied, the norms of the two scientific communities do not generally discourage media contact; rather, they are either neutral or ambivalent towards such contact. However, the scientific culture leads to expectations about the ways and means in which science is publicly presented and about to the role of scientists in relation to journalism.

5.2.4 The Organizational Context of Public Communication in Science

As our PR survey showed, science organizations—especially through their PR offices—have a significant influence on how the media cover research (see Baerns 1990):

- They produce and disseminate their own content to media editorial departments and journalists by means of press releases, press conferences and exclusive information.
- They increase the visibility of their scientists to journalists and encourage the scientists to be in contact with the media.
- They manage media queries to the organization and, when necessary, forward them to scientists who seem to be suited to handling them.
- They observe and regulate—usually in subtle ways—direct contacts between scientists and journalists that occur without their involvement.

Of course, all these processes work selectively. In other words, the PR department controls the representation of its organization so that the interests of the organization are promoted. These consist above all of the general legitimization of the organization in the eyes of those on whom it is dependent (both politically, in terms of regulation, and financially, for support), increasing the organization's position in various markets (e.g. training and research services, third-party funds), and exercising influence on political decisions relevant to research.

Depending on the organizational leadership's and PR staff's implicit media effect models, a number of communications goals result. General goals are a high media presence, a positive image and the development of a characteristic organizational profile or the establishment of a 'brand'. Specific goals include the marketing of services, the representation of the organization's positions in the public political dialogue (issues management), and attitude and behaviour change of the population (e.g. through education on health risks). The way these goals are ranked varies from organization to organization.

Scientific successes that are attributed intrascientifically to specific individuals form the basis of the proof of performance of research organizations, especially of non-university research organizations that cannot refer to the 'educating' function as a primary or supplementary legitimizing activity. The close integration of scientists into organizational PR is indicated, for example, by the high percentage of scientists (69%) who said in our survey that they had provided information to their PR department in the past three years.

According to their answers, nearly a third of the surveyed scientists require the approval of their science organization before speaking to journalists. Rules that require scientists to obtain approval for contact with the media, or that require them at least to notify the PR department of pending or completed press contact, are intended not so much to prevent such contacts as to ensure that they are conducted in accordance with the interests of the organization. Generally, press offices make efforts to motivate scientists to increase contact with the press rather than hinder it.

The influence of the organizational context on media contact with scientists is somewhat weaker in universities than in non-university research organizations and university clinics. This is confirmed by the fact that for university scientists the expectation of a critical reaction from the organization is less important in the decision about whether to make contact with the press, and by the fact that they are significantly less often required to obtain approval for media contact. In clinics, there is generally a more careful attitude towards the media than in universities and non-university research organizations. Scientists in clinics are somewhat less likely to consider contact with the press advantageous to their careers, and in the interviews with public information officers of clinics it was more often mentioned that it was necessary to avoid media attention. One reason for this is the relevance of medical ethics in the work of university clinics; for example, raising unfounded hope in patients through overoptimistic media reports of new therapies is regarded as ethically wrong. Another reason is that the threat of scandalous media reporting of possible malpractice or controversial clinical studies is greater for university clinics than for other research organizations.

The current situation of PR in research organizations is characterized by a paradigm shift that can be understood in the context of the 'managerial revolution' in German universities described by Maasen and Weingart (2006). However, that transformation is not limited to universities; rather, it includes the entire research landscape. In the field of PR, there is strong evidence that PR is no longer seen as a fulfilment of a generally understood 'obligation of science to actively provide information to the public'—that is, as a duty or service to the public—but rather as the consistent pursuit of organizational strategic goals, which is analogous to PR's role in the corporate world. Terms such as 'research marketing', 'brand development' and 'branding' are common in the current parlance of public information officers. The goal is no longer simply to ensure 'good press', but—in the sense in which Merten (2000) defines PR as a 'process by which desirable realities are constructed'—to sharpen a precisely defined media image of the science organization that meets the anticipated expectations of the state funding bodies, and that at the same time is attractive to customers in the markets for education, consulting, health and R&D services.

To attain this strategic goal, it is necessary to fine-tune the way the organization presents itself, which is ultimately only possible with central control over all public communication and a commitment by all the members of the organization to adhere to its public communication policies. Such attempts to centralize media communication push against limits—especially in universities—created by the high degree of autonomy afforded by law and tradition to professors and heads of institutes, as well as by the competing loyalties of researchers who feel predominantly obligated not only to 'their' university or research institute, but also to their scientific community, potential clients, a political mission or an interorganizational collaborative project.

5.2.5 Acceptance of Media Communication as a Separate Arena

The PR survey revealed that anticipated media expectations constitute key selection criteria for PR departments. Otherwise, successful PR would not be possible. Public information offices emphasize the rules of the media when dealing with scientists, leading to one of the relatively few typical conflict patterns indicated in the surveys. In the main, PR departments promote acceptance of the ways journalists work, and select scientists for their PR work partly based on the scientists' acceptance of the media's rules of the game.

Despite occasional frustrations, the interaction between scientists and journalists is usually relatively tension-free. In line with earlier German findings (summarized in Peters 2008), our survey indicates that, on the whole, the interaction between scientists and journalists runs smoothly, and that the resulting journalistic coverage enjoys a high degree of acceptance. Of the scientists who had contact with the media in the past three years, 77% characterized their experience as 'mainly good', while only 3% considered it 'mainly bad'. The remaining 20% believed that good and bad experiences were relatively balanced. The generally positive evaluation of contact with the media is evident not only in the general assessments, but also for specific interactions and across a broad range of individual aspects of the interaction (see Table 5.3).

Scientists' evaluations of interactions with journalists, being for the most part positive to ambivalent and only occasionally negative, indicate that in most cases journalism does not seriously offend the central criteria of the scientists acting as sources. Despite conceptual discrepancies with journalistic practice pertaining to the communication model and the consequent normative expectations, communication with the media is pragmatically successful, according to the scientists we surveyed.

Apart from scientists accepting the expectations of the media, the main reason for the generally positive assessments is that reporting by the media in most cases serves scientists' pragmatic communication goals, even though that reporting might violate scientific communications norms. In a list of eight motives for making media contact, the one attracting the highest level of agreement was the goal of creating *'a more positive public attitude towards research'* (see Table 5.2). This corresponds to

Table 5.3 Summarized Assessment of Personal Media Contacts in the Past Three Years

	All[a], $\bar{x}$	Stem Cell Researchers[a], $\bar{x}$	Epidemiologists[a], $\bar{x}$
I was able to get my message out to the public	0.9	0.9	0.8
The journalists treated me with little respect	−1.2	−1.2	−1.2
The information I gave was inaccurately used	−0.8	−0.9	−0.6
The journalists asked the right questions	0.5	0.5	0.4
I felt unsure when talking to the journalists	−1.1	−1.1	−1.0
My statements were distorted	−0.9	−0.9	−0.9
The journalists really listened to what I had to say	0.7	0.7	0.8
I received favourable publicity	0.8	0.9	0.7
The most important information I gave was omitted	−1.2	−1.3	−1.1
Talking to the journalists was pleasant	0.9	1.0	0.7
My research was well explained	0.7	0.7	0.5
The journalists asked biased or unfair questions	−1.2	−1.2	−1.1
	(n = 274)	(n = 173)	(n = 101)

Note: Only scientists with personal experience of the media were included in the calculation.
[a] Mean values on a five-step scale, from −2 (‘strongly disagree’) to + 2 (‘strongly agree’).

the PR goal of legitimization; however, the PR offices of science organizations interpret this general goal specifically—as the legitimization of their own organizations.

Probably encouraged by PR, scientists base their assessment of their contact with the media on whether the contact had the intended persuasive effects (e.g. in legitimization), and the mostly affirmative journalistic coverage of science seems to have these desired effects, according to the scientists themselves. The feared or actual violation of specific scientific criteria, particularly the criterion of accuracy, is apparently secondary in their view. The surveyed public information officers confirmed, for the most part, the predominantly affirmative characterization of science—indicated, for example, by the fact that investigative science journalism is not very common. The PR officers also pointed to the readiness of the media to accept PR material (e.g. press releases) relatively uncritically and sometimes even without reference to its source.

Previous studies indicated that many scientists considered science-related media communication as an ‘extension’ of intrascientific communication. The alternative to this is the belief that media communication about science is an independent arena, in which specific rules—different from those of intrascientific communication—apply (see Peters 2008). Scientists’ astoundingly high level of satisfaction with science reporting, despite the inner logic of the media and the dominance of the legitimizing goal in media communication, is best explained by the second model (media communication as its own arena). For organizational science PR, the applicability of this model is obvious. However, we suspect that this model is also the pragmatic basis for the way in which most scientists with media experience deal with the media.

5.2.6 Effects of the Medialization of Science

The medialization of science and the related professionalization of organizational science PR have a number of consequences for science's self-representation, and consequently for the public image of science and scientific knowledge. The selection and construction of topics offered to the media within the framework of proactive PR, as well as reactions to media requests, simultaneously meet two central criteria:

- The anticipated expectations of the media as a prerequisite for an opportunity for publicity
- The goals of scientific communicators, based on their interests in legitimization, profiling and political impact

A likely direct effect of the medialization of science, as opposed to a hypothetical condition of non-medialization, is an increase in the public presence of science. Increased media presence is aided by:

- A reduction in the journalistic effort because of journalistic work done in advance and the proactive 'push' strategies of scientific PR, which allow for savings in the production of science-related media content
- Better adaptation of scientific topics to journalistic rules of selection and construction (that is, ultimately more attractive scientific topics for the media audience)

A truly surprising observation is that for many actors, including most of the scientific public information officers involved in the study, an important goal is a *mere mention* in the media as frequently as possible (as long as it is non-deprecating). There is a forced presumption that media presence in the 'media society' is a universally effective indicator of social relevance. This assumption also follows from Kohring's (2005) concept of journalism.

A second effect of medialization is the use of non-scientific frames of reference in scientific self-representation. In the field of biomedicine, a 'relevance' construction based on practical applications and corresponding non-scientific benefits seems obvious, and was consistently confirmed by the surveyed press officers. The hermeneutic analysis of media reporting on epidemiology indicated that epidemiology is characterized as a legitimate basis for political regulation (see below). To this extent, political connectivity exists for a self-representation of epidemiological research that is focused on practical effects. In addition to being a relatively simple adaptation to the media's attention rules, focusing on practical use has the advantage, from the perspective of science organizations, that they can legitimize themselves not only with research successes (which do not interest everyone) but also with the prospect of practical benefits.

A particular image of science is portrayed when research is selected based on the rules of media attention and organizational legitimization (through the benefits of application and direct relevance to patients), or when emphasizing potential practical relevance in the presentation of basic research. This creates the impression that biomedical research is strongly oriented towards patient interests, rather than to the scientific goals that it has set for itself. The tendency to present science as a process driven by an orientation towards practical problems may also exist in other areas besides biomedicine.

Indeed, stem cell research is a scientific field that is currently dominated by other images of science. Here, the hermeneutical media analysis identified three main meaning patterns, in which science is constructed as either 'sport', 'guild' or 'hubris'(see Jung 2007a for more details):

- The 'sport' pattern relates to the competition between national teams of scientists. Scientific success is implicitly presented in this pattern as first place in a competition, rather than as progress in knowledge acquisition or as a solution to practical problems.
- Science as 'guild' refers both to processes of intrascientific self-regulation (for example, in dealing with the scandal involving South Korean cloning researcher Woo-Suk Hwang), and to conflicts of interest between science and society (such as the acceptance of research using human embryonic stem cells).
- In the 'hubris' pattern, fantasies of the omnipotence of science emerge as a threat to basic social values, and scientists are portrayed as irrational and unscrupulous.

The function of such meaning patterns, analysed here using examples from stem cell research, is to transform scientific complexity into a form that connects to the everyday culture of modern Western societies through abstraction from factual complexity and respecification of science on the social and normative levels. This results in the inclusion of the audience, in the sense that each person will be located on either one side or the other of a social relationship.

For the purposes of self-representation, sources of scientific information selectively connect to meaning patterns used by the media that create a positive image of the participating scientists and science organizations, or that imply political support for the research. In addition to the application perspective that we have already mentioned, this is especially the case with the sport pattern. Association with that pattern can be used to indicate a success (for example, so that a 'world record' can be touted). But the sport pattern can also be used to demand political support by referring to the competitive disadvantages of the German 'team' compared with the international competition, due to handicaps created by political constraints.

The PR interviews identified further content-related selectivities derived from organizational interests. For example, organizational science PR is not interested in legitimizing science in general, but rather in legitimizing its own science organization.

Results of research produced in the social context of scientific communities that cross organizational borders are appropriated by science organizations and represented as their own achievements. This creates a specific public construct of science—differing from science's own self-image—in which science *organizations* are regarded as the producers of knowledge.

While in the scientists' survey we found some evidence of a medialization of the *research process*, the PR survey did hardly indicate that this form of medialization is specifically catalysed by the public information offices. To the extent that conflicts involving the public acceptance of research topics or methods were discussed in the interviews, the surveyed public information officers mostly sided with scientists, and stated that they used the communication means at their disposal to defend the right to conduct research and would not shy away from conflict with the public if necessary.

5.3 Political Effects of the Media's Thematization of Scientific Topics

5.3.1 Legitimacy of Scientific Knowledge and the Autonomy of Science

The picture painted by the surveyed public information officers, of a predominantly affirmative journalistic treatment of scientific topics as the rule, corresponds to a high level of social trust in science. In public opinion surveys, science is regularly shown to enjoy more public confidence than politics and economics. What is noteworthy about this is that the difference in the levels of trust is not primarily due to a belief that science is more competent; rather, it can be attributed to the assumption that science is independent of interests and oriented towards the common good (Peters et al. 2007). The result is that with 'normal' scientific topics there is essentially little appeal for critical investigative journalism, which generally focuses on contradictions between partial interests and the common good.

The fields selected as case studies—stem cell research and epidemiology—differ in how they are portrayed by the media. Reporting about epidemiology corresponds to the affirmative default. Although public conflicts occasionally arise in epidemiology over the validity of scientific knowledge or the practical results that can be obtained from it, the legitimacy of the science is not called into question. In contrast, in reporting of research using human embryonic stem cells, the issue is the reconstruction of a research field in which a crisis in its relationship with its social context has developed because of tensions between the expectations of researchers and social values (see Jung 2007a,b).

The image of science constructed in articles about epidemiology corresponds to the traditional expectation of science as a producer of safe, objectively true knowledge that is a legitimate basis for political regulation. The fact that scientific knowledge, at a given point in time, is limited and uncertain is not perceived as a ‘crisis’ of science; rather, it results in a demand for more and/or better research. Scientific knowledge is sometimes called into question in articles about epidemiology. These articles refer to factual contradictions in statements by different scientists, weaknesses in method, and the distorting effect of external influences on the process of knowledge generation, but the critique is directed at concrete research and not at the science per se (in fact, the ‘idea’ of science is defended in these articles). Finally, political interference in the scientific process is criticized, underscoring the legitimacy of the autonomy of science.

In summary, the analysis of the epidemiology articles showed that, in certain respects, science occasionally has a credibility problem, but that simultaneously the authority and legitimacy of science—as a form of knowledge, as a process through which to obtain knowledge and as an institution—are reinforced and supported.

In the political arena, this image of science has two key consequences. First, it strongly suggests that the political-administrative system should consider epidemiological knowledge as a basis for health-care policy regulation, underscoring the political relevance of science. Second, it demands respect for the autonomy of science, in so far as it delegitimizes political interference in the process of knowledge generation.

Conversely, the constructs of science (‘sport’, ‘guild’ and ‘hubris’) that are present in reporting of stem cell research imply, to a certain extent, the necessity and legitimacy of political regulation of research. None of these meaning patterns contests either the importance of scientific knowledge or the responsibility of science to generate knowledge; however, the implication is that constraints on science have to be defined according to the interests of society. Applying the hubris pattern, it is necessary to protect society from scientists’ fantasies of omnipotence. In one variant of the guild pattern, the autonomy of science is legitimized through self-regulation (for example, as seen in the Hwang scandal). In another variant, as in the hubris pattern, political control of science is seen as necessary to the extent that the interests of science are perceived as being opposed to those of society. Finally, the sport pattern implies political support of stem cell research in order to make the German ‘stem cell team’ internationally competitive.

5.3.2 ‘Mechanisms’ of Political Effectiveness

According to the thesis of the medialization of politics, media reporting is an important orientation framework for politics. In our survey of decision-makers in the political-administrative system, especially of those responsible for subjects related to health care, we sought indications of whether and in what form the media presence of scientific actors and scientific knowledge had effects that either contributed to the legitimacy of science or to the use of scientific knowledge in policymaking.[3]

The institutionalized effort invested in media observation—in the form of press summaries and timely monitoring of news agency press reports—and the intensity

[3] This is addressed in more detail in Heinrichs and Petersen (2006) and Heinrichs et al. (2006).

of personal media use among decision-makers underscore the high significance attached to media reporting in the political-administrative system.

The relationship between politics and the media has been intensively researched from the perspective of an influence of politics on media reporting (see, for example, Palmer 2000). However, the decisive question about whether decision-makers orient themselves to the media and the effects this has on the political process is much less the subject of detailed research. In our interviews with decision-makers, five general functions of the mass media in the political process could be identified, in addition to the public depiction of politics mentioned above:

- *Topic monitoring and early warning*. The decision-maker interviews confirm, in agreement with the agenda-setting theory (Shaw and McCombs 1977), a high degree of influence of media reporting on the attention structure of politics. In the view of decision-makers, detailed and timely monitoring of topics that fall within their areas of responsibility or specialization, especially topics involving political competitors and other relevant actors, ensures the connectivity of their own activities and also fulfils an early warning function.
- *Media resonance as political success and relevance indicator*. Media reporting provides feedback on political activities. Observation of media coverage is a way to monitor success, in which the criterion of success is media resonance. Optimization of political activities vis-à-vis media response, made possible through media feedback, primarily affects the *presentation* of political initiatives. It is also likely that fields of political activity are adjusted as a result (for example, political initiatives that do not get a response are abandoned, while fields of political activity that elicit a high response are sought out) and, possibly, political positions may also be changed. An interesting implication of equating a high degree of (positive) media response with 'success' in politics is that the same criterion is probably also applied to other actors. Thus, in the political-administrative system, actors that appear frequently in the media (with good press) are seen as especially successful and 'relevant'.
- *Repertoire of arguments and rhetorical devices*. The media reflect discourses about issues, so a media archive is a documentation of issue culture (Gamson and Modigliani 1989)—in other words, an inventory of cultural elements, such as events, dates, metaphors, frames and symbols associated with a specific issue. Politics draws upon the elements of issue culture in order to generate effective messages for public communication.
- *An image of society*. Decision-makers use journalistic observations of society (Kohring 2005) to make inferences about the condition of society outside the political realm. Politically, this type of observation serves as a barrier against surprises; it allows problems to be identified before they become virulent and present a possible threat to legitimacy. In addition, the image of the condition of society created by the media can be used as a basis from which to assess whether new themes and initiatives would be 'connectable' to the general public or the realm of civil society and find resonance there.

- *Factual information and opinion formation*. Finally, the interviews indicated that, among decision-makers, the media provide background information for individuals and assist in opinion formation. Supporting opinion formation among media audiences is a general media function. However, when the media recipients are decision-makers, the individual formation of opinions by this political elite is presumably politically relevant.

These five general functions of the media for politics also create opportunities of political impact for media references to science or for arguments based on scientific knowledge. Scientific knowledge communicated through the media can trigger political activities with the agenda-setting effect, which is viewed partly as a problem because it can result in inconvenient pressure for action. When science organizations, scientific experts or scientific fields are mentioned in the media, those remarks are very likely to be interpreted by the political establishment as an indicator of social relevance. Scientific experts and arguments that are present in media content are sometimes co-opted in political rhetoric. Social scientific expertise in the media contributes to the drawing of a 'picture of society'. Finally, scientific knowledge could potentially be integrated into the political process via opinion formation among individual decision-makers. The advantage in relevance of scientific knowledge conveyed by the media lies in the fact that, because it has been subject to media logic, it is already sociopolitically recontextualized.

5.4 Conclusions

The empirical findings described in this chapter reflect the situation at a point in time and, as such, cannot directly support the thesis that science is subject to *increasing* medialization. However, we found a number of empirical indications that support the idea of a medialization of science: the high value accorded, both within organizations and among individual scientists, to science-related media communication; the institutionalization of media contact and its linkage to leadership roles; and the adoption of media logic for self-representation, resulting in a relevance construction based on non-scientific references. In addition, there are indications of effects of medialization on scientific knowledge production postulated by Weingart (2001), which we have not explored further in this chapter.

We examined the tendencies towards medialization in two biomedical research fields: stem cell research and epidemiology. The essential difference between the two fields, determined by hermeneutical media analysis, is that the media meaning structures in which stem cell research is reconstructed—especially those concerning its use of human embryonic stem cells—provide a partial legitimization of the political regulation of that field of research, while the coverage of epidemiology universally supported its right to autonomous research.

Because politics are medialized, the media presence of science (which is strengthened by its own medialization) has political effects. This is based, for the most part, on the following facts:

- The presumption of sociopolitical relevance is linked to the media presence of scientific actors, events and arguments.
- Science produces media-accessible events to which politics can connect.
- Media reporting makes arguments derived from scientific knowledge accessible (if necessary, by journalistically recontextualizing and honing them). Those arguments contribute to opinion formation among the political elite and are picked up in political rhetoric.

Political effects are associated, first, with the *legitimization of science* or science organizations. The critical aspect for legitimization is not 'trust in science'; public opinion surveys, our survey of press officers, and the hermeneutical media analysis all concur in confirming a high degree of social trust in the institution of science. The factor critical to legitimacy is the sociopolitical relevance of science or science organizations. Adaptation to media logic specifically requires the emphasis of non-scientific references in self-representation. Furthermore, in the political establishment's reception of the media, media presence is interpreted as an indicator of relevance. Therefore, the medialization of science contributes to its social legitimacy.

Secondly, adoption of media logic creates opportunities to *integrate scientific expertise into policymaking*. The special considerations in providing scientific expertise through media reporting (instead of directly through scientific evaluations or expert commissions) are:

- The media's typical sociopolitical recontextualization
- The implicit relevance assessment related to the selection process in reporting
- Broad and easy accessibility resulting from dissemination by the media and from journalistic processing (this final aspect can enhance the status of decision-makers on the periphery of issue-centred policy networks that are not involved in direct communication)

Professional science PR has an interesting role in the medialization of science. One might expect that, as the interface between the public and the media, it adopts public expectations and catalyses them into organizational goals. However, the empirical evidence points almost exclusively to effects on public self-representation, and hardly to effects on the core of knowledge production. On the contrary, the PR officers emphasized the right of science to autonomy. Therefore, scientific PR is a strategy for maintaining autonomy, in the sense that it decouples the media construct of science or the image of science organizations from the internal practice of knowledge production. That is, it produces a differentiation between the intrascientific or intra-organizational self-image and the public image. However, the gap between the intrascientific practice and the public self-representation cannot become too wide without running the risk of being journalistically 'uncovered' and thus creating a legitimacy crisis.

References

Baerns, B. (1990). Wissenschaftsjournalismus und Öffentlichkeitsarbeit. In S. Ruß-Mohl (Ed.), *Wissenschaftsjournalismus und Öffentlichkeitsarbeit*. Tagungsbericht zum 3, Colloquium Wi ssenschaftsjournalismus vom 4/5 November 1988 in Berlin. Gerlingen: Bleicher, 37–53.

Dahinden, U. (2006). *Framing. Eine integrative Theorie der Massenkommunikation*. Konstanz: UVK.

Dunwoody, S. & Ryan, M. (1985). Scientific barriers to the popularisation of science in the mass media. *Journal of Communication*, *35*, 26–42.

Gamson, W. A. & Modigliani, A. (1989). Media discourse and public opinion on nuclear power: A constructionist approach. *American Journal of Sociology*, *95*, 1–37.

Heinrichs, H. & Petersen, I. (2006). *Mediatisierte Politikgestaltung? Medien, Expertise und politische Entscheidungsprozesse in wissenschaftsbasierten Themenfeldern*. Unpublished report, Institute for Environmental and Sustainability Communication, University of Lüneburg.

Heinrichs, H., Petersen, I. & Peters, H. P. (2006). Medien, Expertise und politische Entscheidung: das Beispiel Stammzellforschung. In R. Wink (Ed.), *Deutsche Stammzellpolitik im Zeitalter der Transnationalisierung*. Baden-Baden: Nomos, 119–140.

Imhof, K. (2006). Mediengesellschaft und Medialisierung. *Medien & Kommunikationswissenschaft*, *54*, 191–215.

Jung, A. (2007a). Generalisierte Bedeutungsstrukturen als Mechanismus gesellschaftlicher Integration: Das massenmediale Konstrukt von Wissenschaft im Kontext der Stammzellforschung. Unpublished paper, Programme Group Humans–Environment–Technology, Research Centre Jülich.

Jung, A. (2007b). Proximity between science and its social environment: A paradoxical effect? Epidemiology and stem cell research in the German media. Unpublished paper, Programme Group Humans–Environment–Technology, Research Centre Jülich.

Kepplinger, H. M. (2002). Mediatisation of politics: Theory and data. *Journal of Communication*, *52*, 972–986.

Knorr Cetina, K. D. (1981). *The manufacture of knowledge: An essay on the constructivist and contextual nature of science*. Oxford: Pergamon.

Kohring, M. (2005). *Wissenschaftsjournalismus: Forschungsüberblick und Theorieentwurf*. Konstanz: UVK.

Maasen, S. & Weingart, P. (2006). Unternehmerische Universität und neue Wissenschaftskultur. *Die Hochschule*, *15*, 19–45.

Merten, K. (2000). *Das Handwörterbuch der PR, Bd. 1*. Frankfurt: F.A.Z. Institut.

Palmer, J. (2000). *Spinning into control. News values and source strategies*. London: Leicester University Press.

Peters, H. P. (2008): Erfolgreich trotz Konfliktpotential—Wissenschaftler als Informationsquellen des Journalismus. In H. Hettwer, M. Lehmkuhl, H. Wormer & F. Zotta (Eds.), *Wissenswelten: Wissenschaftsjournalismus in Theorie und Praxis*. Gütersloh: Bertelsmann Stiftung, 108–130.

Peters, H. P. & Heinrichs, H. (2005). *Öffentliche Kommunikation über Klimawandel und Sturmflutrisiken. Bedeutungskonstruktion durch Experten, Journalisten und Bürger*. Jülich: Forschungszentrum Jülich.

Peters, H. P., Lang, J. T., Sawicka, M. & Hallman, W. K. (2007). Culture and technological innovation: Impact of institutional trust and appreciation of nature on attitudes towards food biotechnology in the USA and Germany. *International Journal of Public Opinion Research*, *19*, 191–200.

Projektgruppe Risikokommunikation (1994). *Kontakte zwischen Experten und Journalisten bei der Risikoberichterstattung', Ergebnisse einer empirischen Studie*. Unpublished report, Institut für Publizistik, Westfälische Wilhelms-Universität Münster.

Sarcinelli, U. (1989). Mediatisierung und Wertewandel: Politik zwischen Entscheidungsprozeß und politischer Regiekunst. In F. E. Böckelmann (Ed.), *Medienmacht und Politik. Mediatisierte Politik und politischer Wertewandel*. Berlin: Wiss.-Verl. Spiess, 165–174.

Sarcinelli, U. (1998). Mediatisierung. In O. Jarren et al. (Eds.), *Politische Kommunikation in der demokratischen Gesellschaft*. Opladen: Westdeutscher Verlag, 678–679.

Schulz, W. (1976). *Die Konstruktion von Realität in den Nachrichtenmedien*. München: Alber.

Schulz, W. (2006). Medialisierung von Wahlkämpfen und die Folgen für das Wählerverhalten. In K. Imhof et al. (Eds.), *Demokratie in der Mediengesellschaft*. Wiesbaden: VS Verlag für Sozialwissenschaften, 41–57.

Shaw, D. L. & McCombs, M. E. (1977). *The emergence of American political issues: The agenda-setting function of the press*. St. Paul: West Publishing.

Strömer, A.-F. (1999). *Wissenschaft und Journalismus*. Unpublished masters thesis, Institut für Publizistik- und Kommunikationswissenschaft, Freie Universität Berlin.

Vowe, G. (2006). Mediatisierung der Politik? Ein theoretischer Ansatz auf dem Prüfstand. *Publizistik*, *51*, 437–455.

Weingart, P. (2001). *Die Stunde der Wahrheit? Zum Verhältnis der Wissenschaft zu Politik, Wirtschaft und Medien in der Wissensgesellschaft*. Weilerswist: Velbrück.

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Chapter 6
On and about the Deficit Model in an Age of Free Flow

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Abstract This chapter shows that the notion of the 'deficit model' of science communication, which emerged in the post-war context, manifests a certain configuration of the science–society relationship, as well as a particular modality of scientific knowledge production—one that was primarily characterized by fundamental research. Its function is mainly ideological, as much justifying the type of knowledge highlighted as being an intermediary between science and the public sought by the media. The relegation of the deficit model, beginning in the 1980s, corresponds to a transformation of knowledge production, which was henceforth subject to the relentless pursuit of innovation. Adapting to this new role of science entails a resocialization of the actors. This happens through new and emerging patterns that can be adopted and which give the actors a socially valued way to engage in science–society interactions.

Keywords Deficit model, contextual model, ideology, science, social actor, society

For all intents and purposes, the history of the relationship of sciences[1] and society can be summarized as an exponentially growing integration, starting from the early convergence of the Renaissance, reinforced during the Industrial Revolution, and indelibly sealed by the fast-paced acceleration of scientific development in the 20th century (De Solla Price 1963). Today's 'knowledge society' is its natural, homogeneous outcome. Thus 'science links up with modernity, with the emergence of so-called modern societies' and their evolution.

Until now, '*progress* appeared as the product of what could be called the *effect of science,* that is, an imposed representation of nature and society that was increasingly

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[1] I have chosen to refer to 'sciences' in the plural to reflect the diversity of fields and practices.

moving toward scientific knowledge' (Fournier 1995: 7). This '*effect*' came to infuse everyday life for everyone, such that sciences—as Moscovici (1976: 22) pointed out over 30 years ago—'invented and proposed the major part of objects, concepts, analogies and logical forms that we use in our business, political or intellectual tasks'. The relentlessly debated questions about access to scientific production proved an inherent part of this integration movement, as the questions reappeared and were reformulated in a succession of contexts. Thus, attention came to focus less on those persistent questions than on the successive forms they adopted.

With this in mind, this chapter examines one such question, that of the *deficit model*, in two contexts of the 'sciences–society' relationship: first, the context that was explicitly formulated and self-imposed as the dominant theoretical model (this was roughly the period from the end of World War II to the early 1980s); and second, the period from the 1980s to the present, which saw its relegation and a search for replacement models. My inquiry here deals less with the theoretical validity of the deficit model—a question that I feel remains open—than the conditions that made it possible and, concomitantly, those which today serve to stigmatize it.

This chapter is divided into three parts: first, a brief history recalling that sciences and science disclosure have long trod the same path together; second, based on two earlier texts, an examination of the impact of scientific development (basic research) and media on the *discourse* of sciences dissemination in the public sphere; third, a look at the evolution of that discourse in terms of current transformations of the context of scientific production (Gibbons et al. 1995, Nowotny et al. 2002).

6.1 Historical Signposts

While sciences and society were originally dissociated—to state things simply—sciences and sciences disclosure were mutually confounded. Science was disseminated in and by its self-constituting movement, with the help of vernacular languages adopted by a fledgling scientific community to convey knowledge, and via the secret renunciation that surrounded alchemy, astrology and occultism. Progressively, secretly sharing among themselves and the general public, the scientific sages opted for exchange and the ensuing multiplier effect it made possible. Thus, the constitution and presentation of science to the public went hand in hand. Fontenelle [1686] 1990, signalling the Enlightenment with his *Entretiens sur la pluralité des mondes*, marked the start of the public dissemination of sciences, which we today call the 'public communication of science and technology' (PCST) but which has also been known as 'science popularization', 'parallel school', 'sciences disclosure' and so on (Jacobi and Schiele 1990). In creating a 'new genre', presenting scientific discoveries to the reasoning 17th century man, Fontenelle essentially meant that he was 'not a stranger to Science, nor the sage a stranger in the City' (Mortureux 1983: 110). Fontenelle's project anticipates ours, even if the term that denotes this practice and enables this type of social organization did not yet exist (nor, *a fortiori*, did PCST).

I do not propose to give a broad-brushed history of the public dissemination of science and technology (S&T). However, I will recall two of its major conclusions. First, the growing role that PCST played from the 18th century demonstrates the importance of the social function revealed by Fontenelle. As Meadows (1986) points out, PCST became a social necessity from the time that the generalization of the quantitative approach (formalization) in all domains covered by scientific research provoked both a closure of knowledge and a differentiation of scientific fields. Second, well before they sought autonomy and specificity, the activities of public presentation and dissemination of sciences were progressively self-affirmed as distinct practices of scientific exchange. The treatment of science by 19th century newspapers and magazines, with their series on science and their reader-attracting 'science wonders' columns, is illuminating in this regard (Raichvarg and Jacques 1991, Bensaude-Vincent 2000). Moreover, this movement of progressive integration of sciences and society was clearly a factor in the development, diversification and professionalism of these practices. And, while the role of media was already significant, it was only with the rise of mass media after World War II that PCST practices (then called 'popularization') would join a discourse that justified and legitimated them (Schiele 2007).

6.2 1945–1975: The Affirmation of Basic Research and the Rise of Mass Media

In the early 1960s, two discourses—later subsumed under the 'deficit model' moniker—infused the social debate. The first of these, essentially reflecting a consciousness-raised awareness of the role of science's productive forces and its structuring effect on society, placed science literacy, which was highly regarded, head to head with literary culture, qualifying one as progressive, the other as retrograde. The second discourse, coming from the media field, set three categories of actors in relation: at one extreme of the cultural spectrum, the scientists (and other creators of culture); at the other, the general public (the consumer of culture); and, between the two, the 'intermediaries' whose function it was to fill the gap separating the creators from the consumers.

These two discourses devolved from the development of basic research, which revealed all its formidable potential in the development of the atomic bomb during World War II. Exemplifying the two discourses, respectively, were C. P. Snow in England, and A. A. Moles and J.-M. Oulif in France.

6.2.1 The Deficit Model Formulated in a Science Field Perspective

In the early 1960s, Snow [1959] 1974 theorized what would later be called the deficit model by contrasting two cultures, scientists versus others, separated by a 'gulf of incomprehension'. Snow saw the situation as simple: on one side, the rising science culture, with its system of gratifications; on the other, the literary intellectuals and non-scientists, essentially relegated to the social aspect. However, he railed, '[i]t is the traditional culture, to an extent remarkably little diminished by the emergence of the scientific one, which manages the western world' (p. 11). Hence, 'the scientific culture really is a culture not only in an intellectual but also in an anthropological sense. That is, its members [have] common attitudes, common standards and patterns of behaviour, common approaches and assumptions' (p. 9).

As Snow would have it, this prods scientists beyond their values, their religious convictions or even their basic social milieu to adopt convergent ways of thinking. Contrary to this, the literary intellectuals 'still like to pretend that the traditional culture is the whole of "culture"' (p. 15), while having no inkling of the depth, the complexity and the beauty of the scientific edifice:

> Their attitudes are so different that, even on the level of emotion, they can't find much common ground… In fact, the separation between the scientists and non-scientists is much less bridgeable among the young than it was thirty years ago… It is not only that the young scientists now feel that they are part of a culture on the rise while the other is in retreat. It is also, to be brutal, that the young scientists know that with an indifferent degree they'll get a comfortable job, while their contemporaries and counterparts in English or History will be lucky to earn 60% as much' (Snow [1959] 1974: 4, 17).

In Snow's defence, the physicists—his ideal-type of scientist—were then in the forefront of the scientific and public scene. In other words, the idea of the deficit model was formulated at a time when a particular conception of research, namely basic research, was becoming generalized and synchronized with the avowed interest in knowledge itself, for its own sake, for its inherent wonder and promising potential. The movement valorizing basic research had begun well before, in the effervescent spirit of the Enlightenment, and museums such as the Palais de la Découverte in Paris and Chicago's science museums were already highlighting and valuing scientific knowledge for its own sake. As stated by physician Jean Perrin, creator of the Palais de la Découverte: 'We first wanted to familiarize our visitors with the basic research that created science' (quoted in Rose 1967: 206 and freely translated here); it was only later that 'utilitarian research' would replace 'pure research'.

So the deficit model described by Snow depicts an idealized representation of sciences, but also a crystallization of values and attitudes of the relevant social groups and, more generally, of how they perceive themselves and how they relate to the other social groups and to society as a whole. It's a dual relationship: cognitive (observing a form of knowledge and culture) and social (valuing and justifying a way of organizing knowledge production). Thus, the deficit model could also be understood as a certain configuration of the 'sciences–society' relationship, with science embedded in a particular way in the social aspect. Today, as new production modes develop, one can certainly expect new forms of entrenchment (see below).

It is interesting to note in passing that Snow is happy to denounce a growing gap between scientific and literary culture, to the detriment of the second, without proposing any way out of the crisis, whether this would be to plead for a more dynamic teaching system (taking the example of the US) or to signal the emergence of a 'third culture', namely the human sciences, 'concerned with how human beings are living or have lived,…such as the human effects of the scientific revolution'. 'It is probably too early to speak of a third culture already in existence [but w]hen it comes, some of the difficulties of communication will at last be softened: for such a culture has, just to do its job, to be on speaking terms with the scientific one' (Snow [1959] 1974: 70–71). One therefore hopes that the human sciences can play the same role of mediation in the knowledge field as do the 'intermediaries' beset by the media.

6.2.2 The Deficit Model in a Perspective of the Mass Media Field

After the war, newspapers renewed their interest in covering scientific information, which was then in demand and characterized by a generalized optimism. The technologies in medicine, energy, transportation and communications that had developed through the war effort were transposed into civilian use and helped to spur an economic and social change in post-war society. This was the beginning of what we tacitly call *les trente glorieuses* (Fourastié 1979).

However, researchers who hitherto had been very active in the public dissemination of sciences—such as the French science community, which had played an important role in the creation of the Palais de la Découverte in Paris in 1937 (Eidelman 1988a,b)—and who had been partly reduced to silence during the war, saw their role disputed by the science communication professionals. Meadows observed that it was during the wartime hostilities that journalists took over from the scientists—an outcome of the 'growing complexity of the knowledge concerned' (Meadows 1986: 400). Thenceforth, the abstract physical universe could no longer be decoded from common experience. Someone was needed to describe this formal universe and explain its meaning to everyone else, who would no longer have to master a complex arsenal of concepts. And the public audience for science had to be enlarged: traditional knowledge and know-how were deemed inadequate to deal with practical and intellectual tasks, thereby halting the penetration of spin-offs from the achievements of scientific and technical knowledge. To fully express Moscovici's meaning (1976): the genesis of a new common sense, henceforth science-driven, merged with basic social preoccupations.

Amid Snow's keen observations, Moles and Oulif (1967) echoed this movement and its accompanying discourse. They denounced a split in society and proposed to close the gap through the 'mediation' of a 'third man', an 'intercessor' whose function consisted of assuring 'optimal communication at low cost' between a small core of scientists and a majority of consumers. This posture designates the media as the natural mooring site of that mediation; its corollary is an intention to maximize the exchanges. Moles and Oulif also kill two birds with one stone by qualifying the mediation by its self-specifying practice. In so doing, they demonstrate on the one hand the rise of the power of the mass media and their interests, and on the other hand, more generally, the media's strategic positioning (since science popularization at that time represented a challenge for society). Moles and Oulif's model is exemplary, portraying and condensing a diffuse but full representation of the role of media. The same movement occurred in the US: 'By the early 1960s, four major groups had responded to the post-war demand for popular science, each for its own reasons. Each group—the commercial publishers, the scientific organizations, the science writers, and the government agencies—defined "public understanding of science" in slightly different ways to serve their own needs' (Lewenstein 1992: 62). This representation is still active in the media field.

With the rise of the power of the media, the media practitioners sought, often successfully, to be in the forefront of the public scene, moving closer to the scientists—sometimes with the tacit support of the scientists themselves, who basked in the image purveyed—to become confined in a world of concepts and formalisms that kept them distant from the concerns of a society whose transformations, paradoxically, sprang from the application of discoveries by those same researchers. These media practitioners (science journalists) were perceived and still see themselves as the natural intermediaries between a world of science closed unto itself and a querying public with concerns and questions desperately unanswered—a public whose disparate, disjointed knowledge prevents it from comprehending the changes to every aspect of its life and, consequently, prevents it from forming opinions based on their implications. The media's communication of sciences thus became necessary to re-establish a balance and restore a right to speak.

6.2.3 Media Critique

6.2.3.1 Window Dressing

As soon as the demand for media to restore a genuine right to speak was affirmed, it was disputed (Schiele and Jacobi 1988, Jacobi and Schiele 1990). For Roqueplo, media communication became reduced to a 'show of the practice of sciences'. It accredited the 'spectacle, or show, of content' by the mediation not to the objective relationship between theory and practice, but to the exhibition of the 'subjective competency of men of science put on show'. Thus, the media offered a dual show: that of science 'content', and that of 'the authority that legitimates this content and its integration' in 'the field of daily experience' of the reader, the listener or the spectator (Roqueplo 1974: 110). They produce a 'window dressing': behind the window, very visible but apart, are 'the actors and the products'; in front of the window, kept at a distance, is the public. He concludes that the media leads at best to representations of knowledge, but never to a true appropriation.

But denouncing the 'window dressing', while reinforcing the non-reducibles of the deficit model, itself demands caution. As a true defender of a science answerable only to itself, Roqueplo remains enclosed in a concept in which sciences and society are two separate entities. From his angle of approach, the referential is the prior knowledge produced by scientists. It can only degrade or degenerate when the media seize upon it, with a lingering question on the extent of the knowledge gap. The facts would have us oppose media at school. Suddenly it is no longer possible for him to conceive that media are operating symbolically, especially on a level other than that of knowledge dissemination (but not necessarily excluding it). Moreover, his approach is based on a scholastic conception of scientific knowledge, which sees the retention of rudimentary knowledge inculcated at school as the indicator of science culture.

Up to now, this robust school model has largely inspired general studies on science culture, such as those conducted by the National Science Foundation (until recently) and the European Commission (EC). It is not surprising that the general conclusion of these studies points to the public's low yet improving level of science culture. It should be added, however, that these surveys have been enriched over the years with questions about 'interest' in S&T, directing attention to such topics as 'trust' that cover a much broader spectrum than the simple retention of knowledge. The chosen parameters are habitually summarized as knowledge of basic science vocabulary, a certain mastery of the scientific method, and an awareness of the social impacts of S&T (Miller 1983, Miller et al. 1997).

6.2.3.2 Confinement in Average Culture

The role of media has also been broached in another perspective. For Maldidier and Boltanski (1969) and Maldidier (1973), the cultural work of PCST must be grasped at the focal point of a particular form of cultural property and conditions of inherent appropriation, themselves a function of conditions that may or may not modulate social mobility. To understand what is meant by 'average' culture—that which is produced and disseminated by the media—they would have us abandon the traditional distinction between internal analysis (the content of the cultural product) and external analysis (the production conditions, consumer characteristics, and so on). This caesura prohibits the use of information about the public to understand the characteristics of the product, or, inversely, favours only content analysis.

For them, the term 'PCST' negatively denotes its object; that is, in relation to a superior culture of which it is merely a degraded form. The notion of average culture avoids such a trap. It means cultural products for members of the middle class that fulfil their expectations and interests by aligning the intentions and constraints of producers of those goods to the interests of the middle class, the principal consumer. Average culture therefore reinforces everyone in their aspirations for learned culture through products that demand no prerequisite skills or prior learning to be assimilated. Those products, with their equivocal features as substitute products, create an allodoxia, a phenomenon of false cultural recognition—unlike products of learned culture that reach restricted groups composed of 'individuals with prior cultural competencies that pose and presuppose in a quasi-explicit way the elliptical or allusive character of the messages disseminated' (Maldidier 1973: 5).

For Maldidier and Boltanski, the expectations and interests of the public derive from earlier school training and not, as scientific communicators would suggest, from a need to know suddenly intensified by the acceleration of scientific progress.

They also immediately defined PCST as an extracurricular activity, an offshoot of the position it held in relation to teaching. Its consumption results from the alignment or (more frequently) dis-alignment between the cultural capital and intellectual, cultural and social dispositions (Bourdieu 1979, Bourdieu and Wacquant 1992), between the aspirations to scientific knowledge and the level attained in the hierarchy of scientific competencies. In the majority of cases, we are interested in PCST in so far as it maintains a professional mobility.

In showing that PSCT consumers mostly belong to the upwardly mobile or stable middle classes, Boltanski and Maldidier drew a relationship between the appropriateness of the content proposed and the aspirations of consumers. But far from permitting the middle classes to accede to scientific culture, PCST only offers an artificial culture, an approximate, incomplete knowledge. Amid this interplay, the science communicators who, with minimal constraints, take on the task of transmitting to a general public the scientific notions they consider vital to understanding current sciences encounter real difficulties. They must either disseminate scientific knowledge to a relatively limited public, or else communicate general information to a general public. Hence a two-edged discourse: pessimistic but lucid as to the public's interest in science knowledge; optimistic but utopian in reference to the general public's need for scientific knowledge. Science communicators hold contradictory proposals because they cannot know if their activity truly responds to a social demand. Instead, they evaluate their activity against the necessity for PCST, but without really being able to define it or say what it should be.

These critiques of the media's capacity to fill the gap between sciences and society, while pertinent, are nonetheless normative. They are part of a closed circle of understanding that is delineated by the media themselves and the sciences field itself. It is interesting to note in passing that most of the American work on this question during this period also continued to use this perspective on the media and the scientific field. Works on the responsibility of journalists are significant in this regard (Friedman et al. 1986, Goldsmith 1986, Nelkin 1987).

6.2.4 The Deficit Model—a Working Ideology

The question of the deficit model, taken epistemologically, is raised in the social conjuncture where it exists and exerts a presence, and not *in abstracto*. In this case, the post-war years can be characterized by two phenomena:

- The first was the emergence and formation of a social group in the media field, namely science journalists. In hindsight, we know they were part of a larger movement of autonomization of practices in disseminating sciences in the public sphere. We now refer to 'science communicators' to express the diversity of their expertise.

- The second was obviously the acceleration of professionalism in the scientific field[2] and the corresponding training of a social group: scientists attached to the apparatus of basic research (mainly the universities). This professionalism movement was already well under way from the 1930s, but it was mostly after World War II, having demonstrated the social necessity of the research, that the pace quickened. The movement was spurred by the model, observed by Vannevar Bush [1945] 1970, that valued excellence in basic research—a model that held sway in the US and elsewhere up to the mid-1970s.

If, as shown by Eidelman (1988a, b), the professionalism of the research was accompanied by a parallel development in science museums to disseminate this type of culture (the Chicago World Fair in 1933, the creation of the Palais de la Découverte in 1937, and so on), the predominant role in communication that scientists played at the turn of the 1930s was no longer possible at the end of the war. As we have seen, journalists replaced the scientists during the war and held on to that role afterwards. In any case, both these social groups presuppose an exteriority of sciences, outside the realm of the public and the literary intellectuals. The science communicators showed they were the only ones to build a rapprochement with society, while the scientists, bearers of the future, entered into future human sciences to fill a gulf that the literary intellectuals could not even understand.

As I have noted, the affirmation of a social necessity of sciences corresponds on one level to the redeployment of productive forces, and on another level affirms the communication of sciences with an expansion of the means of communication. The idea of the deficit model thus has more to do with the professionalism (or, in the case of the scientists, a new phase of professionalism) of two social groups demanding their domains, their places, and their own legitimacy (Bourdieu 1980). So two movements each led to the formation of specific devices and, correlatively, the establishment of a symbolic distance between them, and between each of them and the other groups of social actors with whom they interact. The deficit model idea characterizes the coincidence of these two movements, which is why the question of the deficit model as posed until now has been ideological, and not theoretical.

This ideological perspective was the one adopted in most of the work conducted up to now. According to Bauer et al. (2007), who opt for a critical approach, the deficit model hinges on two analogies. The first links the necessity of a science culture to schooling: knowledge of sciences (*science literacy*) must be part of the each person's knowledge kitbag, just like knowing how to read, write and count (*basic literacy*). The second analogy states that in a democracy, to be heard and contribute effectively to decision making, a voice must gain mastery of the political process and its apparatus (*political literacy*).

Thus the deficit model attributes lack of knowledge to an undereducated public—a public with a deficit of scientific capacity. This creates on the one hand a constant demand to beef up science education and introduce support programmes to develop

[2] The question of the professionalism of the research is a domain in itself. A past summary suffices for our purposes here.

science culture, and on the other the disqualification of a public deemed doubly ignorant by those who hold to a technocratic approach. For them, the deficit in science capacity sets rolling a deficit in democratic capacity: the public is excluded from participation in decision making on questions about S&T (Bauer et al. 2007: 80, passim).

Similarly, if 'knowledge sharing' is highlighted,[3] for Wynne (1995) the real objective is to perpetuate a power relationship based on the recognition of science's authority: 'A common thread has been anxiety among social elites about maintaining social control via public assimilation of the "natural order" as revealed by science'. In the field of 'science policy', the deficit model therefore reinforces the natural tendency of institutions to deem 'pertinent' and 'realizable' only that which meets their ends and fits their structures (Wynne 1991: 111) and to reject out of hand that which eludes. So they tend to perpetuate such discourse, in this case the discourse of science on the world, and within a particular social relationship. That relationship (between scientists on the one hand and the public on the other) is primarily unilateral, in the sense that one speaks (the learned sage) and the other listens (the public). It is also a totally unequal relationship between an organized institution and dispersed individuals, with actor one speaking on behalf of its collective being and the other listening as an individual (Lévy-Leblond 1994: 38).

Another weakness of the deficit model has always been that it considers knowledge for knowledge's own sake, independently of its conditions of production and application (that is, without its boundary conditions), so the framework that knowledge inhabits is not even envisaged (Ziman 1992). But quite obviously, as we have just seen, the deficit model is itself the expression of a modelling of certain conditions of production and application of scientific knowledge, and that modelling involves the modalities of public valorization. Equally obviously, the deficit model masks the fact that scientific knowledge is never complete, totally consistent or coherent (Wynne 1995). For example, the question of whether or not 'psychology' merits the status of science derives from contradictory conceptions of 'science'. 'In other words, "science" is not a sharply defined and special type of knowledge, which only starts to be misrepresented and misunderstood outside well-defined boundaries by people who simply do not know any better' (Ziman 1991: 100).

The boundary between sciences and society and the corresponding one between knowledge and lack of knowledge are today even more blurred than Ziman might suppose: the deficit model is in a 'bitter crisis', less because its intrinsic limitations have been demonstrated than because its ideological reason for being now lacks purpose. The conditions of scientific production have changed, and new means of communication have overwhelmed the mass media's sphere of influence.

[3] Certainly, the reshaping of the spirit of the Enlightenment is still palpable in the project of dissemination of sciences: the preoccupation—disinterested or not—to achieve a true sharing of knowledge is not insignificant. But to debate it here would require a development greatly exceeding the space allocated to me.

6.3 1980 to the Present: The Free Flow of Knowledge

6.3.1 Two Introductory Remarks

Revealed by the influence of mass media, the communications utopia progressively replaced that of the Enlightenment, starting in the 1970s (Breton [1992] 1997). It first came into its own in science museums: communicating with visitors took precedence over all other considerations. The San Francisco Exploratorium and the Ontario Science Centre in Toronto both opened in 1969 and were the precursors of this trend reversal. Note, incidentally, that the thrust of 'new pedagogies', which were very active at that time, also saw the pedagogical relationship first and foremost as a communication situation. Starting in the 1980s, the Bodmer Report (1985) was first in a long series that saw communication as the means and the end. The report roundly pummelled the knowledge gap, so dear to the deficit model, pleading for a rapprochement of scientists and public by diversifying the means and situations of communication to foster contacts between the two groups, and was no longer fixated solely on elevating the level of knowledge of the public as a whole.

Another trend also in play was the progressive relegation of fundamental research to an ancillary role. It is this second trend, along with the advent of a communications utopia, much more than the media critique or the demonstrated limits of the school model—at least that's the hypothesis of advanced work—that ultimately destabilized the deficit model and its corollary, the concept of public understanding of science (in its restrictive sense). The deficit model was replaced by a participatory logic that values citizen input and advocates open dialogue with scientists, in keeping with contexts and circumstances, to refurbish the image of a science whose contribution to progress was now considered problematic (SCST 2000). The question remains whether these are the real issues today.

6.3.2 Producing Knowledge Today

The increasing integration of sciences and society in recent decades has led to the establishment of a splendid apparatus for the production, storage, treatment and dissemination of knowledge with a view to specifying it, completing it, questioning and rejecting it. The apparatus works almost in real time, thanks to frequent interactions between researchers, laboratories, networks and countries made possible by new information and communication technologies. The OECD (2002: 249) notes that this direct confrontation of work results:

> …became characterized mainly by the increase in international exchanges in the very highly intensive sectors of research–development, by the increased circulation of technologies within multinational corporation networks and by the rise in science and technology cooperation.

The cooperation is reflected in the relentless increase in publications co-signed by authors from different countries. The proportion rose from 14.3% in 1986 to 31.3%

in 1999 (OECD 2002: 51–52). This integration, however, now depends as well on a knowledge production systematically placed at the service of innovation, considered to be its prime source and likewise that of socio-economic development. Noting a reversal of the dynamic, Castells (1996) concludes that the quest for innovation today takes precedence over the quest for knowledge, which tends increasingly to be produced in a context in which potential spin-offs are the sole interest.

There are at least three consequences of this new conjuncture. First, 'the knowledge society is characterized, certainly, by an exponential growth in knowledge, a mix of all disciplines, but even more, by a reconfiguration of production modalities and management' (CST 2002: 22). The 'problems to be solved', the 'needs of the economy and society', the 'uses of technology' thus overdetermine the scientific excellence offering or the technological performance (Valenduc and Vendramin [1997] 2003).

Second, as Gibbons et al. (1994: passim) observed, this recomposition of the role of research brings in its wake a 'diversification of places of knowledge creation', a 'heterogeneity of intervenors', a 'multiplication of exchange networks', an 'increased contextualization of research' and an 'increase in scientists' social responsibility'. The 'knowledge dynamic itself' is now 'marked by internal heterogeneity, growing diversification and the more transitory character of the production and dissemination devices of knowledge'. This results in the progress of the research itself—which has to operate with a veritable archipelago of disciplines, to use Jean-Marc Lévy-Leblond's metaphor, and with a range of supporting actors and institutions. Add to this 'the increasingly imperative contextualization not only of knowledge but in its production too' (Limoges 1995: 2), and:

> [n]ew organizational forms emerge, new types of centres, networks, teams, associations of researchers and other participants…whose existence may be relatively brief…Reduced reaction time, decentralized decision-making are typical of these groups created around a problem and which do not survive its resolution (Limoges 1995: 9).[4]

Third, universities and other places of knowledge production, in the direct line of such changes, are invited to create 'a strongly innovation-oriented environment

[4] This dynamic of current research must be re-examined in a wider perspective. On this topic, Cadix (2007: 94) states: 'the R&D structure of major groups worldwide has greatly evolved over the last 15 years, the share of pre-competitive research having increased significantly. This evolution signifies that enterprises have progressed autonomously in the field of scientific knowledge, leading to a kind of privatization of knowledge'. In 2006, 'for the first time', emphasizes Greco (2007a), investment in R&D exceeded US$1,000 billion (synopsis produced from OECD data (2006), National Science Foundation (2006) and *R&D Magazine* (2006)). In his view, this trend reflects an evolution initiated 20 years ago and marked by three events: increase in R&D investment, faster growth of investment in the private sector than the public sector (ratio 2:1), and transfer of bipolar research (Europe and North America) towards research that is at least tripolar with the arrival of Asia (Indo-Pacific) (Greco 2007a: passim). This demonstrates that basic research, while still playing a determining role, is increasingly deployed in the aforementioned systematic of innovation, which of course reveals the economic logics. And it is these logics at work in the social aspect which force the recomposition of the field and its practices and finally set them in motion—by circumscribing its margin of autonomy, and by stamping their mark on the forms and modalities of knowledge production.

where dialogue between…Education and Industry develops naturally,…a *milieu*… that facilitates the production and use of knowledge'. It is also suggested that they add a dissemination component to their research and training mission, so that the scientists involved in communication techniques can participate in a dialogue with the public. This is the objective pursued by the *Scientific Communications Act of 2007* (HR 1453), adopted by the US House of Representatives (Greco 2007b).

So the question of boundary between the scientific field and society, which we had thought resolved, rears its head again. While the emphasis on basic research had in essence self-enclosed the scientific field unto itself, the reversed polarity (that is, having other actors intervene as part of the process) forced it open and questioned its monopoly on legitimate authority. A scientific problem will of course receive a scientific answer in the scientific field, but the intermeshed interests of the actors retransmit a kind of 'authorized talk' as much as a 'talk of authority' (Bourdieu 1975).

Herein lies the current issue. The norms and practices of scientific rationality do not operate alone (if they ever did); nor do they any longer suffice to dissociate interiority from exteriority. Certainly, scientific participation always implies recognition of truth as a central value of the methodological canons that define rationality (Bourdieu 1975). And it is certainly in and by its self-regulation mechanisms, as in any other area, that the scientific field co-interacts with other contexts. However—and this is an important 'however'—the contemporary qualitative leap springs from the magnitude of interactions between the contexts and the *intricatio* of their co-evolution (Nowotny et al. 2002). Suddenly contemporary society is marked by pluralism and diversity, a rise in complexity and uncertainty (Friedman et al. 1999), and greater openness of 'systems of knowledge production'. This evolution, which brings a 'reconfiguration' of the role of 'knowledge' and 'actors', *de facto* restores a place to 'context', until now denied by the prevailing objectivism:

> Pre-existing contexts and deep social substructures, influence science-before-the-event, just as its future impacts anticipate science-after-the-event. The setting of priorities and the patterns of funding are not self-evident or self-referential; rather they are the result of complex negotiations in a variety of contexts, where expectations and vested interests, unproven promises and mere potentials play a role (Nowotny et al. 2002: 20).

However, the instantaneity and the volume of exchanges enabled by information and communications technologies not only transform practices in the scientific field, they are now a fact of life for society as a whole. Suddenly, this transversal and heterogeneous lay expertise in communication bites into the mass media's capital of authority, overwhelmed as it is, notably in the PCST field, by the de-multiplication of contexts precisely where communication is deployed (Breton and Proulx 2002).

The valorization discourse on fundamental research is now receding, its associated representations, notably the deficit model, declining in symbolic effectiveness and operativity accordingly—whence comes a renewed questioning of the relevance and validity of those representations. At the same time, the diversification of information sources reducing the mass media's impact on society are being viewed anew, and their capacity to fill a knowledge deficit is now jeopardized by a generalized access. But before scrutinizing the replacement models, we must consider the impact of current transformations on the organization of work.

6.3.3 Common Work Conditions

The evolution of the conditions of research work must be understood relative to those that govern the working world. In the dynamic of current massification, there is no distinction between the researcher's working conditions and those of the employee or worker. Researchers toil under the same shingle—at the whim of burgeoning or shrinking demand that determines whether their expertise is needed or not. 'Faced with a highly competitive and volatile economy', says Rifkin, viewing the situation in the US:

> [m]any companies are paring down their core labor pool and hiring temps in order to be able to add and delete workers quickly in response to seasonal and even monthly and weekly trends in the market.
>
> …Even scientists who, by virtue of their expertise, are widely thought to be immune to job insecurity in the high-tech knowledge economy are being reduced to temp work. On Assignment Inc, a temporary agency specializing in leasing scientists to companies ranging from Johnson & Johnson to Miller Brewing Company, has more than 1100 chemists, microbiologists, and lab technicians ready to lease around the country…The federal government has begun to follow the lead of the private sector, replacing more and more full-time civil servants with temps to save on overhead and operating costs' (Rifkin: 1995, 192, 193).

Certainly, places exist where the image is still 'competency' and 'legitimacy'. But amid this dire trend characteristic of the third industrial revolution, it is becoming increasingly the exception, according to Rifkin, to guarantee permanent jobs to a substantial number of researchers. For Rifkin, the new technologies mean an economic system reorganized through the massive use of modern technologies—automation—with a concomitant reduction in labour. The wave of re-engineering and automation answers a need to increase productivity in a globalized economic context. It translates daily into the laying off of increasing numbers of qualified workers, including scientists. This often leaves the sole perspective of the future as a succession of temporary jobs (Rifkin 1995).

This recomposition of the work sphere, Rifkin continues, also pursues a second objective: 'the movement toward contingent workers is part of a long-term strategy by management to cut wages and avoid paying for costly benefits like health care, pensions, paid sick leave, and vacation'. This leads some observers to ask if such an evolution will not ultimately 'reduce employee loyalty'—who are we kidding?—adversely affecting the business community down the road (Rifkin 1995: 191). There is growing uneasiness about the question of values in this new environment: substituted values, since they replace those that should be promoted in order to imagine a life in research.

6.3.4 Ongoing Acculturation

Such a dynamic stimulates the production of new knowledge, increases exchanges between research teams and intensifies the production of new goods and services, but it demands prior development of new skills and abilities, individual and collective.

In this spirit, Bauer (1998) showed that the times when the 'sciences–society' relationship was reformulated also reaffirmed the need for a science literacy, and that the two happen (through long economic cycles and structural adjustments) to emerge from crisis when the potential for innovation in S&T is in full swing. According to Bauer, the social valuing of S&T that accompanies the social debate characterized a requirement for acculturation to new competencies.

No one will dispute that innovation and mastery of S&T changes cannot be the product of a minority, however well educated it may be. They depend fundamentally on a collective competency. 'The capacity of a population with insufficient science and technology culture to act and react became…distinctly lessened'. And this 'capacity for action and reaction' is exercised in all 'places of decision' (CST 2002: 28). Each must be able to judge the quality of abundant and multiform information from its source, and then sort, evaluate and integrate it to extract useful knowledge or arrive at a decision (CST 2002: 5, 2 passim):

> The rapid advances in research raise many questions in terms of impact, acceptability, ethics and law. The answers to these question don't come solely from science and technology activity. Citizens are called upon, there again, to exercise their critical judgment and enter into the new relationships with the sciences.
>
> Indeed we go from a culture of sciences, with all its certainties and objectivity, to a culture of research, with the risks, complexity and uncertainties that characterize it (CST 2002, 25–26).

In this perspective, PCST would fulfil a dual function: on the one hand a destabilization of knowledge and the abilities till then required for entry into the scientific field and the workforce (a critical step in deconstructing an obsolete knowledge relationship), and on the other hand a function giving value to the emerging competencies (a positive step in establishing a new relationship). So the whole debate on the effect and limitations of the deficit model and its replacement by a discourse on the contextual model (or any other substitute model) in the PCST field can be seen as an adjustment of the function and reformulation of the discourse without actually deconstructing the ideological operativity as such.

6.3.5 *Referential Shift: Which Science Literacy Today?*

To examine this question, let's first return to the notion of science literacy, noted several times but not yet fully examined. This notion should be handled circumspectly, since it is 'like general culture and culture in general': like content, it draws on a determinable body of knowledge and competencies; as process, it designates their transmission via agents—the media among others—which means evaluating the scope, effectiveness and penetration. But to limit oneself to these two aspects 'is to forget that culture, be it general or scientific, primarily involves collective representations, and more precisely categories of thinking, symbols, values and models' (Fournier 1995: 7). As such, science culture—in the fashion of culture—is a complex of signs and meanings embedded in the devices of values, attitudes and meaning that come to crystallize practices. Thus defined, science culture refers to a societal context (Jantzen 2001), to 'all the modes whereby a society appropriates science and technology' (Godin et al. 1998: 2) and, individually, to a person's attitudes, knowledge and skills (Schiele et al. 1994). In summary, this definition refers to the collective and individual dispositions on which are based the interpretations—and more generally the meaning—that the social actors give to their real, anticipated or imagined actions when they adopt a posture in a given social situation (in which they are called upon to participate or which they envisage doing).

Recent work (Bauer et al. 2007) points to three moments in time when science culture has been questioned. Initially limited to assessing the knowledge of basic scientific concepts considered to be known and mastered by the public, the objective widened until it encompassed the relationships between sciences and society. Beginning in the 1960s, it sought to measure *science literacy*. The National Science Foundation, the American Association for the Advancement of Science and others were compelled to intervene on this level. In successive studies by Science and Engineering Indicators (Washington D.C.), the assessment of knowledge of the 'scientific method' and mastery of 'scientific reasoning' left no lingering doubt as to what they considered important. After 1985, the main consideration was *attitudes* (public understanding), and since 1990 the operative for assessment has been *trust* in science.

So the surveys have gone from a limited understanding of science culture, reduced to disjointed elements of factual knowledge (Miller 1983), to a questioning of its symbolic and operative aspects. On the one hand, this means questioning the modalities of society's distancing from itself, and thence one of the forms of exteriority whereby 'it becomes visible to its members' (Quéré 1982) in a given situation; on the other hand, it is a questioning about the interactions between the fields of action in which the social actors evolve (for example, the logics at work in the interactions between associative experts and activists). While science literacy was seen at the beginning as the product of an exteriorized method, and deferred to a subjectless statement, it now involves contexts in which actors and situations evolve and adopt postures to speak about the objects they are dealing with. Today's knowledge is increasingly produced in a context of and with a view to optimization. Interest in its intrinsic value blurs into the value of its potential operationalization.

These aspects certainly interact with each other, but we can nonetheless question which one really depicts the 'sciences–society' relationship. Is it merely superficial discourse? Partly! In this case, Bauer[5] attributes a dual process: the acculturation to new skills, and the relegation of others deemed outmoded. Is it in terms of knowl-

[5] However, let us enlarge the angle of approach a little: to speak of the 'sciences–society' relationship is reductive. There is no 'one' 'sciences–society' relationship at any given moment, but a conjuncture of co-occurring relationships, interacting with each other. Bauer's work sheds light on only one of these components. Moreover, there is no reason *a priori* to think that these different relationships inter-articulate with each other to form a coherent whole. Various discourses can coexist, which explains why social actors sometimes have one opinion about science while researchers have another. For example, the growing interest in the environmental question, an

edge and the assimilation of modes of reasoning inherent in scientific thinking? Or does it concern the formation of the social identity? If that is the case, what is the ideal type of identity sought or desired in a given situation? On this precise point, Forgas defines social identity as:

> …an individual's knowledge that he belongs to a certain social group together with some emotional and value significance of his membership. In other words, an individual self-image and self-concept may be thought of as, to some extent, dependent on his group memberships, and in particular, on the differentiation which exists between his own group and others (Forgas 1981: 124).

Sennett (2006: 7) continues in the same vein: 'as a general rule identity concerns not so much what you do as where you belong'. To put it another way, the appreciation of competency is certainly a necessary indicator, but is not enough. The knowledge and skills in themselves—the fact of knowing this or that, or knowing how to do this or that—have meaning only in keeping with the social context where they operate, the situation in which they are mobilized, such that those situations are experienced by the actors, and the type of social inclusion that emerges.

Therefore, the social function of PCST has less to do with the dissemination of knowledge, the coming together of scientists and the public, or democratic participation in a society dominated by S&T than it has to do with the values mobilized to give value to a type of social identity sought and, by corollary, the adoption of a particular posture as much related to knowledge as its implementation. It is this interiorization of a social relationship with the sciences, much more than the mastery of specific knowledge, that really counts (without excluding its necessity, of course), for it is the *dispositio*—the manner of imagining, thinking and projecting oneself in a situation of appropriation, production and knowledge use—that achieves the potential.

6.3.6 Conditions of Emergence of New Values

These various aspects of the contemporary situation show that the strategies and means habitually deployed by PCST no longer fulfil the task in a society that has become at once more complex, more fluid and constantly subject to change—a direct consequence of its profound dynamic—and whose underlying values are recomposing rapidly.

The transformations in the work sphere are altering the values traditionally associated with it. They are also changing the relationship with knowledge

awareness-raising of man's impact on the environment, illustrates the coexistence of opposing discourses among the actors. In a society responding to the dynamic of innovation, man is faced with the risk of a 'technician' evolution; but, while simultaneously inventing ways of using knowledge, he equally strives to measure and counter 'the effects … of his handiwork'! (Jantzen 1996: 26, passim): two logics—among others—operating in tension; both in the social dimension.

passed down from the Enlightenment. The Enlightenment[6] saw knowledge as constitutive to the individual subject: the acquisation of knowledge—a voluntary effort—transforming the knowing subject, enabling one to go beyond one's original condition, to tear away, to transcend it. Man was defined in terms of intrinsic qualities, in terms of an 'interiority' that determines his 'personality'. The role of the school and all processes of dissemination of culture consisted of 'training', an act of education on the 'self', and not in 'informing', since it is this 'interiority' which is the objective and challenge of education and culture. They are not reducible to the transmission of a quantity of know-how, abilities, competencies or information about sciences or any other domain, but to an interior 'modelling'.

Elsewhere, but in the same vein, there is the researcher (the ideal type of Snow and Bush) in his laboratory but also in a quest to 'go beyond', not only to extend a specific knowledge but more especially to transcend himself, since discovery means projecting oneself beyond a given state of knowledge deemed insufficient. In and by this process, which leads to discovery, he seeks to attain a higher level of understanding (that is, awareness)—an effort that completely engages the researcher. 'We know', wrote Bachelard [1938] 1970: 14), 'compared to earlier knowledge, by destroying ill-made knowledge, by surmounting that which, in the mind itself, forms obstacles to spiritualization'.

Before, in the mindset of the Enlightenment, to value and promote the sharing of a science culture was to have the public participate in this metaphor of the man 'acting within'. It was understood that this provoked encounter with knowledge would alter man's perception of science and its relationships with society as he came to know more, that access to a certain knowledge of sciences transforms him, that he becomes an 'other'. 'The classic humanist man', wrote Breton, 'is a man directed from within'. This conception sketched out such notions as 'depth of feelings' or 'riches of the interior life'. In discovering the 'subconscious', Freud helped nourish this concept of the human being as 'acting from within' (Breton 1997: 54). And this powerful metaphor was now opposed by the accompanying effects it had impelled and set in motion.

The paradox of the utopia of the Enlightenment can be summarized this way: today's society has retreated from the values it helped to create and build, since its organizational mode no longer serves them. Instead it helps to erase them. Even the ideological derivation of the deficit model remained subject to this metaphor—a metaphor that now rings false since it is no longer in sync with the conditions that affirm today's rising values.

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[6]For Laïdi (1999: 15–16; freely translated), the Enlightenment yields three principles: 'The first is that of mastering the destiny of the Man of Reason … The second is that of going beyond, tearing away from his original condition to transcend oneself, to surmount and achieve the universal…The third, finally, consists of believing and thinking that History has a meaning, that History is oriented, thus reinforcing the idea that men are beholden to the events they live, and they can orient them towards their objectives and their finalities'.

6.3.7 Recomposition of the Identity Relationship

What are those rising values? A first line of reply comes from Breton's analysis, in which he showed that the new communication utopia provides an 'alternative metaphor'. 'Modern man is first of all a "communicating being". His interior is fully exterior'. And the messages he reacts to are not from a 'mythic inside, but rather from his "environment"' (Breton 1997: 55, passim). The 'communicating' man is wholly overdetermined by his environment. 'He draws his energy and his vital substance not from his own inner depths, but from his capacity, as an individual "connected" to "vast communication systems", to collect, to process, to analyze the information needed to live' (Breton 1997: 56). The advent of a communication utopia as symbolic horizon therefore offered social actors a framework of interpretations of changes that would affect them, notably in the work world, starting in the 1970s—a framework that enabled the adoption of an identitary posture, recomposed around this alternative metaphor, mobilizing new norms and soliciting new rules in the daily interactions of participating actors (Weber [1920] 1967).

A second line is proposed by Sennett (2006). His analysis revealed a dissolution, or at least a considerable weakening, of the social link due to the evolving conditions of production and work. Sennett is very careful to state that his analysis deals only with certain firms (those most likely to benefit from leading-edge technologies) but points out that they are the ones that set the tone for organizational change. He shows that the end of the Bretton Woods accords in the early 1970s, which ultimately freed up capital, accompanied by a major international movement of those firms and the creation of new financial tools, translated into a radical transformation in the power relationships of enterprises to the benefit of investors and to the detriment of the frameworks that had hitherto ensured its development and operation. By wagering on short-term results, investors, indifferent to the culture of the organization, speeded its transformation. Increasingly at the whim of the marketplace, organizations had to become more dynamic, more flexible and able to change: 'Stabilty seemed a sign of weakness, suggesting to the market that the firm could not innovate or find new opportunities or otherwise manage change' (Sennett 2006: 41).

The ever-burgeoning communications revolution (*computerization*) added its own thrust to this accelerating movement of 'creative destruction' (Schumpeter [1942] 1975). It is characterized first by a rapid deployment of automation, a faster flow of activities, and time compression, with constant demand for ever shorter response times to remain competitive; and second by a reduction in middle management now considered superfluous: 'No group is being harder hit than middle management. Traditionally, middle managers have been responsible for coordinating the flow up and down the organizational ladder. With the introduction of sophisticated new computer technologies, these jobs become increasingly unnecessary and costly' (Rifkin 1995: 101). Why? Because communication technologies providing complete, unequivocal information at all levels of the organization simultaneously reduce the middle-level coordination work: 'e-mail and its derivatives [diminish] the mediation and interpretation of commands and rules verbally passing down the chain of command' (Rifkin 1995: 101).

The result is a new form of centralization (Sennett 2006: 4–43) and at the same time greater flexibility, the most obvious effect of which is the modulation of production and externalization sequences. These changes clearly alter the organization of work, but to an even greater extent they affect the work experience of the individual social actor, and ultimately everyone. Suddenly, the interiorization of once-valued attitudes, skills and competencies blunts their once-valued meaning. The effort becomes obsolete, just as the modes of appropriation and mobilization of knowledge formerly needed to perform now outmoded tasks no longer have currency. For example, with widening automation, learning new skills takes on a whole other meaning:

> As automation spreads, the field of fixed human skills shrinks. Fifty years ago, holding a conversation with a machine about one's bank account would have seemed a sci-fi fantasy; today it's taken for granted. Here again appears the idealized new self: an individual constantly learning new skills, changing his or her 'knowledge basis'. In reality that ideal is driven by the necessity of keeping ahead of the machine. (Sennett 2006: 44; by 'new self' Sennett refers to the new idealized 'me', a social actor, obliged to compose and adapt to changes over which he has little power.)

The new social actor, unlike the earlier one, is flexible and mobile. He does not envisage a lifetime career in the same organization; he shuns dependence and keeps his distance from the state providence that institutionalized it, preferring to self-manage his children's education, his retirement investments and his medical coverage. In a way, he is a perpetual freelancer, maintaining an active extended network of relationships, without which his margin of manoeuvre would be reduced! At his task-oriented job, his mindset lets him pass readily from one task to another[7] (Rifkin 2000, Sennett 2006: 44–50, passim). And what he has to know in order to do it is self-referencing. For what comes next, no problem, he'll start from zero. When asked what knowledge is required to go from one job to another, Sennett replied 'Each time you start a new job, you need to fake it'.

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[7] 'This new way of working permits what management-speak calls the delayering of institutions. By outsourcing some functions to other firms or other places, the manager can get rid of layers within the organization. The organization swells and contracts, employees are added and discarded as the firm moves from one task to the other. The 'casualization' of the labor force refers to more than the use of outside temps or subcontractors; it applies to the internal structure of the firm. Employees can be held to three- or six-month contracts, often renewed over the course of years; the employer can thereby avoid paying them benefits like health care or pensions. More workers on short contracts can be easily moved from task to task, the contracts altered to suit the changing activities of the firm. And the firm can contract and expand quickly, shedding or adding personnel … Taken together, these three building blocks of institutions—casualization, delayering, and nonlinear sequencing—shorten the organization's time frame; immediate and small tasks become the emphasis … Socially, short-term task labour alters how workers work together'. (Sennett 2006: 48–50).

6.4 Rethinking 'Sciences–Society' Relationships in the Current Context

Lévy-Leblond (1994: 41) pleaded to reverse the perspective 'for a problematic of science and technology enculturation aimed at changing society'. This would involve 'changing the science we do, its organization and its orientations'. In fact, it is the transformations of society—partly due to constant interaction with science—that change the organization and orientation of society, which changes the conditions of its enculturation, not the reverse.

That is why there is something surrealistic about asking researchers today what they think are society's expectations, without reference to the conditions of their vocation, neither mentioning it nor comparing it to other conditions elsewhere. How can we now mention 'sciences' without bringing in 'society' (as in the deficit model) and not reify the idea of a distinction between 'science' and 'society' as if they are radically dissociated from each other. The argument may be that this is well known and that talking about 'sciences' and 'society' today leads nowhere, that it is but a handy artifice of language. In any case, the studies measuring the extent of the distance between or rapprochement of public researchers and the science public are misleading. They re-actualize a spontaneous conception that produces, maintains and perpetuates the effect of a social distance between scientists and the rest of society that is refuted by present transformations (Bourdieu 1979). (But this spontaneous concept has promise, explaining in part why the applied policies to develop and valorize science culture have, until now, always fed into the deficit model as a conceptual framework and general principle of action.) So there's some work cut out ahead: to deconstruct these distance effects because they mask reality.

In this new perspective, it is useful to recall that the legitimacy of scientists to undertake risky research is more in question since they are no longer the sole contractors or participants. In short, one-way communication is no longer possible because henceforth this new organization of research will work with a generally more educated, more aware and alerted public (SCST 2000). Also, in a society overdetermined by sciences in which researchers are heading off in all directions, we can heartily anticipate a raft of debates and controversies. Amid all this, we must ask whether the future knowledge society will be a pacified society.

Whatever the future holds, new instances of negotiation (national or supranational) will be necessary to manage opposing discourses and instigate some sort of cooperation. Raising the educational level makes it necessary to invent the instances and processes of negotiation, in which knowledge dissemination comes into its own once it is linked to the issues and challenges. These will be new places of 'action–dissemination' that associations, pressure groups, NGOs and others try to establish in working to crystallize tensions. And this criss-crossing of actors and interests will surely scrutinize and question the status of sciences. All in all, this recomposition of the public role, dispersed into various interested or mobilized publics, will force a cohabitation of legitimacies, with arbitration becoming one of the real issues of our society.

However, while the public is increasingly present in the debates, this is undoubtedly also because the myth of 'progress' no longer operates as before (exit the Enlightenment). The public is ambivalent. It doesn't necessarily run counter to sciences or scientists. It is neither reactionary nor obscurantist. It simply considers that scientific progress does not necessarily mean enhanced well-being and better quality of life. That is why it hopes, and is finding ways, to be heard. While it is natural for researchers to want to share with the public their passion for scientific knowledge and truth, even to alert public opinion in certain circumstances today, such undertakings can only reconcile the interests of actors nurtured on other logics and engaged in other systems of action.

From this flows a co-extensive evolution of the conception of PCST and its role. The intrinsic theoretical limitations of the deficit model, conceptualized as a transitive communication relationship (scientist → media practitioner → public), clearly illustrate the difficulties of going from one conception of scientific culture to another. Today's interest is less in knowledge for its own sake than in its uses, and the heterogeneous array of participants in the debates will force PCST to refocus on the activities, competencies and skills of the actors, the situations they are part of, and the postures they assume, as well as their convictions, attitudes and values.

Finally, the time has come to go beyond the opposition between 'sciences' and 'society' because it does not sufficiently acknowledge that sciences are not 'elsewhere' but 'within' our society's organization. It is time to act and ensure that the current context of producing scientific knowledge renders a one-way communication null and void, dispels a now outmoded discourse, and admits once and for all that an ambivalent public is neither obscurantist nor anti-science, but certainly more critical since it feels that progress is no longer the answer. And it is time to recognize that the new media enable flexible forms of organization and action and a self-organizing effect that we are only beginning to understand.

If the contextual model, which is now replacing the deficit model, represents the new reality of scientific production and its dissemination in the public sphere, the conditions of possibility required in order to pose the question of the contextual model as a theoretical problem and not as an ideological answer will have come together. My objective in this chapter has been precisely to spark a discussion on these questions.

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References

Bachelard, G. ([1938] 1970). *La formation de l'esprit scientifique*. Paris: Vrin.

Bauer, M. (1998). 'La longue durée' of popular science, 1830, present. In D. Devèze-Berthet (Ed.), *La promotion de la culture scientifique et technique: ses acteurs et leurs logiques*. Paris: Université Paris 7, Denis Diderot, 75–92.

Bauer, W. M., Allum, N. & Miller, S. (2007). What can we learn from 5 years of PUS survey research? Liberating and expanding the agenda. *Public Understanding of Science*, *16*, 79–95.
Bensaude-Vincent, B. (2000). *L'opinion publique et la science—A chacun son ignorance*. Paris: Institut d'édition sanofi-synthelabo.
Bodmer, W. (1985). *Public understanding of science*. London: Royal Society.
Bourdieu, P. (1975). La spécificité du champ scientifique et les conditions sociales du progrès de la raison. *Sociologies et Sociétés*, *7(1)*, 91–118.
Bourdieu, P. (1979). *La distinction—Critique sociale du jugement*. Paris: Les éditions de minuit.
Bourdieu, P. (1980). *Questions de sociologie*. Paris: Les éditions de minuit.
Bourdieu, P. & Wacquant, L. J. (199). *An invitation to reflexive sociology*. Chicago: University of Chicago Press.
Breton, P. ([1992] 1997). *L'Utopie de la communication*. Paris: La Découverte.
Breton, P. & Proulx, S. (2002). *L'Explosion de la communication à l'aube du XXIe siècle*. Montréal, Paris: Boréal, Editions La Découverte & Syros.
Bush, V. ([1945] 1960). *Science, the endless frontier—A report to the President on a program for postwar scientific research*. Washington, D.C.: National Science Foundation.
Cadix, A. (2007). Intervention dans l'atelier 'Recherche et enjeux de société'. In J.-P. Alix (Ed.), *Sciences et société en mutation*. Paris: CNRS Edition, 94.
Castells, M. (1996). *The rise of the network society*. Cambridge and Oxford: Blackwell.
CST (Conseil de la Science et de la Technologie) (2002). *La culture scientifique et technique au Québec*. Bilan, Sainte-Foy: Government of Quebec.
De Solla Price, D. (1963). *Little science, big science*. New York: Columbia University Press.
Eidelman, J. (1988a). La création du Palais de la Découverte—Professionnalisation de la recherche et culture scientifique dans l'entre-deux guerres. Thesis, Université Paris V, René Descartes.
Eidelman, J. (1988b). Culture scientifique et professionnalisation de la recherche. In D. Jacobi & B. Schiele (Eds.), *Vulgariser la science*. Seyssel: Champ Vallon, 175–191.
Fontenelle, B. Le Bovier de ([1686] 1990). *Entretiens sur la pluralité des mondes*. Paris: Editions de l'aube.
Forgas, J.-P. (1981). *Social cognition—Perspectives on everyday understanding*. London: Academic.
Fourastié, J. (1979). *Les trente glorieuses—ou la révolution invisible de 1946 à 1975*. Paris: Fayard.
Fournier, M. (1995). *L'espace public de la science ou la visibilité sociale des sciences, Etude réalisée pour le compte du Conseil de la science et de la technologie*. Sainte-Foy: Government of Quebec.
Friedman, S. M., Dunwoody, S. & Rogers, C. L. (Eds.) (1986). *Scientists and journalists—Reporting science as news*. New York, London: The Free Press.
Friedman, S. M., Dunwoody, S. & Rogers, C. L. (Eds.) (1999). *Communicating uncertainty—Media coverage of new and controversial science*. Mahwah (New Jersey), London: Lawrence Erlbaum Associates, Publishers.
Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, P. S. & Trow, M. ([1994] 1995). *The new production of knowledge: The dynamics of science and research in contemporary societies*. London: Sage.
Godin, B., Gingras, Y. & Bourneuf, E. (1998). *Les indicateurs de la culture scientifique et technique*. Study conducted for the Ministry of Industry, Trade and Technology, the Ministry of Culture and Communications, and the Conseil de la science et de la technologie. Sainte-Foy: Government of Quebec.
Goldsmith, M. (1986). *The science critic—A critical analysis of the popular presentation of science*. London, New York: Routledge & Kegan Paul.
Greco, P. (2007a). Science museums in a knowledge-based society. *Journal of Science Communication*, *6(2)*, 1–3 (http://jcom.sissa.it/).
Greco, P. (2007b). University in the 21st century. *Journal of Science Communication*, *6(2)*, Editorial (http://jcom.sissa.it/).
Jacobi, D. & Schiele, B. (1990). La vulgarisation scientifique et l'éducation non formelle. *Revue française de pédagogie*, *91*, 81–111.

Jantzen, R. (1996). La cité des sciences et de l'industrie—1996–2006. De la décennie de floraison… Vers la décennie de raison? Mission report.

Jantzen, R. (2001). *La culture scientifique et technique en 2001: Constats pour agir demain. Constater, impulser, agir*. Mission report presented to the Ministry of National Education and the Ministry of Research, Paris.

Laïdi, Z. (1999). *La tyrannie de l'urgence*. Quebec: Musée de la civilisation.

Lévy-Leblond, J.-M. (1994). La vulgarisation: Mission impossible. *Interface*, *15(2)*, 41.

Lewenstein, B. V. (1992). The meaning of 'public understanding of science' in the United States after World War II. *Public Understanding of Science*, *1(1)*, 45–68.

Limoges, C. (1995). L'université entre la gestion du passé et l'invention de l'avenir. Symposium de la Commission de planification, ronéotypé.

Maldidier, P. (1973). *Les revues de 'vulgarisation', contribution à une sociologie des cultures moyennes*. Report, Centre de Sociologie Européenne (Centre de Sociologie de l'éducation et de la Culture), Ecole Pratique des Hautes Etudes (ronéotypé).

Maldidier, P. & Boltanski, L. (1969). *La vulgarisation scientifique et ses agents*. Report, Centre de Sociologie Européenne, Ecole Pratique des Hautes Etudes (ronéotypé).

Meadows, J. (1986). Histoire succincte de la vulgarisation scientifique. *Impact*, *144*, 395–401.

Miller, J. D. (1983). Scientific literacy: A conceptual and empirical review. *Daedalus*, *11(2)*, 9–48.

Miller, J. D., Pardo, R. & Niwa, F. (1997). *Public perceptions of science and technology—A comparative study of the European Union, the United States, Japan and Canada*. Bilbao: Fundación BBV.

Moles, A. A. & Oulif, J.-M (1967). Le troisième homme, vulgarisation scientifique et radio. *Diogène*, *58*, 29–40.

Mortureux, M.-F. (1983). *La formation et le fonctionnement d'un discours de la vulgarisation scientifique au XVIIIe siècle à travers l'œuvre de Fontenelle*. Paris: Didier-Erudition.

Moscovici, S. (1976). *La psychanalyse, son image et son public*. Paris: Presses Universitaires de France.

Nelkin, D. ([1987] 1995). *Selling science—How the press covers science and technology*. New York: W. H. Freeman and Company.

Nowotny, H., Scott, P. & Gibbons, M. (2002). *Re-thinking science. Knowledge and the public in an age of uncertainty*. Cambridge: Polity Press.

OECD (Organisation for Economic Co-operation and Development) (2002). *Science, technologie et industrie, Perspectives de l'OCDE 2002*. Paris: OECD.

Quéré, L. (1982). *Des miroirs équivoques—Aux origines de la communication moderne*. Paris: Aubier Montaigne.

Raichvarg, D. & Jacques, J. (1991). *Savants et ignorants—Une histoire de la vulgarisation scientifique*. Paris: Seuil.

Rifkin, J. (1995). *The end of work. The decline of the global labor force and the dawn of the post-market era*. New York: Tarcher/Putnam.

Rifkin, J. (2000). *The age of access. The new culture of hypercapitalism where all of life is a paid-for experience*. New York: Tarcher/Putnam.

Roqueplo, P. (1974). *Le partage du savoir*. Paris: Seuil.

Rose, A. J. (1967). Le Palais de la Découverte. *Museum 2*, *0(3),* 206–208.

Schiele, B. (2007). Publicizing science! To what purpose?—Revisiting the notion of public communication and technology. *Science Popularization*, *8*, 65–75, and *9*, 66–73. Also appeared in French as Publiciser la science! Pour quoi faire? In I. Paillart (Ed.), *La publicisation de la science*. Grenoble: Presses Universitaires de Grenoble, 11–51.

Schiele, B. & Jacobi, D. (1988). La vulgarisation scientifique—Thèmes de recherche. In D. Jacobi & B. Schiele (Eds.), *Vulgariser la science*. Seyssel: Champ Vallon, 21–47.

Schiele, B., Amyot, M. & Benoît, C. (1994). *When science becomes culture—World survey of scientific culture*. Ottawa: University of Ottawa Press.

Schumpeter, J. ([1942] 1975). *Capitalism, socialism, democracy*. New York: Harper.

SCST (Select Committee on Science and Technology) (2000). *Science and society*. Third report. London: House of Lords.
Sennett, R. (2006). *The culture of the new capitalism*. New Haven and London: Yale University Press.
Snow, C. P. ([1959, 1964] 1974). *The two cultures and a second look*. London and New York: Cambridge University Press.
Valenduc, G. & Vendramin, P. ([1997] 2003). La recherche scientifique et la demande sociale. *Associations Transnationales/Transnational Associations*, *6*, 298–305.
Weber, M. ([1920] 1967). *L'éthique protestante et l'esprit du capitalisme*. Paris: Plon.
Wynne, B. (1991). Knowledge in context. *Science, Technology, and Human Values*, *16(1),* 111–121.
Wynne, B. (1995). Public understanding of science. In S. Jasanoff, G. E. Markle, J. C. Petersen & T. Pinch (Eds.), *Handbook of science and technology studies*. Thousand Oak, London, New Delhi: Sage, 361–388.
Ziman, J. (1991). Public understanding of science. *Science, Technology and Human Values, 16(1),* 99–105.
Ziman, J. (1992). Not knowing, needing to know, and wanting to know. In B. V. Lewenstein (Ed.), *When science meets the public*. Washington: American Association for the Advancement of Science, 13–20.

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Chapter 7
Towards an Analytical Framework of Science Communication Models

Brian Trench(✉)

Abstract This chapter reviews the discussion in science communication circles of models for public communication of science and technology (PCST). It questions the claim that there has been a large-scale shift from a ‘deficit model’ of communication to a ‘dialogue model’, and it demonstrates the survival of the deficit model along with the ambiguities of that model. Similar discussions in related fields of communication, including the critique of dialogue, are briefly sketched. Outlining the complex circumstances governing approaches to PCST, the author argues that communications models often perceived to be opposed can, in fact, coexist when the choices are made explicit. To aid this process, the author proposes an analytical framework of communication models based on deficit, dialogue and participation, including variations on each.

Keywords Communication models, deficit model, dialogue model, participation model

Science communication has been telling a story of its own development, repeatedly and almost uniformly, for almost a decade. The story is a straightforward one: science communication used to be conducted according to a ‘deficit model’, as one-way communication from experts with knowledge to publics without it; it is now carried out on a ‘dialogue model’ that engages publics in two-way communication and draws on their own information and experiences.

This chapter examines the validity of the claim that we have been living through such a fundamental shift in approach, and considers the possibility that several models, including deficit and dialogue models, can coexist. I argue the need for clearer articulation of the choices being made in science communication practice and propose a framework for the structuring of those choices.

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7.1 From Deficit to Dialogue: a Story Too Often Told?

The 'grand narrative' in public communication of science and technology (PCST) since the late 1990s has had compelling force. It has been replayed in policy statements, in academic studies, in debates on public communication within scientific communities, and in public debates on science–society relations. We have learned, the story goes, that one-way, top-down communication of packaged scientific information does not work. Now science communication makes it easier for the public to talk back, and scientists need to listen, so that understandings can be developed together.

One of the several remarkable features of this story is how broadly it has been adopted, across the continents and by governments, scientific societies, intergovernmental bodies, civil society organizations and many other interests. To give any one illustration would risk misrepresenting the universality of the process by which a key idea has diffused across the world and been naturalized.

There are, of course, local and specific variations, for example in the naming of some strategies as 'public engagement', but the main thrust of the argument is clear and it is shared: the old, traditional ways are discredited; the new ways are better. The story is not just one of opposition—it is one of evolution, of progress from deficit to dialogue.

After several years of repetition, the story may be wearing thin, at least as an accurate descriptive account of what has happened. It is, at best, implausible that scientific communities and those working closely with them in policy or publicity have shifted their approach radically over a short period. Cultural change, even at the level of relatively self-contained subcultures, tends to happen on longer cycles and to be more ambivalent. When the story is told in its British version, as one of change marked by a report from the House of Lords Select Committee on Science and Technology Committee (SCST 2000), the change of direction is all too neatly tied to the change of millennium. In fact, that report spoke, among other things, of a 'mood for dialogue' that was growing within the population over a longer time and might, therefore, take time to manifest itself more clearly.

In some scientific communities, too, the 'mood for dialogue' was evident several years before the House of Lords report. In the 1990s, the Biotechnology and Biological Sciences Research Council (BBSRC) in Britain stated that it had devised 'a programme of activities designed to enhance public access to science and scientists with a view to improving public confidence and stimulating open debate about science and technology'.[1] The council said its activities were increasingly about 'mutuality' and 'transparency in the way BBSRC interacts with the public'. Thus, the keywords of the dialogue model were established in at least one important field before this model received broader and higher level endorsement.

So, at the level of description, the deficit-to-dialogue story needs qualification. Indeed, it needs more, because in precisely that field of biotechnology and biological sciences there were particular pressures to open dialogue and the responses were equivocal. The widespread and sometimes militant social reaction to developments in

[1] http://www.bbsrc.ac.uk

biotechnology, and in genetic engineering in particular, could not be faced down by mere repetition of scientific information. A former *New Scientist* editor has recalled several initiatives from the late 1980s onwards to engage media and the wider public in discussion of the implications of then current scientific developments. He cites the example of the UK National Consensus Conference on Plant Biotechnology in 1994, sponsored by the BBSRC, but concludes that it was a ‘one-off’. ‘No one at the top of the BBSRC saw the need to develop the model’ (Dixon 2007).

In Ireland, the strong reaction from citizen groups to trials of genetically modified (GM) crops prompted scientists and companies in biotechnology and genetics to facilitate and engage in public debate, including with committed opponents of GM foods. A technology foresight report that contributed significantly to a radical increase in government spending on scientific research included among its recommendations a proposal for a ‘national conversation on biotechnology’ and advocated ‘a communications strategy in biotechnology that uses a partnership approach with ongoing, transparent and open dialogue’ (Technology Foresight Ireland 1999). As the heat went out of the GM foods debate, this recommendation disappeared from view. In 2004, a website established by government specifically to facilitate public education and debate on biotechnology was closed down.

We shall return later to consider the social and political factors that influence the adoption or abandonment of a science communication model. For now, we can further question the story of a uniform shift from deficit to dialogue by pointing to the very evident persistence of the deficit model. Sociologist Brian Wynne, who is strongly associated with the early identification and critique of the deficit model in the early 1990s (Wynne 1991, see also Ziman 1991), has observed the ‘multifold reinventions of the public deficit model’ (Wynne 2006). He and colleagues have noted that the apparent consensus about dialogue covers ‘deeper ambivalence. Old assumptions continually reassert themselves … No sooner have “deficit” models of the public been discarded than they reappear’ (Wilsdon et al. 2005).

Perhaps the most visible example of an unreconstructed deficit model is the work of popular science writer Richard Dawkins. His is more than an individual case, as his book, *The god delusion* (2006) has been a best seller and clearly has wide resonance in scientific and science-attentive communities and beyond. Through his books, lectures, TV programmes and many other public interventions, Dawkins presents a view of science and its place in the world that resonates widely within and beyond the scientific communities. Although a professor of public understanding of science at Oxford University, Dawkins has rarely reflected on the diversity of publics for science, and even less on the diversity of possible approaches to communication with those publics (Dawkins 2006).

He has increasingly narrowed his field of attention to a critique of religion and the obstacles he sees it presenting to the spread of science and reason in society. Two websites are maintained as a ‘clear-thinking oasis’ with Dawkins’s support.[2] Dawkins calls on other clear thinkers to join his campaign:

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[2] richarddawkins.net and richarddawkinsfoundation.org

> The enlightenment is under threat. So is reason. So is truth. So is science, especially in the schools of America. I am one of those scientists who feels that it is no longer enough just to get on and do science. We have to devote a significant proportion of our time and resources to defending it from deliberate attack from organized ignorance. We even have to go out on the attack ourselves, for the sake of reason and sanity. (Richard Dawkins Foundation for Reason and Science 2007)

Dawkins's crusade links at least as much to the advocacy work of atheists, rationalists and sceptics as to any specifically science-based communities or movements. But the adoption of science's cause by such interest groups has perceptible influence among scientists, both as individual citizens and as professionals. Scientists and medical practitioners are well represented in such organizations. The 13th European Skeptics Conference met in 2007 in Dublin under the banner, 'The assault on science: Constructing a response'. The conference theme referred to 'the continuing rise in popularity of the complementary and alternative medicine sector, the ongoing battles between evolutionary biologists and the intelligent design movement, the increased activities of fundamentalist religious movements, the granting of degrees in science to students of alternative practices such as homeopathy and so on'.[3]

Other such initiatives cite postmodernist trends in contemporary culture and corporate special interests as further sources of antagonism to science. Sense About Science, a British group with many leading scientists among its supporters, is dedicated to 'work with scientists to respond to inaccuracies in public claims about science, medicine, and technology'.[4] The priority attached to this enterprise encourages a form of public communication that is inevitably didactic rather than dialogical.

The Sense About Science annual lecture in 2007 was delivered by medical scientist Professor Raymond Tallis, who identified the uncongenial climate for science:

> … in ever more oppressive regulatory constraints, in opposition to ethical research on humans and animals and on responsible stem cell research, and in the credence given to anti-science, junk science, and to the authority of individuals who have no scientific training or understanding to pronounce on science.

Even where the vocabulary has changed, the underlying assumptions may be those that inform the deficit model. Wynne (2006) writes that public engagement with science activities is 'based, albeit ambiguously on closer inspection, on replacing the previous deficit model's primitive one-way assumption about educating an ignorant public into "(scientifically) proper attitudes" with an alternative two-way dialogue'. He concludes that the replacement is more nominal than real.

A review of the discussion of public communication in the publications of professional societies suggests that a deficit model remains the default option in many sectors of science (Trench and Junker 2001); it has its adherents among PCST practitioners and analysts, too (Trench 2006).

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[3] Statement published at http://www.irishskeptics.net

[4] http://www.senseaboutscience.org

Given the persistence of the deficit model, it seems like an act of denial to state in a review of approaches and definitions that 'science communication as defined here cannot be considered as a one-way dissemination of information to the lay public' (Burns et al. 2003). That review proposes dialogue as a means to 'more effective science communication'; that is, to achieve certain ends decided at the point of origin. This suggests that the shift to two-way communication is partial.

Several models of science communication, including one-way dissemination, and the particular deficit-model application of one-way dissemination, continue to coexist with two-way models that place varying emphasis on interactivity. So, while the story being told in PCST circles undoubtedly has value as a reminder about the limits of one approach and the possibilities of another, it is more normative than descriptive. The supposed shift from deficit to dialogue has not been comprehensive; nor is it irreversible.

7.2 Communication Models in Other Fields

The discussion about models of science communication links to discussions in many other fields in which similar problems have been posed. It is perhaps inevitable that a relatively new field of inquiry and practice, such as science communication, needs to rerun such debates for itself. But this discipline is maturing and, in the spirit of listening and engagement espoused so widely in science communication, this section will refer to theoretical and strategic debates elsewhere in communication that have a bearing on PCST.

In communication theory, critiques of received transmission models from the 1970 had already focused on dialogue and conversation as defining activities, mainly because of the influence of German cultural critic Theodor Adorno and German social theorist Jurgen Habermas. A concept of two-way communication as dialogue came to form the centrepiece of a social and political theory espoused by British sociologist Anthony Giddens. He developed the concept of a 'dialogical democracy' as a more fully realized form of democracy and of dialogue as 'the capability to create active trust through an appreciation of the integrity of the other' (Giddens 1994).

The critique of mass media as one-way only had been prefigured in the late 1920s by the German playwright Bertolt Brecht, who contrasted 'distribution' and 'communication' in a frequently cited and insightful commentary on radio:

> Radio should be converted from a distribution system to a communication system. Radio could be the most wonderful public communication system imaginable, a gigantic system of channels—could be, that is, if it were capable not only of transmitting but of receiving, of making the listener not only hear but also speak, not of isolating him but of connecting him. (Brecht 1979/80)

Adorno's critique of the cultural industries and Habermas's theory of the public sphere gave new life to the argument as it applied to media in general, and to television in particular. Communication as a two-way process became the byword of much theorizing of media, society and culture. Mass media were widely seen to have contributed to the loss of conversation.

The shift in thinking in mass communication theory and research challenged received ideas of the audience. Reviewing the future of the audience concept, communication theorist Denis McQuail noted that in the early days of communication research the audience was conceptualized as the body of ‘receivers of messages at the end of a linear process of information transmission’. But this view gave way gradually to one of the media receiver ‘as more or less active, resistant to influence, and guided by his or her own concerns, depending on the particular social and cultural context. The communication process itself has been reconceptualized as essentially consultative, interactive, and transactional’ (McQuail 1997).

As digital and online media assumed a much larger place in the mass communication field, the notion of audience has come under greater strain, often giving way to the notion of ‘users’, which is drawn from information and communication technologies. Concepts of interactivity have been extensively debated, not only as they refer to human–computer interaction, but also as they refer to mediated communication processes between individuals and groups.

In journalism studies, the late James Carey, one of the most influential academics in the field, posited a possible ‘journalism of conversation’ in the 1980s. The notion influenced a movement, known as ‘public journalism’ that problematized the presumed public that journalists addressed and proposed, as Carey put it, a more ‘humble journalism’ as a means to support more active engagement of citizens and politics (Rosen 1999). Rosen had to acknowledge that ‘in the years ahead, there may be no people calling themselves public journalists’ but, by the late 1990s, the underlying ideas were finding new vehicles and new forms of expression in the debates about citizen journalism on the web, and about the shifting boundaries of journalism.

Similar trends are visible in fields of communication more directly related to PCST, such as risk communication and health communication. To the received view of risk assessment, based on ‘objective’ calculations of probability and impact, Sandman (1987) added the imaginatively named ‘outrage’ to account for ‘subjective’ factors. ‘Call the death rate (what the experts mean by risk) “hazard”. Call all the other factors, collectively, “outrage”. Risk, then, is the sum of hazard and outrage. The public pays too little attention to hazard; the experts pay absolutely no attention to outrage. Not surprisingly, they rank risks differently. Risk perception scholars have identified more than 20 “outrage factors”’. These factors include voluntariness, control, and fairness. The resulting formulation, risk = hazard + outrage, is now widely used.

In health communication, a ‘medical model’ based on transmission of expert knowledge has been contrasted with an ‘educational model’ that takes account of the perceptions and understandings of the sectors of the population being addressed. But, reflecting the resilience of expert-centred approaches, Lee and Garvin (2003) criticize ‘commonly accepted views of health communication [as] inadequate because they imply a one-way transfer of information based on a one-sided relationship between communicator and receiver’. They present three health communication practices that, they say, all ‘ignore the social context of information receivers, and … deny the agency and adaptive powers of recipients’. The authors propose that ‘researchers and practitioners must move beyond traditional practices of information transfer (based on a “monologue”) toward a more useful and appropriate concept of information exchange (based on a “dialogue”)’. In a concluding observation that has resonance for science communication, they write: ‘This change in orientation cannot possibly happen overnight, nor will it come without considerable changes in the relations of power embedded in the world of medicine’.

Even public relations—perhaps widely perceived as the branch of communications most strongly wedded to persuasion, even manipulation—was influenced by this spirit. From the 1980s, textbooks on public relations (such as Grunig and Hunt 1984) have contrasted one-way public information and publicity models with two-way models, whether ‘asymmetrical’ (that is, aimed to persuade more effectively through gathering information on publics) or ‘symmetrical’. Symmetrical communication, in this context, refers to promotion of mutual understanding, exchange of information and negotiation of mutually beneficial solutions.

Beyond disciplines and activities defined as ‘communication’, for example in science education, there is also increasing emphasis on the need to engage the relevant ‘audiences’ or ‘publics’ (in science education, students) more actively. Approaches characterized as ‘inquiry-based’, ‘interactive’ or ‘project-based’ draw on a longer established educational philosophy of constructivism that stresses the understandings and experiences that students bring. Nobel Prize-winning physicist Carl Wieman is a high-profile exponent of such an approach, leading an initiative at the University of British Columbia in Canada to transform science teaching so that students ‘reason through ideas and argue their points of view’ (Cartlidge 2007).

Inevitably, the trend in communication theory has had its critics. John Durham Peters noted that ‘dialogue has attained something of a holy status’ with contemporary dialogians (a term he chose to rhyme with theologians) (Peters 2000). Reclaiming a dissemination model of communication alongside dialogue, Peters noted that not all culture is mutual or interactive. But he also insisted that ‘the rehabilitation of dissemination is not intended as an apology for the commissars and bureaucrats who issue edicts without deliberation or consultation’.

In an observation with an obvious bearing on the assessment of dialogue and engagement activities in PCST, Peters noted that the adoption of more strongly audience-oriented communication styles and strategies chimed with the needs and precepts of marketing (that is, more effective persuasion of the public) and did not necessarily engender more active citizen participation:

> Dialogue is valuable, but it is a strict and jealous god. It is not necessarily the most vernacular form of political talk, but the most demanding and difficult; dialogue’s law is not self-expressive pleasure but rather self-denying listening. Conversation is no more free of history, power, and control than any other form of communication. (Peters 2000)

Peters’s critique of exaggerated claims made for conversation and dialogue is the source of a reconsideration of the ‘infatuation with dialogue’ in public relations. Stoker and Tusinski (2006) defend the possibility that dissemination can enhance responsibility, diversity and reconciliation and that dialogue may be based on a selective choice of stakeholders 'who could reciprocate through an economic and emotional attachment'. They advocate engagement and reconciliation models as more authentic and more ethical than dialogue, because those models are more respectful of difference:

> Using this framework, we engage people or publics in communication, not in an effort to change them or even to change us, but because as human beings, we value our relationships with other human beings.

It is perhaps surprising that a consideration of public relations practices could offer a basis for a critique of dialogue that implies no reversion to dissemination, much less the specific version of dissemination—the deficit model—that has prevailed in science communication. The specific terms used may not be entirely suitable, but an outline emerges of further options, in a space we shall call 'participation', where the aim is not in any supposedly measurable outcome but the process itself.

7.3 Complex Factors and Clear Choices

In the 'co-evolution of science and society' (Gibbons 1999), the pressures and trends in relations between science and society are contradictory, or at least not one-directional. This has implications for how the field of science communication models forms and re-forms, and for how PCST practitioners and analysts see that field.

At the level of social theory, it has been argued influentially (Beck 1992) that individuals and groups are engaged in the continuous negotiation and assessment of risks, many of which derive from the impacts of scientific and technological developments. We are, on this basis, said to be in a 'risk society'. Full recognition of this would mean active engagement between scientists, technologists, policy-makers, interest groups and others, to assess current trends in and future implications of developments in science and technology.

The notion of 'Mode 2' science (Gibbons et al. 1994) describes a practice of science that is open and reflexive, where boundaries between disciplines and between science and non-science are increasingly porous. This socially contextualized science is assessed not only on the basis of the reliability of the knowledge it produces (as in 'Mode 1' science) but also on its social robustness.

Whether such theories are taken as descriptions of current reality or as outlines of emerging trends, they find some support in the increasing public presence of scientists in a variety of advisory, consultative, expert witness, debating and other roles in which they present options and views arising from their professional experience and capacity, rather than packaged elements of proven knowledge (Peters 2008).

In dealing with such topics as embryonic stem-cell research, energy, climate change and pandemic risks, science comes into contact with ethics, economics, public service provision and business. In those contexts, knowledge derived from scientific research is just one ingredient of public policymaking and public debate, and scientists are called on to open 'science-in-the-making' for public scrutiny.

One factor drawing scientists more often into the public domain as ‘public experts’ is the growth in number and influence of civil society groups or non-government organizations (NGOs) concerned with matters that have significant scientific content. It has often been claimed that environmentalism, as it developed from the 1960s, had a specific impact on public attitudes to science. In many countries, the rate at which various applications of biotechnology have been adopted has been significantly influenced by the strength and the stances of NGOs.

These developments have led some to advocate ‘upstream engagement’ of the public, in part through such organizations, in the shaping of the scientific research agenda (Wilsdon and Willis 2004). Civil society organizations receive express attention from national governments in European countries that have been early adopters of dialogue techniques such as consensus conferences. The European Commission supports initiatives to develop such techniques in association with NGOs.

Technological developments also facilitate this opening of science to public view. The pervasive use of internet communication for internal scientific and public communication creates opportunities for more interactivity between scientists and publics. It also permits public access to ‘backstage’ conversations between scientists, including those that negotiate uncertainties in science. In this way, the internet helps to turn science communication ‘inside-out’ (Trench 2008).

Against these trends that favour greater openness and reflexivity in science, and thus encourage approaches to science communication based on dialogue, engagement and participation, there are simultaneous trends working in different directions, or working to limit the impact of such approaches.

Oddly enough, the most powerful of these countervailing trends is the very widespread, almost universal, public policy commitment to the ‘knowledge economy’ or the ‘knowledge society’. Over the past decade, this theme of policymaking has come to assume a central place for very many national governments and international intergovernmental bodies. A common feature of knowledge economy policies is the high priority they attach to science and technology or, more specifically (and tellingly), to research and development.

At one level, this development appears to be a boost for science communication: scientific research gets more attention and resources; new scientific institutions are established, through merging and redefinition of existing ones or from the ground up; outreach or dissemination is often required of those receiving public funds. However, the limits quickly become clear: the knowledge at issue in the knowledge society is almost exclusively knowledge that can be turned into technologies, services and products. The reflective, interpretive knowledge of the humanities and social sciences hardly features, and the prevailing models for performance measurement discriminate against them.

Even within the natural sciences, the policy view is limited and scientists wishing to secure a slice of the larger resources pie are obliged to fit their work into largely predetermined categories. The dominant discourses and policies of the knowledge society obscure science’s cultural and social value, and science communication’s possible contribution to broad social access, balanced dialogue and cultural completeness. 'Knowledge' economy/society policies and discourses may be promoting a new social separation of science, rather than fuller integration.

The common emphasis on improving national competitiveness within a global knowledge economy also constrains the practice of dissemination and outreach. Across the developed world—and, in different ways, in the developing countries—there is perceived to be a crisis in the interest of young people in science studies and careers. Projections of future shortfalls in the supply of scientifically and technically qualified people are a commonplace of knowledge economy strategies. Those driving the knowledge economy look to the institutions benefiting from the new funds to reverse this trend: public communication is seen to serve a labour market purpose. Working with school students, although it may take interactive forms (because no other form would engage these audiences), may be most importantly about addressing a public deficit in attitudes towards science, and thus a reinvention of the supposedly discarded deficit model of science communication.

In concert with this public policy trend, interest groups have emerged in and on the fringes of the scientific communities. They propose doctrinaire responses to perceived 'anti-science' tendencies in the public, or reject the proposition for equitable dialogue on the basis that it downgrades legitimate expertise. For example, Durodié (2003) argues against the trend to dialogue on the basis that it mistakenly posits that the validity of scientific knowledge can be democratically decided and that it potentially absolves policymakers from responsibility for their decisions. Durodié was vigorously contested by Jackson et al. (2005), who not only defended the value of dialogue but extended its reach 'upstream', to deliberation on 'setting the research agenda'.

That discussion is a clear reminder that science communication does not come in a one-size-fits-all model, called 'dialogue'. And the terminology of 'dialogue' can refer to a wide range of practices and strategies. As indicated in the discussion of dialogue approaches to public relations, as also claimed by Wynne (2006) in relation to PCST dialogue and engagement initiatives in Britain, and as evidenced in the insistence of many in this field on 'real dialogue' and 'public engagement', the dialogue banner may be used to refer to refinement rather than replacement of a dissemination model. The talking-back part of 'two-way communication' in such situations may be, above all, a means to retune the talking-to; the listening may be more for improved targeting than for learning. In this way, there is no significant departure from linear, engineering-derived views of communication. The sender retains primary control; all that has been added is a feedback loop.

When Hanssen (2004) says that 'the exact meaning of scientific research can only be clarified on the basis of a dialogue with a broad range of social actors', he has something more far-reaching in mind than a discussion between experts and lay groups on, say, the latest evidence of public risks from high-voltage power lines. Indeed, the analogy he draws with public interpretation of art, and the distinction he makes between discussion of application and discussion of implication, make this very clear. Either the notion of dialogue has to be stretched to breaking point or, as I shall suggest below, we use an additional concept to encompass such approaches.

The complex social circumstances I have sketched present a landscape very different from that suggested by discussions of a decisive shift from deficit to dialogue. They also challenge people in science communication to articulate much more clearly the strategic choices they are making.

When we consider the deficit–dialogue relationship carefully, we can see that there are circumstances in which the 'old' way can have a legitimate place, after it has been weighed up with due care. Hanssen (2004) speaks of the challenge of 'working on the integration of classical and alternative forms of science communication'. Dickson (2005) has made a defence of the deficit model, reflecting his own particular interest in science communication in developing countries.

In his assessment of the 'crossroads' at which science communication found itself at the start of the millennium, Miller (2001) noted that the then British Minister for Science, Lord Sainsbury, had pronounced the demise of the deficit model but warned:

> the end of the deficit model does not mean there is no knowledge deficit … many communications about science will still mainly be about passing on the latest scientific knowledge.

Sturgis and Allum (2005) note the many criticisms of the received deficit model, considering them 'in many ways valid', but they argue that the criticisms 'do not sufficiently problematize the deficit model to justify scrapping it altogether'. A report on Engaging Science, a 2006 conference in Britain, observed that 'in rejecting the knowledge deficit model so forcefully … the narrow view of public engagement ignores the clear public appetite for information, as well as the empowering character of an understanding of the nature of science' (Wellcome Trust 2006).

Einsiedel (2007) claims that 'a more nuanced view of publics has emerged': they can be active and knowledgeable, playing multiple roles and receiving science but also shaping it. However, she also cautions against overstating how far the balance has shifted between scientists and publics. She cites Jasanoff (2005), who pointed out that not all members of the public want to be 'full-blooded cognitive agents who test and appraise public knowledge claims, including those of experts, according to culturally sanctioned criteria of competence, virtue and reasoning'. Einsiedel had earlier argued that the 'cognitive deficit model' and 'interactive science model' both:

> … have things to contribute to the ongoing discussions about the public and science … Contrasting [the cognitive deficit model] with the interactive science model may have analytical value, but one thereby tends to overemphasize the stark differences between the two and to overlook the possibility that these frameworks may be complementary rather than mutually exclusive. (Einsiedel 2000)

To various degrees, these versions of a reclaimed deficit model remove from it the presumption of incorrigible cognitive deficiency in the public, and the assumption that more knowledge or information about science means greater appreciation or support for science.

From this brief discussion, we see that:

- The deficit model survives as the effective underpinning of much science communication.
- A legitimate case can be made for retention of a dissemination model in certain circumstances.
- 'Dialogue' refers to multiple options that span a considerable spectrum.

The bipolar view of deficit and dialogue is neither an accurate account of recent developments nor a useful guide to current and future practice and analysis. There is at least as much continuity as discontinuity in the historical trend. There are several variations on dissemination, of which the deficit model is just one. There are variations on dialogue, among them consultation and engagement, where 'consultation' is taken to refer to dialogue set up on a relatively restricted agenda, for a specific purpose, and in a limited time frame, and 'engagement' involves a relatively open agenda, the content of which can change, in a process might not be strictly time-bound.

Van Sanden and Meijman (2008) draw a related distinction between dialogue with a functional goal and dialogue with a conceptual goal. The 'conceptual goal' appeared to be in the mind of Irish Deputy Premier Mary Harney in a speech that proposed a move 'towards a civic science', defined as 'a science engaged with and invited into the national dialogue … responsive to the public and worthy of the public trust' (Harney 2003). (It is worth noting that the challenge of 'civic dialogue' that Ms Harney presented to her audience of scientists, other academics and policymakers was not taken up.)

The many possible approaches to PCST can be seen as on a continuum, in which the boundaries between neighbouring options are porous and shifting. The next section of this chapter proposes a framework for situating various models of science communication. It departs from the deficit–dialogue dichotomy for all the reasons outlined above, but also in order to add a third main frame—participation—within which we can situate models and strategies that go beyond the limits of real and existing dialogue.

7.4 Framework for Analysis

Among recent contributions to the discussion of identifiable models of science communication are the following:

- A 'map' of science communication activities prepared for the Wellcome Trust in Britain identified three models of communication in relations between science and the media: the deficit model, the consultation model and the engagement model (Research International 2000).
- In a review of scientists' discussions of public communication, a colleague and I (Trench and Junker 2001) identified five models of communication that scientists

implicitly considered available to them in their public interventions: deficit, dissemination, duty, dialogue and deference.

- Lewenstein (2005) described four models: the deficit model, the contextual model, the lay expertise model and the public participation model.

The precise number is not significant in itself. What matters in an endeavour of this kind is that the entities named are (at least approximately) conceptually equivalent to each other and that the distinctions between them are reasonably clearly drawn. For example, the contextual model may be taken as contained within the dialogue model, as implied by Gross (1994):

> The contextual model implies an active public: it requires a rhetoric of reconstruction in which public understanding is the joint creation of scientific and local knowledge … In this model, communication is not solely cognitive; ethical and political concerns are always relevant.

Table 7.1 shows a grid centred on a triad of models of science communication that distinguishes between dialogue and participation on the basis of my earlier discussion of the ambiguities and limits of dialogue in many of its current applications. The three models are:

- *Deficit*. Science is transmitted by experts to audiences perceived to be deficient in awareness and understanding.
- *Dialogue*. Science is communicated between scientists and their representatives and other groups, sometimes to find out how science could be more effectively disseminated, sometimes for consultation on specific applications.

Table 7.1 Analytical Framework of Science Communication Models

Base Communication Models	Ideological and Philosophical Associations	Dominant Models in PCST	Variants on Dominant PCST Models	Science's Orientation to Public
Dissemination	Scientism		Defence	They are hostile
		Deficit		They are ignorant
	Technocracy		Marketing	They can be persuaded
Dialogue	Pragmatism		Context	We see their diverse needs
		Dialogue	Consultation	We find out their views
	Constructivism			They talk back
			Engagement	They take on the issue
Conversation	Participatory democracy	Participation		They and we shape the issue
			Deliberation	They and we set the agenda
	Relativism		Critique	They and we negotiate meanings

- *Participation*. Communication about science takes place between diverse groups on the basis that all can contribute, and that all have a stake in the outcome of the deliberations and discussions.

We might say that these represent one-way, two-way and three-way models. The first two are essentially linear, and the last is multidirectional: communication takes place back and forth between experts and publics and between publics and publics. Whereas the main object of dialogue may be the applications of science, in the participation model the concern is more with implications. However, as in any analytical scheme, the boundaries between categories will appear more definite than they manifest themselves in actual application.

By characterizing the dominant models in science communication in this way, I am not proposing a hierarchy or an evolution. All three will continue to have their uses in particular circumstances. In an extended communication project or in an unfolding public debate, participants may move from one approach to another. However, as a general observation, we might say that communication processes become more open-ended and more open to values as well as facts in the transition from deficit to dialogue and participation.

In Table 7.1, the three dominant models in science communicator are presented in column 3 with ‘upstream’ and ‘downstream’ associations ranged to left and right, respectively. The horizontal alignment of models and their corresponding public orientations is intended to indicate the relative emphasis on the science- or public-centredness of the process.

In column 1, the dominant science communication models are related to established and more widely recognized communication models, as discussed above. Column 2 lists some ideological and philosophical perspectives that affect how the models are applied in the particular contexts of PCST. These need more discussion than space permits here. The influence among scientific communities of scientism (the belief that science is the superior knowledge system and can provide answers to all the questions worth asking) may well be the key factor in the shaping of dissemination as a deficit model. Wynne (2006) maintains that scientism is the ideological underpinning of the common characterization of certain public dispositions as ‘anti-science’.

Column 4 lists some known variants of the three core models of science communication. Introducing these variants allows us to consider more options, but also to recognize smaller gradations when analysing current practices. It also offers a wider repertoire for planning science communication initiatives:

- *Defence*.[5] Here the public is envisaged as hostile; one example is the posture of the Richard Dawkins Foundation (see above), but the model can also be recognized in communication that focuses in other ways on ‘anti-science’.

[5] Colin Johnson, vice-president of the British Association (BA), offered this variant on the deficit model in response to a presentation I gave to the BA Festival of Science in Dublin during September 2005.

- *Marketing*. Here the purpose is to persuade the public, for example about the drop in science and technology student numbers, perhaps by promoting successful scientists as role models or presenting science as ‘fun’.
- *Context*. Contextualized practices take into account the diversity of publics and of the ways their experiences and perceptions shape their reception of information. These practices can be functionalist, as in marketers’ ‘segmentation’ of markets, or more culturally situated, as in the consideration of PCST in multicultural societies.
- *Consultation*. The public’s opinions are sought by various means, with a view to redefining messages or negotiating about applications.
- *Engagement*. Here there is a stronger emphasis on how publics express concerns, raise questions and become actively involved.
- *Deliberation*. This is presented as a ‘heightened’ form of public participation, which calls on a wider set of understandings about democratic processes, and in which the public contributions about the ‘why’ and ‘why not’ of science help set the agenda for science communication and, eventually, for science.
- *Critique*. Here science is held to account through reference to other intellectual disciplines and cultural activities that can offer insights into the public meanings of science. The term ‘critique’ is used by analogy with the public processing of experiences and interpretations of the arts and other cultural expression.

In column 5, the dominant models and the variants are translated into terms of an implicit modelling, within scientific communities, of the publics’ role. This translation draws on discussion among science communicators and in this chapter.

To articulate choices more clearly, as I have advocated, it would be worthwhile to develop an alternative model or models—looking at these processes from the perspective of attentive and active publics.

References

Beck, U. (1992). *Risk society—Towards a new modernity*. London: Sage.

Brecht, B. (1979/80). Radio as a means of communication—A talk on the function of radio. *Screen*, *20(3–4)*, 24–28.

Burns, T. W., O’Connor, D. J. & Stocklmayer, S. M. (2003). Science communication: A contemporary definition. *Public Understanding of Science*, *12(2)*, 183–202.

Cartlidge, E. (2007). New formula for science education. *Physics Today, January,* 10–11.

Dawkins, R. (2006). *The god delusion*. London: Bantam Press.

Dickson, D. (2005). The case for a deficit model of science communication. Paper presented to PCST Working Symposium, Beijing, June 2005.

Dixon, B. (2007). What do we need to say to each other? *New Scientist, 6 January,* 46–47.

Durodié, B. (2003). Limitations of public dialogue in science and the rise of the new ‘experts’. *Critical Review of International Social and Political Philosophy*, *6(4)*, 82–92.

Einsiedel, E. (2000). Understanding ‘publics’ in public understanding of science. In M. Dierkes & C. von Grote (Eds.), *Between understanding and trust—The public, science and technology*. London, New York: Routledge, 205–215.

Einsiedel, E. (2007). Editorial: Of publics and science. *Public Understanding of Science*, *16(1)*, 5–6.
Gibbons, M. (1999). Science's new social contract with society. *Nature*, *402 (2 December),* C81–84.
Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P. & Trow, M. (1994). *The new production of knowledge—The dynamics of science and research in contemporary societies*. London, Thousand Oaks, California, New Delhi: Sage.
Giddens, A. (1994). *Beyond left and right—The future of radical politics*. Cambridge: Polity Press.
Gross, A. (1994). The roles of rhetoric in the public understanding of science. *Public Understanding of Science*, *3(1)*, 3–23.
Grunig, J. & Hunt, T. (1984). *Managing public relations*. New York: Holt, Rinehart and Winston.
Hanssen, L. (2004). The representation of science. In *Public communication on science and technology—Some insights from the Netherlands*. Amsterdam: National Organisation for Public Science Communication, 64–67.
Harney, M. (2003). *Towards a civil science—A mission for the 21st century: An address to the Royal Irish Academy*. Dublin: Royal Irish Academy.
Jackson, R., Barbagallo, F. & Haste, H. (2005). Strengths of public dialogue on science-related issues. *Critical Review of International Social and Political Philosophy*, *8(3)*, 349–358.
Jasanoff, S. (2005). *Designs on nature: Science and democracy in Europe and the United States*. Princeton, New Jersey: Princeton University Press.
Lee, R. G. and Garvin, T. (2003). Moving from information transfer to information exchange in health and health care. *Social Science and Medicine*, *56*, 449–464.
Lewenstein, B. (2005). Models of public communication of science and technology. Manuscript retrieved on 25 November 2007 from http://communityrisks.cornell.edu/BackgroundMaterials/Lewenstein2003.pdf.
McQuail, D. (1997). *Audience analysis*. London: Sage.
Miller, S. (2001). Public understanding of science at the crossroads. *Public Understanding of Science*, *10(1)*, 115–120.
Peters, H. P. (2008). Scientists as public experts. In M. Bucchi & B. Trench (Eds.), *Handbook of public communication of science and technology*. London: Routledge.
Peters, J. D. (2000). *Speaking into the air—A history of the idea of communication*. Chicago, London: University of Chicago Press.
Research International (2000). *Science and the public: Mapping science communication activities*. London: Wellcome Trust. Retrieved on 18 November 2007 from http://www.wellcome.ac.uk/assets/wtd003418.pdf.
Richard Dawkins Foundation for Reason and Science (2007). Mission statement. Retrieved on 18 November 2007 from http://www.richarddawkinsfoundation.org.
Rosen, J. (1999). *What are journalists for?* New Haven, London: Yale University Press.
Sandman, P. (1987). Risk communication: Facing public outrage. *EPA Journal*, *13(9)*, 21–22. Retrieved on 18 November 2007 from http://www.psandman.com/articles/facing.htm.
SCST (Select Committee on Science and Technology) (2000). *Science and society*. Third report. London: House of Lords. Retrieved on 19 November 2007 from http://www.publications.parliament.uk/pa/ld199900/ldselect/ldsctech/38/3801.htm.
Stoker, K. & Tusinki, K. (2006). Reconsidering public relations' infatuation with dialogue: Why engagement and reconciliation can be more ethical than symmetry and reciprocity. *Journal of Mass Media Ethics*, 21(2/3), 156–176.
Sturgis, P. & Allum, N. (2005). Science in society: Re-evaluating the deficit model of public attitudes. *Public Understanding of Science*, *13(1)*, 55–74.
Technology Foresight Ireland (1999). *Health and life sciences—Report from the Health and Life Sciences Panel*. Dublin: Irish Council for Science, Technology and Innovation, and Forfás.
Trench, B. (2006). Science communication and citizen science—How dead is the deficit model? Paper presented to Scientific Culture and Global Citizenship, 9th International Conference on PCST, Seoul, Korea, 17–19 May 2006.

Trench, B. (2008). Internet: Turning science communication inside-out? In M. Bucchi & B. Trench (Eds.), *Handbook of public communication of science and technology*. London, New York: Routledge.

Trench, B. & Junker, K. (2001). How scientists view their public communication. Paper presented to Trends in Science Communication Today, 6th International Conference on PCST, Geneva, Switzerland, January 2001. Retrieved on 25 November 2007 from http://visits.web.cern.ch/visits/pcst2001/proc/Trench-Junker.doc.

Van Sanden, M. & Meijman, F. (2008). Dialogue guides awareness and understanding of science—An essay on different goals of dialogue leading to different science communication approaches. *Public Understanding of Science*, 17(1), 89–103.

Wellcome Trust (2006). Meeting of minds—Engaging debate at the Engaging Science conference. *Wellcome News*, *47* (June 2006), 12–13.

Wilsdon, J. & Willis, R. (2004). *See-through science—Why public engagement needs to move upstream*. London: Demos.

Wilsdon, J., Wynne, B. & Stilgoe, J. (2005). *The public value of science—Or how to ensure that science really matters*. London: Demos.

Wynne B. (1991). Knowledges in context. *Science, Technology and Human Values*, *16(1)*, 111–121.

Wynne, B. (2006). Public engagement as a means of restoring public trust in science—Hitting the notes but missing the music? *Community Genetics*, *9(3)*, 211–220.

Ziman, J. (1991). Public understanding of science. *Science, Technology and Human Values*, *16(1)*, 99–105.

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Chapter 8
Before and After Science: Science and Technology in Pop Music, 1970–1990

Massimiano Bucchi[a](✉) and Andrea Lorenzet[b]

Abstract Media contexts other than news—including fiction—are frequently neglected by scholars in the field of science communication. This chapter uses the example of pop music to describe how the rich articulation of popular culture with regard to science and technology can interact in non-linear, unpredictable ways with specialist knowledge. Pop music can thus yield significant understanding of the public images and visions of science. Examples can be provided of how the uses and appropriation of science and the social meanings of science and technology in this context—from the 'de-evolutionary' theory underlying Devo's pop songs to Kraftwerk's 'man–machine' ideology—have often preceded more explicit concerns about the implications of science and technology that later became visible in other contexts, such as the news media.

Keywords Public communication of science and technology, science and technology in popular culture, science and technology in pop music

8.1 Science Communication and Pop Music

This chapter discusses how science and technology (S&T) themes can interact with popular culture and, more specifically, with representations of S&T active in popular music. To date, studies of science communication and popular discourse about science have barely touched on this genre, but have focused pre-eminently on the role and presence of science within the news media—the daily press in particular (Bauer 1998, Liakopoulos 2002, Nisbet and Lewenstein 2002, Bucchi and Mazzolini 2003) —and, more rarely, within literary and cinematic fiction (Turney

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1998, Nelkin and Lindee 2004, Kirby 2008). We shall also use the example of pop music to show how science communication may follow paths often different from those envisaged by traditional, linear models of the relationship between specialist discourse and popular discourse about science. To this end, this introductory section will conduct a brief critical review of traditional models of science communication. Some discussion of features characterizing pop music as part of popular discourse will also be needed to illustrate its relevance in capturing popular images of science.

8.1.1 Towards a Different Understanding of Science Communication

For at least two decades, studies from different disciplinary perspectives have challenged the main assumptions of a traditional, 'transfer vision' which interprets—among other aspects—the public level of science communication as a blurred and degraded mirror of the specialist and expert discourse (Bucchi 2008). More specifically, scholars have underlined the non-linearity of communication processes (Lewenstein 1995a,b, Bucchi 1996, 1998), the active role of transformative and selective processes in which the public is involved (Wynne 1989, 1995, Epstein 1996), and the rhetorical and instrumental use of the specialist/public distinction by scientists and scientific institutions themselves (Hilgartner 1990). Many of these reflections have been encapsulated in the idea of a *continuum* of expository levels for science, mutually influencing one another, in which messages, narratives and interpretations of scientific knowledge shuttle back and forth between two extremes: the intraspecialistic stage and the popular stage. Viewed thus, science communication is no longer a process in which scientists merely address the public with specific information that the public can only accept or reject. Rather, there operate multiple interactive processes which involve—and to some extent blur—the communication levels.

Although undoubtedly innovative, the *continuum* model still tends to describe the whole process of communication as a form of knowledge transmission, leaving some of the key assumptions of the 'transfer' vision unchallenged. While the continuum allows the transformation of knowledge along its communicative path, the direction of such transformation is largely pre-established—its touchstone remains firmly at the specialized level.

More recent attempts to supersede the transfer vision more substantially have introduced the notion of 'cross-talk' to describe the science communication process (Bucchi 2004). In the cross-talk model, ideas circulating in the public arena and in the specialist discourse can, under some circumstances, interact in ways other than the trickling down of specialist knowledge.

In his study of genetics in popular culture, for example, Jon Turney has shown that key achievements in the research agenda, including Watson and Crick's discovery of the DNA structure, did not immediately attract the attention of the general media.

On the other hand, popular ideas on the transformation of species and the modification of man have had a much longer history (Turney 1998), as documented for instance by the French novelist Emile Zola's famous claim—30 years before the rediscovery of Mendel's laws of heredity—that 'heredity has its laws, just like gravitation' (Zola 1871, see also Lewontin 1996).

Understanding of science communication may benefit from abandoning the transfer metaphor to investigate the multiple interactions of specialist and popular discourse. Communication may thus be seen as intense short-circuiting or cross-talking between those discourses—rather than as plain transfer—which takes place under certain circumstances and centres on key discursive 'boundary objects' (e.g. 'gene', 'DNA', 'Big Bang', 'AIDS') lying at the intersection between specialist and popular levels.

These objects make communication possible without necessarily requiring consensus, for an object may be interpreted and used in quite different ways within different types of discourse. 'Gene' can thus be seen as a boundary object: a label providing a common language both in specialist and in public contexts, although translated differently in a laboratory conversation and in a car advertisement (Star and Griesemer 1989, Nelkin and Lindee 1995, Keller 1995, Bucchi 2004). On this view, the spell intrinsically tying communication to understanding as in the transfer vision can be finally broken. A model of science communication as cross-talk also implies seeing communication not simply as a *cause* (for example, of changes in public opinions and attitudes due to the transfer of certain results or ideas), but also as the *result* of developments in both discourses allowing the formation of an intersection zone. Of course, it is likely that once this intersection has formed it will facilitate exchanges across different discourses, thereby reinforcing itself recursively. Another advantage is that the cross-talk model recaptures a view of communication as a *process* that sustains (and has to be sustained by) actors' interactions, rather than as a taken-for-granted point of departure.

From this perspective, discourses on S&T active within popular culture, including pop music, can acquire new relevance as one of the modes in which public and specialist levels are able to engage in cross-talk (that is, in rich, multiple-meaning interactions).

8.1.2 Performativity and Meaning in Pop Music

In recent decades, studies in musicology and cultural theory have stressed that pop music is an important object of social and cultural research (Middleton 1990, Longhurst 2007), and that its relevance extends well beyond lyrics and music. Pop music can also be understood as a true dramaturgical *mise-en-scène* (Goffman 1959) incorporating several expressive codes and ritual elements. In other words, any pop music event or act, be it the issue of a record or a live performance, comprises a wide codex range that often transcends the musical content to encompass, for example, non-verbal codes, gestures, and expressive and emotional aesthetics.

These elements can be interpreted as the symbolic means to produce a social performance (Frith 1996, Alexander 2006). In this context, pop music performances use—but also generate and manipulate—images and metaphors circulating within public discourse and easily recognizable by audiences.

A major role is also played in these processes by technology, which (through devices such as the electric guitar, amplifier, synthesizer, computer, Walkman or iPod) has become essential for both the production and the consumption of pop music (Bull 2000, Pinch and Trocco 2002, Pinch and Bijsterveld 2003).

This chapter thus investigates the social representations, myths and symbols related to S&T circulating within pop music culture, paying particular regard to the period between 1970 and 1990. Given the preliminary and exploratory nature of this work, that period has been selected as one in which S&T themes were particularly salient in pop music. For the same reason, the analysis does not seek to be comprehensive, its aim being instead to reflect on some of the specific images of S&T that have attracted particular attention in pop music.

8.2 Science and Technology in Pop Music, 1970–1990

Until the end of the 1960s, S&T themes received scant attention within pop music. A minor exception was the famous collage of personalities featured on the cover of the Beatles' *Sgt. Pepper's Lonely Hearts Club Band* (1967). The collage includes Aldous Huxley, grandson of the famous biologist Thomas H. Huxley and brother of Julian Huxley, Nobel laureate in physiology and renowned science popularizer. Aldous Huxley had become famous for his novel *Brave new world* (1932) describing a dystopia in which reproduction and sex had been totally disconnected by technology, with reproductive techniques being used as a means of social control. However, neither *Sgt. Pepper* nor the rest of the Beatles' output (and that of the most significant pop musicians of the time) contains any significant reference to S&T.

It was only at the beginning of the following decade that pop music began to make its first significant references to S&T, developing an interest for the pervasive development of technology and its consequences for key themes, such as individual identity and social organization.

8.2.1 Doubles and Machines: Technoscience and Identity in Electro-Pop Music

Artificial intelligence and life creation were among the first and most significant themes in pop music's reflection on S&T in the 1970s and 1980s. Of particular relevance in this regard was the modern myth of fabricating 'technological doubles' of human beings. From a philosophical point of view, the idea of a mechanical double originated in Descartes' image, inspired by Renaissance advances in the mechanical arts, of man as a 'wound up watch' (Turney 1998).

The theme of the 'double' was amplified by the debate on artificial intelligence, which had been ongoing since the 1950s. The debate particularly focused on the creation of machines capable of humanlike reasoning; one landmark often identified was the publication of Alan Turing's article 'Computing machinery and intelligence' in the journal *Mind* in 1950, which many consider to mark the birth of computer science.

The same theme was also nourished by the life sciences, particularly after the discovery of DNA structure (1953) and through the debate on recombinant DNA techniques. The latter became prominent in the early 1970s, particularly in connection with the 'Berg letter' and the proposed moratorium (1974), until the cloning issue attained high visibility in the public debate in many countries after the Dolly experiment (1997).

Themes of identity, doubles and machines acquired special salience in parallel with the development of electronic pop music. In this respect, reflection on technology and the mechanical reproducibility of human features can also be seen as ensuing from the pervasive use of synthesizers and other devices to recreate—and transform—sounds produced by traditional instruments and human voices.

Groups like Kraftwerk ('power plant' in German) provide perhaps the most significant examples of how technoscience imagery relating to the myth of the double and robots penetrated pop music. Founded by two former classical music students, Ralf Hütter and Florian Schneider, the band liked to describe its music as 'robot pop', and it relied mostly on synthesizers to compose and perform its songs. During live performances and on album covers like *The man machine* (1978), Hütter and Schneider dressed up as impersonal robots, using standard uniforms and pale make-up to erase any trace of personal identity.

Adding to this minimal-futurist aesthetic were robotlike gestures and largely automatized live performances: on one occasion, the band members left their seats among the audience to reach the stage when the first three tracks of the concert had been completed. When on the stage, they took the place of mannequins arranged as their substitutes before the beginning of the set. Kraftwerk's album titles, covers and lyrics abounded with references to technology (their 1975 album, *Radio-activity*, opening with the sound of a real Geiger counter measuring radioactivity) and in particular to Doppelgänger-like dilemmas:

> We're charging our battery
> And now we're full of energy
> We're the robots
> We're functioning automatik
> And we are dancing mechanik
> We are the robots
> We are programmed just to do
> Anything you want us to
> We are the robots
> (Kraftwerk, 'The robots', 1978)

Despite recognizing a depersonalizing effect, Kraftwerk did not depict man's relation to technology in negative terms. Their work was neither a moral crusade nor an expression of acritical enthusiasm for technology; rather, it was a *mis-en-scène* of the human condition in a technological age.

Quite differently, another key electro-pop artist, Gary Numan, interpreted with his band Tubeway Army the myth of the double in mostly negative form, as a metaphor for contemporary alienation, the loss of identity and emotions, and the impossibility of establishing social ties. Numan enjoyed a brief but impressive period of popularity with hits like 'Cars', 'Are friends electric', 'I disconnect from you', 'Remember I was a vapour', 'We are glass'. On the cover of the album *Replicas*, Numan is portrayed in a bleak room with a single light bulb, while his pale image is reflected on the window pane. The theme of the album is the social control achieved by political elites by means of technological devices- the Machmen, imaginary androids operating on behalf of a higher order, and whose names are replaced by numbers:

Down in the park
Where the Machmen meet
The machines are playing 'kill-by-numbers'
Down in the park with a friend called 'Five'
(Gary Numan, 'Down in the park', 1979)

Technology is also represented by the pop music of those years in terms of a fascination with artefacts and machines. In a sort of futurist revival, cars, motorways and high-speed trains are seen as embodying the positive face of progress and technological innovation. In Autobahn (1974), one of their most successful albums, Kraftwerk used their synthesizers to imitate cars and motorway sounds. Gary Numan's 'Cars' emphasized the feeling of safety and comfort provided by a car's shell, seen as a refuge from the fragmentary experience of contemporary social life:

Here in my car
I feel safest of all
I can lock all my doors
It's the only way to live
In cars
Here in my car
I can only receive
I can listen to you
It keeps me stable for days
In cars
(Gary Numan, 'Cars', 1979)

The English band Ultravox! and its original leader John Foxx—later the author of solo albums with titles like *Metamatic* (1980)—went so far as to proclaim an outright love of technology. In 'I want to be a machine' (1977), technology is a metaphor for the search for the sublime, an immortal device like Dorian Gray's mirror reflecting the limits of the human condition. In 'Hiroshima mon amour' (1978), the contrast is drawn in the music by a drum machine and a saxophone, and in the lyrics by the paradoxes already explored by film director Stanley Kubrick in his movie *Dr Strangelove, or how I learned not to worry and love the bomb* (1963).

The image of 'a heart beating under the cold shell of technology' and in general a form of technological romanticism are also central to the work of the English 'non-musician' Brian Eno. Works like *Here come the warm jets* (1973), *Taking Tiger Mountain (by strategy)* (1974) and *Another green world* (1975) already outline in their titles this interweaving of technology and emotions, archaic symbolism and the computer age, in a quest for 'another green world' not naively primitive but made possible by technological development itself, just as silence is recreated in synthetic form on the album *Discreet music* (1974). The apogee of this romantic version of S&T was the album *Before and after science* (1977), significantly divided in two parts: 'before science' is wilder and neurotic ('Energy fools the magician' is the title of one of the tracks); 'after science' is serene and pacified.

8.2.2 De-Evolution, Post-Nuclear Eras and Conspiracies: Pop Music and the Dark Side of Technology

During the period analysed here, pop music also dealt with some of the most controversial issues involving S&T: nuclear energy and environmental pollution above all. Bands like Devo, from Akron, Ohio, conceived their entire corpus—as well as their name—as a grotesque reflection on the possibility that industrial pollution and environmental degradation by mankind are actually reversing Darwin's path into 'de-evolution'. Here science has become something distant, difficult to understand and often potentially dangerous: space science, once the most promising frontier of post-war research for popular culture,[1] has emblematically turned into a source of junk debris threatening to fall on our heads (as in the song 'Space junk'):

> A soviet sputnik hit Africa
> India Venezuela (in Texas Kansas)
> It's falling fast Peru too
> It keeps coming
> And now I'm mad about space junk
> I'm all burned out about space junk
> Oooh walk & talk about space junk
> It smashed my baby's head
> (Devo, 'Space junk', 1978)
> What happens next
> De- evolution self- execution no solution
> (Devo, 'I'm a potato', 1990)

Devo's performances resembled those of Kraftwerk in the use of standard uniforms and mechanical gestures. Yet their aesthetic was different, in so far as these elements were used to satirize the return of our civilization to infancy and de-evolution, with technology jeopardizing, rather than enhancing, our distinctive human

[1] In the context of pop music, think about David Bowie's hit of 1969, 'Space oddity', or the whole album *Ziggy Stardust and the spiders from Mars* (1972).

qualities—as summarized by the title of their debut album *Q. Are we not men? A. We are Devo* (1978).

In the same years, another American band, Pere Ubu from Cleveland, centred its early output on the fear of a nuclear holocaust, and the alienation and anguish of survivors of a late industrial era constantly besieged by technology installations and science experiments (as in the song 'Chinese radiation', based on the rumours of Chinese nuclear experiments current at the time). These themes were musically expressed in disarticulated sounds and psychotic vocals by leader David Thomas. In his own words, 'We found it hard, in 1975, to imagine that anyone would live to see the year 2000'.[2]

Technology—employed in a primitive and anti-modern fashion with the recovery of instruments such as the protosynthesizer Theremin—is here reduced to debris, amid total disillusionment about its potential to elevate the human condition.

> Thinkers and poets of the past
> they had to leap into the dark so blindly
> whereas we'll stand free and upright like men …
> The day's golden light!
> Linked with our machines our eyes are beaming
> It won't matter at all how weird things are seeming
> We have the technology not available before
> We have the technology
> (Pere Ubu, 'We have the technology', 1988)

Fears of nuclear disaster have also been framed by pop music within the broader picture of energy concerns, for example by advocating the development of alternative energy sources at least two decades before this became a salient public issue in most countries. This is evidenced by the song 'Electricity' by English band Orchestral Manoeuvres in the Dark (OMD), which achieved its biggest hit with 'Enola Gay', a song about the B-29 aeroplane that dropped the atomic bomb on Hiroshima:

> Our one source of energy
> The ultimate discovery
> Electric blue for me
> Never more to be free
> Electricity
> Nuclear and HEP
> Carbon fuels from the sea
> Wasted electricity
> The alternative is only one
> The final source of energy
> Solar electricity
> (OMD, 'Electricity', 1980)

In another song, 'Tesla girls' (1984), OMD evokes the figure of inventor Nikola Tesla and again addresses energy and some of its uses, the purpose being to reflect on the potential negative implications of research and technology advances,

[2] http://www.ubuprojex.net

emphasizing the public's difficulty in understanding such advances and the gulf between them and society's needs.

> Tesla girls
> testing out theories
> electric chairs and dynamos
> dressed to kill they're killing me
> but heaven knows their recipe
> (OMD, 'Tesla girls', 1984)

Scientists feature in pre-eminently negative terms in many of the songs by the Stranglers, an English band founded in 1974 by biochemist Hugh Cornwell. In songs like 'Nuclear device' or 'Genetix', scientists and politicians are depicted as involved in a conspiracy to use knowledge to the detriment of the general population—as in 'Genetix', where race segregation is the secret target of genetic experiments.

> The first law of segregation
> States that any gamete male
> Or female can carry the
> Determinant gene of only one
> Pair of alternative characteristics.
> The second law of free assortment
> States that in a cross involving
> One pair of alternative characteristics
> The characteristics will segregate
> In the second filial generation
> In the relative proportions of 9, 3, 3, 1
> (The Stranglers, 'Genetix', 1979)

8.3 Concluding Remarks

As the examples presented here indicate, S&T features in a sector of pop music of the 1970s and the 1980s in a form difficult to capture with models emphasizing the transfer of information and knowledge from the experts to the public. Instead, science theories and personalities, research fields and technological artefacts were used and reinterpreted by pop musicians to build narratives on the individual's relationship with S&T, as well as on the links among science, politics and society at large. Thus, for example, reflections on the 'myth of the double' and on artificial intelligence were drawn upon in electronic pop music to depict the condition of human subjectivity vis-à-vis the increasing role of technology in contemporary society. Similarly, Darwin's theory of evolution was reframed as de-evolution by bands like Devo as part of their critique of the degradation of Western civilization.[3]

[3] Several other pop musicians have been fascinated by Darwin and his theories. *Darwin* is also the title of a concept album on evolution by Italian progressive pop band Banco del Mutuo Soccorso (1972).

If we consider science communication as an emerging process, rather than stemming from a specific source and aimed at a specific target, we can interpret the role of such S&T images as part of a more articulated 'cross-talk' among several communication levels in which a variety of elements—including science results, visible scientists and technology products—are mobilized as ingredients of different 'performances'. These can sometimes take the form of true 'social dramas' (Turner 1982) that offer the public opportunities to reflect critically on issues connected with S&T.

In this context, it is possible to identify at least three ways in which narratives and images circulating in pop music have nourished broad science communication processes. These three ways are related to the *past*, the *present* and the *future*.

First, pop music has often anchored the new elements introduced by S&T to longstanding myths already present and active in popular culture. It is not difficult, for example, to detect in Kraftwerk's 'man–machine' ideology or in Ultravox's early work echoes of the Frankenstein myth or of Dorian Gray's obsession with perfection and eternal youth, albeit reframed in a modern technological context.

Second, representations of S&T in pop music—such as when Devo or Pere Ubu deal with evolutionary theory or nuclear power—are contextualized in the present and provide their audience with material to interpret and evaluate their own condition and the state of society.

Third, in imagining the future, these narratives often anticipate the most heated public debates on S&T issues. Themes like those touched upon by Gary Numan in albums such as *Replicas*, for example, further confirm that popular ideas about cloning individuals were circulating much earlier than the advent of scientific research and techniques for cloning (Schwartz 1996, Turney 1998, Bucchi 2004).

Each of these levels does not necessarily exclude the other two; rather, the interaction of different temporal dimensions is part of a process whereby scripts and narratives are textured so that popular culture can make sense of specific aspects of technoscience and the inherent uncertainty perceived in connection with its social role and implications.[4]

References

Alexander, J. C. (2006). Cultural pragmatics: Social performance between ritual and strategy. In J. C. Alexander, B. Giesen & J. L. Mast (Eds.), *Social performance*. Cambridge: Cambridge University Press, 29–90.

Bauer, M. (1998). The medicalization of science news—from the rocket-scalpel to the gene–meteorite complex. *Social Science Information*, *37*, 731–51.

Bucchi, M. (1996). When scientists turn to the public: Alternative routes in science communication. *Public Understanding of Science*, *5*, 375–94.

Bucchi, M. (1998). *Science and the media. Alternative routes in science communication*. London, New York: Routledge.

[4] A more general analysis relevant to this point is in Nowotny (2005).

Bucchi, M. (2004). Can genetics help us rethink communication? Public communication of science as double helix. *New Genetics and Society*, *23(3)*, 270–83.

Bucchi, M. (2008). Of deficits, deviations and dialogues: Theories of public communication of science. In M. Bucchi & B. Trench (Eds.), *Handbook of public communication of science and technology*. London: Routledge, 57–76.

Bucchi, M. & Mazzolini, R. G. (2003). Big science, little news: Science coverage in the Italian daily press, 1946–1997. *Public Understanding of Science*, *12*, 7–24.

Bull, M. (2000). *Sounding out the city: Personal stereos and the management of everyday life*. Oxford: Berg.

Epstein, S. (1996). *Impure science: AIDS, activism and the politics of knowledge*. Berkeley: University of California Press.

Frith, S. (1996). *Performing rites. On the value of popular music*. Cambridge, MD: Harvard University Press.

Goffman, E. (1959). *The presentation of self in everyday life*. Garden City: Doubleday.

Hilgartner, S. (1990). The dominant view of popularization: Conceptual problems, political uses. *Social Studies of Science*, *20*, 519–39.

Keller, E. F. (1995). *Refiguring life. Metaphors of XXth century biology*. New York: Columbia University Press.

Kirby, D. (2008). Cinematic science. In M. Bucchi & B. Trench (Eds.), *Handbook of public communication of science and technology*. London: Routledge, 41–56.

Lewenstein, B. (1995a). Science and the media. In S. Jasanoff, G. E. Markle, J. C. Petersen & T. Pinch (Eds.), *Handbook of science and technology studies*. Thousand Oaks, CA: Sage, 343–59.

Lewenstein, B. (1995b). From fax to facts: Communication in the cold fusion saga. *Social Studies of Science*, *25*, 403–36.

Lewontin, R. (1996). In the blood. *The New York Review of Books*, *23 May,* 31–2.

Liakopoulos, M. (2002). Pandora's box or panacea? Using metaphors to create the public representations of biotechnology. *Public Understanding of Science*, *11(1)*, 5–32.

Longhurst, M. D. (2007). *Popular music and society*. Cambridge: Polity Press.

Middleton, R. (1990). *Studying popular music*. Buckingham: Open University Press.

Nelkin, D. & Lindee, S. (1995). *The gene as cultural icon*. New York: Freeman.

Nelkin, D. & Lindee, S. (2004). *The DNA mystique*. Ann Arbor: University of Michigan Press.

Nisbet M. C. & Lewenstein B. V. (2002). Biotechnology and the American media: The policy process and the elite press, 1970 to 1999. *Science Communication*, *23(4)*, 359–391.

Nowotny, H. (2005). *Untersättliche Neugier. Innovation in einer fragilen Zukunft*. Berlin: Kulturverlag Kadmos.

Pinch, T. J. & Bijsterveld, K. (2003). Should one applaud? Breaches and boundaries in the reception of new technology in music. *Technology and Culture*, *44(3)*, 536–59.

Pinch, T. J. & Trocco, F. (2002). *Analog days: The invention and impact of the Moog synthesizer*. Cambridge, MD: Harvard University Press.

Schwartz, H. (1996). *The culture of the copy*. New York: Zone.

Star, S. L. & Griesemer, J. R. (1989). Institutional ecology, translations and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–1939. *Social Studies of Science*, *19*, 387–420.

Turner, V. (1982). *From ritual to theatre. The human seriousness of play*. New York: Performing Arts Journal Publications.

Turney, J. (1998). *Frankenstein's footsteps: Science, genetics and popular culture*. New Haven, London: Yale University Press.

Wynne, B. (1989). Sheepfarming after Chernobyl: A case study in communicating scientific information, *Environment Magazine*, *31(2)*, 10–39.

Wynne, B. (1995). Public understanding of science. In S. Jasanoff, G. E. Markle, J. C. Petersen & T. Pinch (Eds.), *Handbook of science and technology studies*. Thousand Oaks, CA: Sage, 361–89.

Zola, E. (1871). *La Fortune des Rougon*, 1981 edition. Paris: Flammarion.

Selected Discography

Kraftwerk, Radio-activity (EMI 1975).
Brian Eno, *Before and after science* (EG 1977).
Ultravox!, *Ultravox* (Island 1977).
Tubeway Army, *Replicas* (1978).
Devo, *Q. Are we not men? A. No, we are Devo* (Warner 1978).
Kraftwerk, *The man machine* (EMI 1978).
Pere Ubu, *The modern dance* (Blank 1978).
The Stranglers, *The raven* (UA 1979).
John Foxx, *Metamatic* (Virgin 1980).

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Chapter 9
The More, the Earlier, the Better: Science Communication Supports Science Education

Cheng Donghong[a](✉) and Shi Shunke[b]

Abstract Since the 1980s, science communication and science education have experienced noteworthy changes and progress. Evolving and expanding on their way to accomplishing their historical missions, the two areas have at least one goal in common—to improve the scientific literacy of the people to enable them to live well in a modern society that is being transformed by science and technology more rapidly and completely than ever before. Considerable achievements have been made in both areas, but there are still many opportunities to do better. The authors review and analyse work in science education and science communication over the past three decades, focusing on common goals. They argue that problems in science education, such as shortages of trained science teachers, can be reduced in the short term by applying practices from science communication, by linking scientists and science communicators more closely with educators, and by doing so at an earlier stage in students' school education.

Keywords Education, science, science communication, science community, science education, scientific literacy

9.1 Introduction

The decade of the 1980s was a period of impressive social reform, during which the world witnessed great changes in the political and economic spheres. These social shockwaves and the ripples that followed are attributed by many, to a certain extent,

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to the ‘stirring hand’ of science and technology (S&T)—creations nurtured by society that paid society back with their impacts. History reveals the interactive relationship between science and society. As science communicators, we are concerned with that relationship and with the active elements in it.

Campaigns for the public understanding of science (PUS) and for science education reform have been important elements in the science–society relationship. Both types had occurred before the 1980s, but two crucial documents that appeared in the middle of 1980s illuminated science communication and science education and the links between them. In 1985, the Royal Society published *The public understanding of science*, initiating an enduring global PUS campaign; and in 1986 the American Association for the Advancement of Science (AAAS) published *Science for all Americans*, signalling the direction of a new round of science education reform and initiating the long-term Project 2061 scheme.

The following years saw more, broader and much more sophisticated activities in the two domains. UNESCO initiated a campaign for science education in 1990 (UNESCO 1990) and strengthened it in the *Declaration on science and the use of scientific knowledge* in 1999 (UNESCO 1999) and a series of other declarations. In the face of urgent social problems accompanying the progress of S&T and society generally, the science community took the lead in a re-examination of the remit of science communication, paying close attention to the scientific literacy of the public. Many national governments began to take steps to prepare their citizens for a knowledge-based society, and expressed concerns about the social implications of S&T communication and education.

In all these areas, science communication and science education were closely connected. Although two different social activity domains, they share the goals of raising public scientific literacy and fostering the harmonious development of science and society. For a long time, however, each evolved in its own disciplinary ‘space’ and followed its own track. In dealing with social problems, the two disciplines were not well prepared to take better and more effective joint actions.

From the science communication perspective, there is plenty of room for the science communication community to provide assistance or services for science education. This is especially true in the areas of institutional construction, effective initiatives and resource allocation. There is a need for such assistance.

This chapter looks into science communication and science education separately, focusing on similar or common challenges in the two domains, and then presents our ideas about possible solutions. We argue that the science communication community should take active steps to integrate with the science education community and provide practical, facilitative support for its counterpart, especially in primary and secondary school education. The more support, and the sooner it is delivered, the better. If the two communities are to achieve their mutual objectives, we should make full use of science education as a main channel for the improvement of public scientific literacy and the continued construction of scientific culture.

9.2 Science Communication: From Popularization to Social Participation

In its early days and for a long time afterwards, science was considered the business of a small group of people—mainly the literate upper classes. As scientists moved towards specialization and professionalization just before the middle of the 19th century and scientific associations like British Association for the Advancement of Science and the AAAS began to grow (Bruce 1987, Kett 1994), science entered a long 'golden age' of popularization. The birth of the Science Service in 1921 allowed an even greater audience to be reached through new media (Rhees 1979, Lewenstein 1994). After World War II, especially from the late 1950s when science popularization began to take in the entire society, the traditional public 'gee whiz' at the wonder of science gradually gave way to concerns about the social impacts of scientific advancement and about public science literacy.

The most significant changes took place in the 1980s. One event with long-lasting effects was the release of *The public understanding of science* (the Bodmer Report) in 1985. Perhaps its most valuable contribution was that it put forward the idea of engaging the public in science (Briggs 2003). The report can be regarded as the starting point for PUS campaigns on a global scale (Broks 2006); ever since then, the public has been encouraged to participate in science.

The underlying rationale for PUS campaigns was sophisticated. On the one hand, while enjoying the benefits brought by S&T, the public was alert to the threats of nuclear weapons and environmental pollution from the inappropriate application of technology. Antagonistic voices were becoming louder (Gregory and Miller 1998). On the other hand, public scientific literacy surveys in the US and some other countries showed that public command of scientific expertise was at a low level—an apparent inconsistency in modern social systems, which rely ever more heavily on the progress of S&T.

In such a context, better public understanding of science was erected as a milestone to be reached. It matters, said the Bodmer Report, because it contributes to the enrichment of the individual's life, the improvement of public life and the national prosperity (Royal Society 1985). Better understanding comes from improved public scientific literacy. Discussion of scientific literacy was widespread, its connotations multiplied and the concept became enriched.

The tide swirled to a climax in the 1990s, as the campaign swept across the world. More international organizations and more countries joined in, especially the developing countries. In this rapidly changing social context, public science communication became a grand view in at least the following aspects:

- The scope of the movement expanded. While the science content of communication activities grew and methods multiplied, activities in many countries spread from cities into rural areas and from upper classes to other groups (especially to underrepresented social groups, such as women and ethnic minorities, whose particular requirements had usually been neglected).

- Infrastructural and institutional construction mushroomed in many countries. S&T museums and science centres were built. Universities inaugurated discipline subjects and created professorial positions related to science communication.
- Science reporting in the mass media soared, and the internet became a major tool for communicating S&T.
- National governments drew up strategic plans for science communication and backed them up with managed programmes and increasing financial investments.
- Public engagement became the leading trend, in both theory and practice. The didactic 'top-down' concept was edged out by 'bottom-up' methods that emphasized listening to and engaging in dialogue with the public.

In this expanded ensemble of science communication, one of the key tunes was still the one calling for us to raise the scientific literacy of the public at large.

From 2000, science communication was further recognized for its value in national, social, scientific and technological progress. From the national perspective, public understanding of and participation in science was highlighted in social governance. It was widely taken into national policy frameworks for S&T, and seen to be closely related to a nation's general competitive capacity, creative ability and sustainable economic development. Guiding policies were tailored more closely to the real world, and large-scale national action plans emerged here and there, such as the Science and Society Action Plan of the European Commission's Research Framework Programme and China's Outline of National Action Plan of Scientific Literacy for All Chinese Citizens.

From the societal perspective, the dynamic function of science communication in raising the public's awareness and ability to take part in social activities was broadly accepted by consensus. Although the meaning of 'public engagement in science' is understood and explained differently in different countries or communities (due to their different stages of development), this does not stop them producing well-planned and well-received activities corresponding to their local needs. As a result, science communication around the world has an animated, multifaceted collection of patterns and objectives. With the encouragement and support of national governments, more and more scientists and scientific institutions are now approaching the public through the education system, the mass media and many other channels. One of their missions is to join the public and get it involved in knowing, discussing and assessing the unavoidable questions about ethics, uncertainties and risks in S&T, and get it involved in decision making. The public needs to be scientifically literate to live well in modern societies, and scientific literacy remains the basic target of all the efforts of the science communication community.

After three decades of strategies, plans, campaigns and initiatives, however, some problems remain unsolved in the domain of PUS. The public at large continues to hold a comparatively high interest in science, but public scientific literacy has lingered at a marginal level over the years (OECD 1997, European Commission 2002, Cheng et al. 2006, Broks 2006).

To tackle this problem, science communicators need to come up with new ideas and make harder efforts. In our view, we need to take a progressive and pragmatic approach, and actively cultivate citizens' scientific literacy through science education. In the vernacular of our country, the science communication community should uphold the banner of public scientific literacy, march forward and abreast with science educators, take a positive stand to combine with them, and assist and support their efforts.

In the following discussion, we examine how science education has developed in the recent past, discuss the possibility of science communication and science education coupling to produce better results, and to describe a few commendable cases where this has already happened.

9.3 Science Education: from Passing on Knowledge and Skills to Nurturing Scientific Literacy

In parallel with mainstream PUS campaigns advocating 'science for all' in the 1980s, science education was brought into focus amid waves of education reform.

Science has been taught in schools as a legitimate part of the curriculum for no more than 200 years. But science education, a group of young subjects compared with grammar, Latin and mathematics, put its roots deeply into education systems and grew up quickly and vigorously. It soon became an object of concern and study by many educators, education researchers and sociologists, and was also a key area of concern of governments and international organizations. For example, science education always features prominently at United Nations conferences and in UN documents on S&T policies or education policies. Specific statements about science education are also made in papers and resolutions about other topics, such as development, poverty alleviation, health and the environment.

The reason for this focus on science education is the proliferation of S&T into all areas of social life and the dynamic response of education systems. The background message is that, in an era of globalization, economic growth based solely on capital investment gives way to growth that relies heavily on science-based technology and higher worker productivity. S&T not only decides the products and the markets, but also transforms the content of labour at the same time. In particular, the advent of computer as a tool in production and management is none other than a revolution in traditional notions of labour.

In these circumstances, human resources become an indispensable and non-negligible component of the competitive capacity of any country. If a nation does not possess an abundant labour resource with a fundamental S&T education, if qualified engineers cannot be easily hired, if there is no cutting-edge creative corps, or if there is not substantial research and development to support S&T innovation, the nation will be beaten in an international contest for products and markets that is growing harsher day by day. In the production chain from design and innovation through manufacturing to selling and servicing, countries without this nucleus of competitive S&T capacity have no choice but to cling to the manufacturing link, making low value-added products through high resource consumption.

Scientific literacy is also likely to become a personal, internal requirement for citizens who aspire to meet their social obligations, pursue their aspirations and live dignified lives. Educating youngsters in school to develop scientific literacy enables them to take up their responsibilities for the future of their society, their families and themselves, and has become a natural obligation of school education systems, placed on them by society at large.

For these economic and social reasons, many countries have made it their priority to improve the quality of science education, starting from the elementary stage.

In the current round of science education reform, the goal has shifted from producing sci-tech elites (capable candidates for upper level S&T education) to developing every student's scientific literacy. This strategic change has given rise to a chain reaction in many other areas of education, such as curriculum development, pedagogy and evaluation. The teaching of science as a package of knowledge has been converted into the nurturing of scientific literacy, so the content of courses has changed as well. This down-to-earth policy and practice reflects the aim of 'scientific and technological literacy for all' (UNESCO and ICASE 1993), which followed the advocacy of 'education for all' put forward in 1990. Overall reform in the education domain as a whole has also showed the impacts of PUS campaigns, particularly the notions of 'science for society' and 'going to the public'.

Today, the science education aim of improving the scientific literacy of all students is the dominant trend. However, it has not yet been achieved. Three big, embarrassing obstacles block the way:

- A lack of excellent science education resources
- A deficiency of qualified science teachers
- Declining interest in science among young students

A common challenge facing science educators around the world is the need to develop new curriculums for general scientific literacy and to find suitable, up-to-date teaching materials. The Project 2061 office of the AAAS assessed the science textbooks in use in secondary schools in 1999, and commented that 'not one of the widely used science textbooks for middle school was rated satisfactory' (Koppal 1999).

The shortage of suitable teachers for new courses is also a global problem, and has resulted in a drive to transform teacher education and provide in-service training for science teachers. The consensus of educators and policymakers is that teachers are the crux of science education reform; the question is where to find (or rather, to develop) teachers who are capable and well prepared to teach for scientific literacy.

Today, when societies and economies rely more and more on S&T, a paradoxical emerging trend has alarmed the leading industrialized countries of the West: young people are losing their interest in S&T and are moving away from choosing S&T as a career. Many research reports have detected the trend. Although various corrective measures have been taken in recent years, the current situation is no cause for optimism. Politicians understand the seriousness of the problem clearly: ‘Stimulating interest among Europe’s young for science and technology is crucial if Europe is to have a future based on the best use of knowledge’ (Potočnik 2007).

As we see it, there is no quick way to remove the three key barriers to achieving the new science education objectives. It is therefore worth considering the adoption of some strategies and initiatives from the PUS domain to reduce the barriers and reinforce science education reform.

9.4 Backing Up Science Education

In our review of science communication and science education, it is easy to notice the conspicuous interrelation between the two domains. Two aspects stand out: one is the compatibility of the aims of the two domains; the other is the interdependency of solutions in both areas. Starting in the 1980s and from different angles (such as ‘science in society’ and ‘education for future citizenship’), both called for scientific and technological literacy for all. The common goal is to produce citizens, now and in the future, who can participate in the life of modern society and are fortified with the values of democracy, and to ensure a sustainable future for a planet that has been transformed by the application of high technologies. Science communication and science education belong to different social domains, but because they share a goal and their target groups overlap, they can surely support and benefit each other by sharing initiatives, human resources and information.

To enhance public scientific literacy is one of the primary goals of science communication activities, while school science education is normally regarded as the basis or main channel for reaching that goal. Science education must respond to modern society’s calls for the scientific literacy of every citizen, and at the same time produce a large enough cohort of high-quality scientists and engineers each year to meet economic and technical demand. To achieve these twin goals, science education (especially in primary and secondary schools) must urgently renew its teaching materials and facilities. Unfortunately, current levels of human resources and facilities make it hard to carry out this significant transformation. Therefore, there is an urgent need for large numbers of S&T professionals with an empirical approach to scientific inquiry to help schoolteachers in transforming their pedagogy. This may mean huge investments in school systems, and will certainly take some time.

Nevertheless, if we take a wider look at the problem, we might find a way around the problem, at least for the short term. ‘To win the battle with borrowed troops’, as an ancient Chinese war strategist described, could be the right strategy. If it is possible to overcome deficiencies in school science education by drawing on the resources available in the science communication domain, why not do it?

For example, we could use the facilities in scientific institutions as resources for science education, mobilize S&T workers and science-based organizations to support science teachers in their teaching practices, and follow the example of out-of-school hobby group practices to employ inquiry-based learning methods in science classes. The following section discusses these and other options.

Generally speaking, science communicators pay close attention to the interaction between S&T developments and the demands of society, and they are used to answering queries and dealing with doubts. Seen from the point of view of science communicators, science education is a kind of large social project, in which the goal of scientific literacy for all school students closely matches the 'science for all' goal of science communication in the 1980s.

Starting from this position and taking into consideration the interactions of the two domains, this section expands on the involvement of science communicators in science education.

We could bring science education under examination from various angles, such as by following the primary–secondary–tertiary education hierarchy, by dividing it into school education and out-of-school education, and so on. However, in the light of our knowledge of lifelong learning, we divide it here into formal education, non-formal education and informal education.

9.4.1 Formal Education

Science communicators have been doing a lot in formal science education, including:

- Taking an active part in science education policymaking
- Giving advice and making recommendations to governments on science education reform and getting involved in drafting reform documents
- Working on curriculum development and creating curricular standards
- Training science teachers
- Opening laboratory facilities to schools for them to practise inquiry-based education

One eye-catching achievement has been the Pollen Project, which is being carried out in 12 European countries. The project is a joint action, but is implemented under the guidance of local education authorities. Scientists come to work side by side with primary schoolteachers, and cooperate with teachers and curriculum specialists in curriculum development, teacher training, online consultation and the like. The joint activity stimulated and strengthened female schoolteachers' interest and confidence in teaching science, and aroused students' curiosity about science (especially girls and children from disadvantaged family backgrounds).

The Pollen Project sheds light on two important factors. One is that the science community should be intervening in formal science education at an earlier stage. It is too late to intervene at the higher degree level, as people used to believe to be appropriate. As we understand it, the Pollen Project had its roots in an initiative of physics Nobel laureate Georges Charpak. He once led a group of scientists from the

French Academy of Sciences into primary schools and kindergartens and set up a programme named '*La main à la pate*' in cooperation with teachers there. Through the programme, they brought an inquiry-based approach into early-stage science education.

The second important lesson is that the transformation of pedagogy is just as important as content reform in science education. Reformed teaching methods are an effective and important way to maintain the appeal of science to young people—a key requirement for any nation that wants to retain its competitive S&T edge in the future. To make these changes happen, it is extremely important that the science community's intervention into science education should directly assist schoolteachers to transform their teaching methods from traditional 'didactic' practices to inquiry-based approaches.

9.4.2 Non-Formal Education

Non-formal education is an important supplement to formal education, and has been attracting more and more attention in many countries. Science communication practices in this arena have included:

- Organizing many types of science activities for primary and secondary students in conjuction with science institutions and organizations, such as summer camps, science fairs and so on
- Running workshops or training courses for special target groups, such as pragmatic technique training for farmers
- Opening research institutes, science museums and science centres for students to practise hands-on experiments

The organizers of non-formal science education programmes lay stress on cultivating participants' interest and keeping them engaged through an inquiry-based approach. Success arises from the correct combination of science education with social practice, and these activites work best when they pull S&T and the public closer together and foster the scientific literacy of the target group.

Notable successes include the British Association for the Advancement of Science's youth programmes and the S&T activities for teenagers organised by the China Association for Science and Technology (CAST):

- The British Association's Young People's Programme[1] aims to engage and inspire young people with S&T and its implications. It sponsored a series of well-designed award schemes for young people of all ages, such as CREST Investigators for primary students, BA Science Communicators for ages 11+, and BA CREST awards for years 11–19. As well as these awards programmes

[1] http://www.the-ba.net/the-ba/YPP/index.html

for children, the British Association also provides training and resources for teachers and organizes events for young people to experience S&T directly.

- CAST organizes series of science contests, such as the National Adolescents Science and Technology Innovation Contest[2] to foster adolescents' innovation and practical abilities. Its Big Hands Hold Small Hands outreach programme encourages hundreds of scientists to go to schools every year to present popular science lectures and mentor students' scientific activities.

9.4.3 Informal Education

Informal education is either an industry that needs billions of dollars in investment (Friedman 1995), or an extensive space where society is the classroom, living is learning and the learner is every member of the society. This is a field in which lifelong learning is driven by the interests, needs and curiosity of individuals, and the invisible educational channel through which public scientific literacy is improved bit by bit and day by day by way of seeing, listening, touching and experiencing.

Science communicators are active in informal education in many ways, including:

- Organizing science weeks or science days, such as the EU annual Science Week, which creates an atmosphere of scientific culture that 'bathes' the public
- Presenting participatory exhibitions by science museums and science centres to advance lifelong learning
- Cooperating with journalists to deliver science information through the mass media
- Running popular science websites for more interactive science communication.

For informal science education to be effective, it is pivotally important that the science community collaborates with the media world. The media do not produce knowledge (they are merely the vehicle for its passage), but their speed, coverage and influence magify its efficacy. PUS surveys in several countries demonstrate that the media, especially television, have become the main channel by which the general public obtains S&T information. In recent years, with the support of the science community around the world, there has been much more media coverage of science-related topics (such as climate change, genetic modification, tsunamis, avian influenza and so on). This has raised the public's awareness of the science and increased its ability to deal with unexpected events.

The many cases of successful informal science education have relied heavily on effective science communicators. However, in our view, there is still enormous space for the closer integration of the two domains to achieve greater depth, breadth

[2] http://www.xiaoxiaotong.org

and universality. This is still an underdeveloped enterprise, in which there are many valuable things waiting to be accomplished and investigated.

9.5 Conclusion

The discipline of public S&T communication grew from a need to deal with contemporary social problems. It grew by developing its practitioners' consciousness of responsibility, and then by examining its own social accountability. In a parallel process, science researchers and organizations, partly through their involvement in science communication, should take up their social responsibility to engage in science education.

The involvement of the science community in non-formal and informal science education is already undergoing a kind of regularization and professionalization with the addition of a 'third assignment': science communication. Sweden and France passed laws in 1979 and 1981, respectively, asking science research institutions to take up that third assignment (Felt 2003). In 1993, Research Councils UK was also asked to include science communication as one of its missions (British Council 2001). In 2006, the same requirement was promulgated by the Chinese Academy of Sciences in its *Outline of medium and long term development of science communication,* which is in effect from 2006 to 2020.

We believe that the science communication community should deepen its involvement in science education at the earliest possible level to achieve the common goals of the two domains. Science communicators should make a much wider and much better contribution by:

- Bridging the gap between scientists and science educators by taking responsibility for coordinating scientific expertise, facilities and information to support science education in and out of schools
- Promoting systematic reform in both domains to put support for science education into the science communication agenda and, at the same time, introducing the best practices of science communication into science education
- Helping to organize social activities for science education in schools and providing assistance in those activities
- Engaging in science education research
- Training science teachers

The science of the 21st century will play a major role in human society: our fate, and the fate of our society, are bound up with it. For this reason, science communicators should intensify their efforts, and go to the public, to the society and into science education. It is expected of us and is also our social responsibility. It will also benefit the development of our discipline.

Science communication and science education have never been seen so vigorous as today, but they are really just beginning to develop. They need to be adjusted, rationalized and improved for greater effectiveness. The two domains' traditional separation and isolation from one another is no longer appropriate.

To equip the 21st century public with basic modern scientific literacy, we need to create favourable environments and conditions. We need to build a multi-element resource system for science education that includes teachers, schools, governments, scientists, science communicators and science institutions and creates an extensive, spacious arena for cooperation and collaboration.

Science communicators are uniquely placed to catalyse this transformation.

References

Briggs, P. (2003). *The BA at the end of the 20th century: A personal account of 22 years from 1980 to 2002*. Retrieved from http://www.the-ba.net/the-ba/AbouttheBA/HistoryoftheBA.

British Council (2001). *Public understanding of science*. UK Partnerships, Briefing Sheet 6. Retrieved from http://www.britishcouncil.org/science-society.htm.

Broks, P. (2006). *Understanding popular science*. New York: Open University Press.

Bruce, R. V. (1987). *The launching of modern American science, 1846–1876*. New York: Knopt.

Cheng, D., Metcalfe, J. & Schiele, B. (Eds.) (2006). *At the human scale: International practices in science communication*. Beijing: Science Press.

European Commission (2002). *Science and society action plan*. Retrieved from http://ec.europa.eu/research/science-society/pdf/ss_ap_en.pdf.

Felt, U. (Ed.) (2003). *Optimizing public understanding of science and technology*. Retrieved from http://www.univie.ac.at/virusss/opus/mpapers.html.

Friedman, A. J. (1995). Creating an academic home for informal science education. In J. H. Falk & L. D. Dierking (Eds.), *Public institutions for personal learning*. Washington: American Association of Museums, 135–140.

Gregory, J. & Miller, S. (1998). *Science in public: Communication, culture and credibility*. New York: Plenum Trade.

Kett, J. F. (1994). *The pursuit of knowledge under difficulties*. Stanford, CA: Stanford University Press.

Koppal, M. (1999). *Heavy books light on learning: Not one middle grades science text rated satisfactory by AAAS's Project 2061*. Retrieved from http://www.project2061.org/about/press/pr990928.htm.

Lewenstein, B. V. (1994). A survey of activities in public communication of science and technology in the United States. In B. Schiele (Ed.), *When science becomes culture: World survey of scientific culture*. Quebec: MultiMondes Editions.

OECD (Organisation for Economic Co-operation and Development) (1997). *Promoting public understanding of science and technology*. Retrieved from http://www.oecd.org/dataoecd/-9/28/2754562.pdf.

Potočnik, J. (2007). *New approach to science teaching needed in Europe, say experts. IP/07/797, Brussels*. Retrieved from http://europa.eu/rapid/pressReleasesAction.do?reference=IP/07/797-&format=HTML&aged=0&language=EN&guiLanguage=en.

Rhees, D. J. (1979). A new voice for science: Science Service under Edwin E. Slosson, 1921–19. Unpublished Masters thesis, University of North Carolina. Retrieved on 6 December 2007 from http://scienceservice.si.edu/thesis/index.htm.

Royal Society (1985). *The public understanding of science*. London: Royal Society.

UNESCO (1990). *World conference on education for all: Meeting basic learning needs*. Retrieved from http://unesdoc.unesco.org/images/0009/000975/097552e.pdf.

UNESCO (1999). *Declaration on science and the use of scientific knowledge*. Retrieved from http://www.unesco.org/science/wcs/eng/declaration_e.htm.

UNESCO and ICASE (1993). *Project 2000+ declaration: Scientific and technological literacy for all*. Retrieved from http://unesdoc.unesco.org/images/0009/000977/097743eo.pdf

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Chapter 10
Hollywood Knowledge: Communication Between Scientific and Entertainment Cultures

David A. Kirby(✉)

Abstract There is a longstanding perception among scientists and members of the entertainment industry that they represent two distinct cultures. In this social context, science communication is not merely communication from an expert community to a lay community but is more akin to intercultural communication. This perception has led to the development of a new category of science consultant within Hollywood: 'boundary spanners'. Boundary spanners take on the identity of a scientific expert in the scientific community and that of a filmmaking expert in the entertainment industry. At the same time, their authority within those communities also rests upon their own unique social identity as a boundary spanner. The boundary spanner's process involves the synthesis of information from the culture of science, the translation of that information into the culture of entertainment, and finally the transformation of the information into a finished cultural product. For boundary spanners, success is achieved when the transformed product on the screen bears enough resemblance to scientific authenticity to satisfy both the scientific and the entertainment communities.

Keywords Cinema, entertainment industry, boundary spanner, science consultant, intercultural communication, scientific expertise

> The scientists believe they are gods and the entertainment people believe they are gods themselves. So, let us say it is a battle of gods.
>
> —Pablo Hagemeyer of 'The Dox' consulting group.[1]

Historically, filmmakers employed research scientists as consultants to instil their films with scientific accuracy (Kirby 2003a,b, Frank 2003).[2] Even in successful

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[1] Unless otherwise noted, all information and quotes concerning Pablo Hagemeyer and The Dox come from Pablo Hagemeyer, interview by David Kirby, Munich, Germany, 13 December 2001.

[2] My discussion in this chapter is predominantly confined to boundary spanners' work on popular, fictional films. Despite television's faster paced production practices, the processes by which boundary spanners deal with science are comparable between television and film.

collaborations, communication can be difficult because scientists and entertainment producers may have radically different goals for fictionalized science. There is a longstanding perception among scientists and members of the entertainment industry that they represent two distinct cultures, with different languages, customs, value systems, sets of cultural assumptions and cultural practices. In this social context, science communication is not merely communication from an expert community to a lay community but is more akin to intercultural communication. How, then, do these 'gods' throw aside their differences to allow effective communication?

Science consulting as intercultural communication has led to the development of a new category of consultant that I refer to as 'boundary spanners'.[3] Boundary spanners' ability to facilitate communication between these two unique social groups rests on their claims to membership in both. Boundary spanners are not research scientists but are individuals who mediate between the scientific community and the entertainment industry. Filmmakers pose specific queries to a boundary spanner. The spanner then locates an appropriate specialist, obtains and synthesizes scientific information, and translates it into the language of cinema. Management of their social identity allows boundary spanners to interact with unique social groups and to negotiate information transfer between cultures. Thus, boundary spanners allow two distinct cultures to communicate successfully without the need for either to adapt culturally to the other.

10.1 Intercultural Science Communication and Boundary Spanners

Ribeiro (2007) recently addressed the impediments to intercultural science communication in his examination of the interaction between Brazilian and Japanese engineers in the steel industry. Ribeiro argues that the inability of those two cultural groups to speak the same language actually aids communication because it prevents them from committing cultural indiscretions. Instead, they rely on interpreters who not only speak both languages but also understand the norms of each culture. In addition, the interpreters' long-term connection within the steel industry gives them credibility with both the Brazilian and the Japanese engineers. In his view, interpreters allow information transfer without the need for adaptation to another culture's forms.

In Ribeiro's model, an interpreter's mediation of information transfer comes as much from their membership in a social group shared by all the participants (the engineering community) as it does from their familiarity with the customs of each culture. In the case of Hollywood, however, there is no shared social group when mediating between the scientific community and the entertainment industry. Therefore, a boundary spanner must effectively inhabit multiple social identities.

[3] I am adapting the term 'boundary spanner' from Kelly Moore (1996: 1596), who used it to describe scientists who inhabit both scientific and political social identities.

A boundary spanner's capacity to facilitate information transfer depends on their ability to assume an identity unique to each social group and maintain their own unique social identity as a mediator. Boundary spanners readily move between the social worlds of science and entertainment and mediate translation processes. Specifically, boundary spanners take on the identity of a scientific expert in the scientific community and that of a filmmaking expert in the entertainment industry (see Fig. 10.1). At the same time, their authority within those communities also rests upon the fact that they have their own unique social identity as a boundary spanner. If their identity were solely that of filmmaker, why should other filmmakers trust their scientific advice? Likewise, why should scientists trust the boundary spanner to understand how to translate scientific information onto the screen if they are merely another scientific expert?

To manage these various social identities, boundary spanners must portray themselves as authoritative within each community. This authority rests entirely upon the perception that boundary spanners can operate as experts within each group. Expertise is central to interactions between scientists and the entertainment industry. However, the concept of expertise is not as simple as a delineation between those who possess knowledge and those who do not. Collins and Evans (2002) usefully distinguish between categories of expertise as they relate to scientific culture. They define 'contributory expertise' as sufficient experience within scientific culture to contribute to the creation of knowledge, while they define 'interactional expertise' as enough knowledge of scientific culture to interact with those who have contributory expertise.

It is clear that these categories of expertise can be adapted to cultural arenas other than science, such as the filmmaking industry. It would be fair to say that trained filmmakers have contributory expertise in the creation of movies, while film critics have interactional expertise in the realm of filmmaking. Boundary spanners, then, must possess at least interactional expertise in both science and filmmaking. In addition, they must also be perceived as having contributory expertise as a boundary spanner who can appropriately synthesize scientific information in a way palatable to the entertainment industry. The fluid nature of their expertise allows them to mediate between social worlds and serve as an accepted liaison between scientific knowledge and fictional representations.

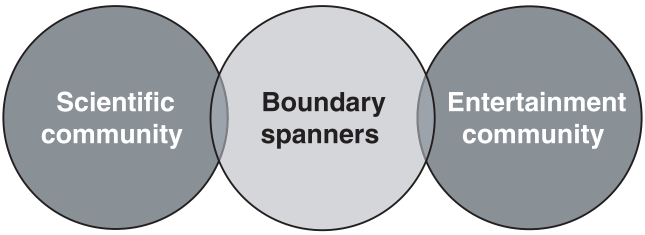

Fig. 10.1 Boundary spanners claim social identities within each culture but retain their own unique social identity

10.2 Mediating Social Identities in Entertainment Culture

I will focus my analysis on two of the earliest examples of boundary spanners in the entertainment industry: The Dox and Donna Cline. While science consultants have worked in cinema from its earliest days (Kirby 2003a), the boundary spanner approach is a relatively recent phenomenon. Generally, boundary spanners are individuals with some scientific training who also develop extensive experience working in the entertainment world.

The Dox, a science consulting agency based in Munich, mainly serves the German entertainment industry, although some work has been done in the US. The Dox is organized as a traditional company, with the three founding scientists, Pablo Hagemeyer, Florian Gekeler and Patrick Weydt, serving as the board of directors. All three are trained as medical scientists and have published extensively in scientific journals, including prestigious journals such as *Nature*. After forming the agency in 1997, they began advising for news and documentary organizations before branching out to fictional films and television series. The Dox has worked on over 25 fictional films and television movies, including *Die Wolke* [*The Cloud*] (2005), *Das wilde Leben* [*The Savage Life*] (2006), *Stadt, Land, Mord* [*City, Country, Murder*] (2007) and *Awake* (2007).

Donna Cline, who has consulted on over a dozen major Hollywood films in the past decade, is a prototypical boundary spanner.[4] She operates as an independent consultant, rather than through a company structure like The Dox. Cline earned a masters degree in biomedical illustration and trained as a forensic artist before moving to Hollywood to work in the entertainment industry. She worked as a storyboard artist and illustrator before engaging in consulting work on several fictional films, including *The Doctor* (1991), *Outbreak* (1995), *The Relic* (1997), *Deep Blue Sea* (1999), *Red Dragon* (2002), and *The Shaggy Dog* (2006).[5]

Crucially, at the outset both Donna Cline and The Dox needed to convince the entertainment industry that they had sufficient scientific expertise to be useful. For The Dox directors, establishing their scientific authority was the easy part. They were working scientists with official academic degrees and positions at well-known scientific institutions. Since entertainment producers are not part of the scientific social sphere, they did not rely on any of the traditional means for judging the calibre of The Dox as scientists, such as numbers of publications, citation rates, sizes of research groups, or numbers of grants. According to Pablo Hagemeyer, it was enough that they had scientific degrees and worked for prestigious institutions:

> We are not necessarily the highly qualified, high-powered scientists we seem to be, but we do have impressive academic titles and we work in high-quality scientific institutes like the Max Planck. That was enough to convince them we could handle their science and medicine.

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[4] Unless otherwise noted, all information and quotes concerning Donna Cline come from an interview by David Kirby, Pasadena, California, 30 March 2005.

[5] Cline still works as a storyboard artist either in conjunction with her consulting work or separately.

Although there are instances where filmmakers hire high-profile scientists for their publicity value (Kirby 2003a), it is most often the case that they only require an individual with interactional scientific expertise. The Dox directors' impressive titles and their association with prestigious institutions convey to the non-scientist that they not only have interactional expertise but clearly have contributory expertise in the scientific realm.

While The Dox simply had to point to their titles to obtain scientific credibility, Donna Cline had to prove to filmmakers that she had at least interactional scientific expertise. Cline's training as a biomedical illustrator is why she initially worked as a storyboard artist, but it also gave her the interactional expertise to work as a science consultant. As she explains, her background did not make it obvious to the filmmakers that she had scientific credibility. Rather, she first had to prove her expertise to them through her actions. She established her potential as a science consultant during an interview for work as an illustrator on the film *Gross Anatomy* (1989):

> I found out they were having trouble getting access to some very hard-to-reach places. Actually, it was seeing dead bodies. Anyway they were asking me about it, 'Do you know what we can do?' They didn't even know me. I was just there asking if they needed any medical drawings. So I called one of my professors from graduate school and asked if I could bring some people from this movie to come see some cadavers. He said, 'Ten tomorrow is alright.' So I went back and told them, and they were like 'Are you serious?' I told them 'You can't go photograph the bodies. There are laws about that, but we can go in and you can learn all kinds of stuff.' So they asked me to stay for more meetings with the effects guys and they hired me a day and a half later as their technical adviser.

She clearly projected a sense of interactional expertise to the filmmakers because someone with obvious scientific authority—a medical professor—treated her as worthy of being granted access to restricted spaces. Her work on this film gave her credibility in the entertainment industry as a 'scientific expert' and led directly to her next consulting job on *The Doctor* (1991), which she considers 'the most accurate medical picture in Hollywood history'.

In addition to establishing their credibility as scientific authorities, both Cline and The Dox also needed to demonstrate to entertainment producers their familiarity with the culture of entertainment. This was the biggest challenge The Dox directors faced in expanding their consulting business beyond non-fiction media. Initially, their fiction work came through a partnership with a British script warehouse in which they read scripts and provided extensive notes for scriptwriters. Having this intermediary between their organization and entertainment producers meant that they did not require any knowledge of filmmaking practices in their work. They provided advice and the scriptwriters decided how to alter the scripts. Having no knowledge of The Dox's involvement, studios that bought these scripts assumed it was the scriptwriters who understood how to negotiate filmmaking requirements. Therefore, at the outset, The Dox could not convince entertainment companies they had enough interactional expertise to be hired directly.

Hagemeyer perceived that their initial interactions with filmmakers did not go smoothly, especially when they were telling filmmakers what the 'real' science was for a given fictional scenario:

> You feel that the entertainment people say ‘First, we don’t accept you because you studied science and we didn’t. Why can you be so arrogant coming here and telling us what the real story is about? You are so impolite telling us we are stupid.’ They don’t really say this to you, but you get the feeling they are challenging you.

Hagemeyer’s experience points directly to the problems that can arise when scientists communicate within entertainment culture without having interactional expertise in entertainment production. If they had understood filmmaking culture, they would have known not to provide scientific information in such a straightforward manner. Many other science consultants have told me that filmmakers as a group are sensitive to criticism and take offence if they are told they are ‘wrong’. In scientific or academic culture, such a critique is a valued social norm because scientists understand that you are just ‘telling it the way it is’. In filmmaking culture, however, the perception was that the scientists were overtly demonstrating their superiority and undervaluing filmmakers’ own knowledge. The Dox were entertainment outsiders who had to become accepted as insiders before they could obtain regular consulting work.

As Hagemeyer tells it, ‘We had to accept the rules of media and change stories in that direction. We no longer fight for the right of being correct. We fight for the right of telling a good story’. They had to accept that entertainment culture was not going to adapt to the norms of scientific culture but that, as boundary spanners, they had to adapt to entertainment culture.

Unlike The Dox, Cline found it easy to establish her authority as a filmmaking expert. She has been a member of the Hollywood branch of the Illustrators and Matte Artists Union since the mid-1980s and has worked as a storyboard artist since the early 1990s, which helped her overcome the problems faced by scientists working in Hollywood. Through her experiences, Cline developed contributory expertise in filmmaking; this helped her to understand the place of science in the filmmaking process:

> My experiences as a storyboard artist give me an incredible dimensionality in knowing how shots are structured, continuity, story telling, how we cheat, how we don’t, budgets, what is shootable, and what isn’t. That is a remarkably valuable part of my technical advising because I know the filmmaking side of it, not just the scientific component.

Cline cites specific skills and restricted knowledge that only someone with contributory expertise would possess, such as ‘how we cheat’. Her credentials and work experiences position her as an official member of the filmmakers’ social group. As Cline explains it, the perception that she is an ‘insider’ buys her instant credibility with entertainment people even if she is doing work other than that which gained her that credibility:

> There is pretty much a distinction about industry and non-industry. I am considered to be one of them. Unless they don’t know me and they think I’m just a technical person and they find out, wait a minute you know this stuff and they immediately accept me.

It is assumed that Cline, as an insider, will understand the cultural norms of entertainment culture. Actors, for example, understand that she is ‘one of them’, so she can communicate and interact with them more effectively than someone coming in from outside their community.

A clear-cut example of how Cline's intimate knowledge of cultural norms helps her act as a boundary spanner is her understanding of how to behave on the set. As a boundary spanner, she taps into the expertise of a wide range of scientists, and it is often necessary to bring a scientist onto a set. Cline's job is to make sure that either the scientist understands filmmaking's cultural norms or she is able to control the scientist's actions:

> I wrangle them. Because they don't understand set culture and I know that. You don't walk over into this area, you watch where the camera is, you wear soft shoes, and you turn off your phone. There is a whole lot of things that we in the industry don't think about that scientists don't know. They are a visitor there so they are my responsibility. If they see a big issue they are supposed to pull me aside and tell me. Don't just say it, because you don't want to upset anybody. That is the political part. It is so critical that we keep a good, focused set.

Only someone who is a part of this social group will know these unwritten rules. The equivalent situation in the scientific community would be having visitors to the laboratory. Unless you are member of the scientific community, you will not know the codes of behaviour in the lab: what to wear, what not to touch, where you can walk, when to remain quiet, and who you can converse with directly. All boundary spanners, like Cline and The Dox, understand the behavioural rules in both of these restricted spaces.

Cline's comment also points to the central notion of the boundary spanner acting as a mediator in the communication process. One of the key cultural norms in the entertainment industry is knowing who to speak with and, more importantly, how to phrase your conversations. Knowing the rules of conversation is especially tricky for science consultants because they do not fit into the well-established filmmaking hierarchy. Film cultures are not egalitarian communities; instead, they have a very rigid hierarchy of superiors and subordinates. As a storyboard artist, Cline knows exactly where she fits into the hierarchy: she is in the Art Department. If she needs to bring something to the attention of the director or production designer, she goes through her superior, the art director.

As a science consultant, however, she does not have a fixed place within this hierarchy. Therefore, she has to understand the rules for speaking to any individual within the hierarchy. Scriptwriters, for example, are very protective of their work, so when she recommends dialogue she does it carefully, 'with tea and scones'. As she tells it, she needs to know how to 'toe a political line' with every individual in this culture.

10.3 Boundary Spanners in Action: Balancing Social Identities and Mediating Knowledge Transfer

Most science consulting experiences are one-off endeavours. Filmmakers generally employ one or more scientists with very specific expertise and work around the scientists' inexperience in dealing with entertainment culture. To get hired repeatedly, however, a consultant must prove to filmmakers that their utility goes beyond just an understanding of scientific culture or even that they have gained an understanding of entertainment culture. Consultants who find continued employment show their utility to filmmakers by presenting a unique social identity: that of the boundary spanner.

For Donna Cline, her social identity as a boundary spanner comes from her ability to be an effective translator between the two social groups. This ability separates her from the individuals she interacts with in either community:

> I am a translator. I am a visitor to many disciplines and that translation process is certainly my own field of expertise. I start in science with my network and then I mosey over and I am totally immersed in the film thing. I would just go back and forth…the degree they rely on me sometimes is massive. Most often you can definitely have some influence, and it is very useful that I am a film person. That is a unique situation. So that really buys me a lot of credibility. You can have a massive influence because the information you give is from the scientists but the way it is translated comes from my ability to say how to achieve it dramatically.

Boundary spanners' social identity and the advantages it provides emerge from a mode of operation that differs from that of other science consultants. Boundary spanners do not claim to possess a specialized form of scientific expertise (even if they do). Instead, they emphasize that their general level of scientific expertise gives them the credibility necessary to interact with scientists who do have specialized knowledge. They give filmmakers access to a wide range of scientific advice without the need for filmmakers to ever interface directly with the scientific community. Their familiarity with entertainment culture allows them to take this acquired knowledge and put it into a form that filmmakers can actually use. Their inside knowledge of filmmaking also enables them to work with filmmakers during production to turn this modified scientific information into the final product on screen.

The boundary spanner's process, then, involves the synthesis of information from the culture of science, the translation of that information into the culture of entertainment, and finally the transformation of the information into a finished cultural product (see Fig. 10.2). Donna Cline provides a concise summary of this process:

> That's how I work. I take massive amounts of technical information and possibilities, the different ways we can go. I then look at the script and distil it down to cinematographically valuable units of visual and informational material which we transform into a movie. That's my job in a nutshell.

The nature of their social identities within groups is fluid, but their identity as boundary spanners remains unchanged.

The key advantage for a boundary spanner is their ability to communicate with a diverse network of scientific experts. The Dox were able to set up a network of scientific advisers quickly through their combined professional research contacts. When their business grew larger, scientists began contacting them about being involved in the network.

What differentiates The Dox from other boundary spanners is that they are trained scientists with their own scientific and medical expertise to draw upon first,

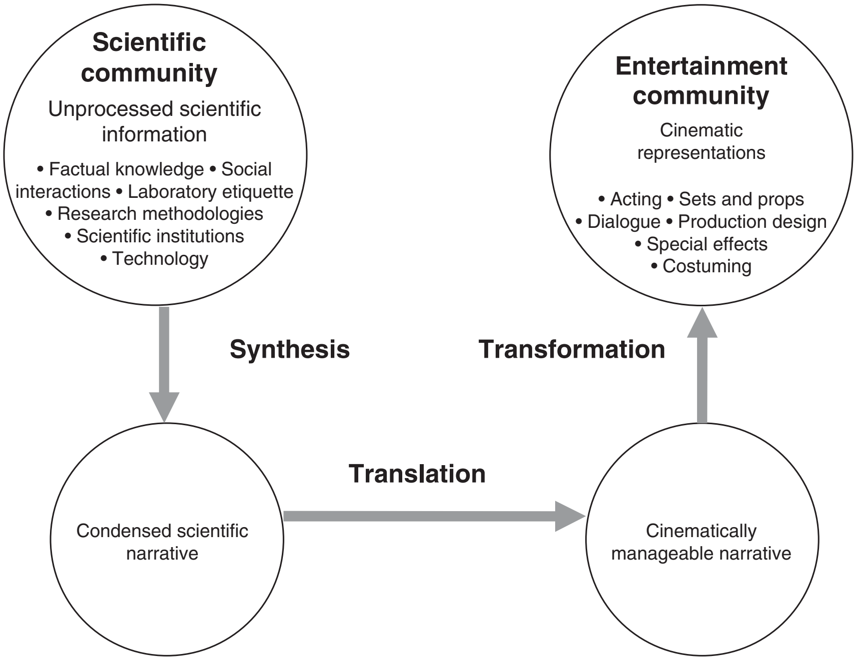

Fig. 10.2 Boundary spanners ensure information transfer without the need for cultures to communicate directly

before they tap into their network. When they accept a new consulting job, they determine which of the three scientists has the most appropriate knowledge base to become the primary liaison with the filmmakers. However, questions often come up that the primary or secondary consultants are unable to answer. In these cases, Hagemeyer says they look to their extensive network of advisers:

> You don't touch a question if you don't have any ideas. Of course, I cannot always answer all questions. Some of them I can, but I give the ones I cannot to the rest of the network. So, what makes us valuable for people who look for scientific knowledge in a popular way is that we can say, 'Okay, maybe we don't know it but certainly all the other doctors in our network know it.' So they draw us a question and we spread it to our network of over 40 doctors. So this is an advantage.

Donna Cline has also developed a vast network of scientific advisers:

> I have access to a network of the foremost experts in many technical fields, both medical and scientific. Medical scientists, doctors, marine biologists, forensic specialists, you name it. The most eclectic disciplines you could ever think of. I have radiation oncologists, heart surgeons, brain surgeons. I have to have a huge network of specialists. So I would say, gosh I have hundreds of scientists in my network.

Unlike The Dox, Cline is totally reliant on her network for scientific information. As discussed below, she operates as a science consultant by using this network to undertake thorough research for a film. Until she has completed her initial research, she in no way considers herself an expert on the topic. Once she has undertaken that research, however, she acts as an authority on the set without the need to constantly tap into her network.

Both these boundary spanners consider their access to their scientific networks a major asset. Just as with the entertainment community, however, boundary spanners need to stress their dual social identities as both scientific and entertainment experts in order to win the trust of the scientific community. Of course, to gain access to the scientific community it is crucial that the boundary spanner project at least interactional scientific expertise. The Dox's scientific network instantly accepted their scientific credibility, while Cline had to prove her scientific authority to each member of her network. Initially, she developed scientific contacts through recommendations of her former professors. Her professors' endorsement told other members of the scientific community that they accepted Cline as a member of their social group. Once her network expanded beyond the confines of her professors' associates, she had to prove to each new member that she could understand the language of science. 'I really think it comes down to homogeneity of communication. We speak the same language and they don't have to jump through all the hoops to explain things', she says. A particular form of language is one of the key distinguishing features of scientific culture, and anyone who understands the language of science receives instant credibility.

Boundary spanners may be able to converse with scientists, but why should scientists trust boundary spanners to mediate information transfer into the entertainment community if they are merely other scientists? They are relying on the boundary spanners' unique social identity as agents who understand the cultural expectations of both communities. In essence, they are expecting boundary spanners to synthesize, translate and transform information in a way that either scientists or filmmakers would not be able to. Scientists must trust that the boundary spanner will maintain the integrity of scientific information when it gets transformed into the context of entertainment texts. As Cline says, the scientists in her network want to know that she will 'protect' the science they give to her. This means that scientists also want assurances that boundary spanners possess at least interactional expertise within the culture of entertainment. Without that expertise, the scientists in the network might as well be speaking to the filmmakers directly.

Unprocessed information from the scientific community rarely has utility for entertainment producers. An initial difficulty is that much of what boundary spanners collect from scientists represents fragmented knowledge. They may speak with dozens of scientists to get information about a single topic. Some of the information may overlap, but much of it will contain different aspects of the same phenomenon or even contradictory information. To make this mass of information useful for filmmakers, the boundary spanner needs to synthesize it into a single narrative.

To illustrate this notion of synthesis, I will take a specific example from Donna Cline's initial research as science consultant on the film *Outbreak* (1995)—the fictional 'Motaba' virus. According to Cline, the filmmakers' initial choice to make the fictional virus similar to but significantly different from the Ebola virus meant that they had to look into every aspect of the science behind Ebola:

> On *Outbreak* we wanted a deadly virus. So I told them the deadliest haemorrhagic fever virus is going to be Ebola. It is an inefficient virus in the sense that it kills its host too quickly. It's usually found in geographically remote areas so it doesn't get spread really, really far. We don't know how it is really transmitted but we think it is bloodborne. But what if it mutated to airborne and was spread by an aerosolized version? So, I started looking into that and I started garnering my epidemiology team. I did my research on it. As we went along they said 'We need to have the visual effects. We need to know what the virus looks like.' So, one part is the morphological nature of the virus. Another part was the clinical manifestations. A third part was possible cures and so on.

Taking a single topic, virology, we see that Cline required fragments of information about all the various aspects involved: morphology, epidemiology, virulence, symptoms, treatments, possible vaccines, sample collection methods and research procedures. To get this information, Cline gathered a 'team' of specialists who each addressed the various aspects of virology. A partial list of the scientists she consulted included epidemiologist David Morens of the University of Hawaii, who coordinated the Centers for Disease Control's response to the 1976 Ebola outbreak in Sudan, pioneering HIV researcher Donald Francis of Genentech, who also worked on the Sudan outbreak, and virologist Peter Jahrling of the US Army Medical Research Institute of Infectious Diseases, who had experience with several high-profile viral outbreaks, including Ebola. Each of these scientists provided her with considerable amounts of information about the various aspects of Ebola.

Cline showed me the research notebook, over a hundred pages long, that she kept on the fictional Motaba virus. This semi-random format was adequate to help her gain expertise on the topic, but the notebook was clearly useless for the filmmakers. To make the information useful to them, she needed to condense her research into a manageable size with a narrative format.

Synthesis is not merely a matter of organization and 'simplification', it also involves deciding which information merits inclusion, which information is irrelevant, and what to do with contradictory information. The scientific community understands that scientific information is not a monolithic entity. Collins and Evans (2002) categorize scientific knowledge about which there are no major disputes among scientists and for which the science is as settled as it ever can be as 'normal science'. Scientific knowledge in flux they refer to as 'golem science'. As they define it, 'golem science is science which has the potential to become normal science, but has not yet reached closure' (Collins and Evans 2002: 267).

For Cline, this means that one scientist may give her information that contradicts advice from another consultant:

> If I ask one question from 10 medical professionals I will sometimes get 10 answers. I try to get behind why there is that disparity. That's my responsibility to do that. Then I will make a decision and give them my best opinion based on my best knowledge. I either decide what meets our story needs or I take the average. I want to make sure it is in the ballpark. It could be behind third base but it is in the ballpark.

Uncertainty is inherent in the scientific process, but filmmakers do not want to hear about it. They expect their experts to tell them how to make their cinematic representations realistic. Therefore, Cline makes decisions to turn scientific divergence into unified knowledge. The synthesis stage, then, requires boundary spanners to transform golem science into normal science.

Distilling information into a single answer is not always necessary, however. Often a boundary spanner must determine whether a filmmaker would benefit from this distillation or would be better served by having several options. Providing a single option can be the more risky strategy. Both the consultant and the filmmakers will be left unsatisfied if the filmmakers find it necessary to reject this single recommendation. Filmmakers may be much more willing to accommodate scientific verisimilitude if they feel they have some choice in which ‘facts’ they can adapt to their needs. On one occasion, filmmakers asked The Dox to provide information on the treatment of Lou Gehrig’s disease. Rather than presenting the filmmakers with the most common treatment (surgery), The Dox believed that it would be better to give them three possibilities (retrovirus, drugs or surgery), even if the other two treatments were controversial or in their embryonic stages. The Dox appreciated that, within the filmmakers’ culture, choices provide flexibility while allowing them to claim scientific integrity.

The next step for a boundary spanner is to tailor the information to the dramatic needs of the filmmakers (see Fig. 10.2). The ‘translation model’ of science popularization has often been criticized for focusing on popularization as merely a process of simplifying the technical language of science (Lewenstein 1992). In the context of science consulting, however, translation is an appropriate metaphor. From the actors’ point of view, a literal ‘translation’ from the language of science into the language of filmmaking is required.

My demarcation between the processes of synthesis and translation is necessary for analytical reasons. The synthesis of scientific material does not require any notion of translation, but boundary spanners routinely simplify terms and concepts during synthesis. In fact, Pablo Hagemeyer sees The Dox’s ability to simplify technical language as the primary benefit of hiring them for a consulting job: ‘The major advantage with us is that we understand science, but we have a simple language for complicated terms or complex things that we know make sense to the fictional folk’.

Translation is not solely about simplifying technical terminology. The boundary spanners’ process involves taking the totality of scientific information, not just factual information, and translating it into the professional language of filmmaking—a language that is predominantly about visualization. ‘Film language’ in this context is not a reference to notions of ‘signification’ or the language of ‘reading’ a film, as discussed by film scholars such as Turner (1993). Rather, it is the literal, technical language of film production that is required to visualize abstract concepts on the screen. Of course, as Turner and others (e.g. Gaither 1996) point out, these technical production practices ultimately reify visual entities, which leads to systems of signification. At a pragmatic level, however, boundary spanners must translate scientific information into a language of production. For *Outbreak*, Cline could not simply provide filmmakers with simplified and condensed explanations of viral infections. This information was only useful if it created a visually rich film (lab sets, gory victims, spooky costumes, etc.) and enhanced dramatic possibilities (central plot, dramatic climax and so on).

The genesis of the information is in the scientific community, and filmmakers only gain access to it after it has gone through the boundary spanners' translation process. Donna Cline credits her success in translation to her ability to understand the languages of both cultures:

> I rely heavily on my experts for my own credibility. I would never presume to know what they know. I mean I defer to their expertise. However, in terms of the translation process and an agility to move back and forth between technical communities and entertainment communities, that is my area. I really am a translator when I am working as an adviser. That is a niche that I have. I think that it is much more different from technical advisers who come in on one specific film. I have one foot in both industries. Therefore, I know the languages of both… That's one of the reasons why it works to hire someone that is a translator rather than a straight-up specialist. I am totally supportive of whatever makes them comfortable. If they need to have a straight-up latent fingerprint expert, let me help you find one. But if they need someone to tell them how fingerprinting would work in the overall scheme of a crime lab, and how that is translatable for the screen, hey I do that.

From a cultural outsider's perspective, it makes sense to hire a scientific specialist to generate advice on specific aspects of scientific culture. Cline, however, points out that as a boundary spanner she can not only produce a specialist if required, she can also mediate between the specialist and the filmmakers to provide a synthetic view that meshes with filmmakers' needs.

The final step in the boundary spanner's mediation process is to assist filmmakers in transforming what is still mostly abstract information into its final, visible form on the screen (see Fig. 10.2). Successful transformation relies on the boundary spanner's ability to switch quickly between their social identities during production meetings and on the set. They need to know when to stress their scientific expertise, when to defend their status as an entertainment insider, and when to emphasize their unique identity as a hybrid between the cultures. Transformation involves both protecting the science and bending it to satisfy visual and dramatic needs during production.

For example, on *Outbreak* Cline participated in a preproduction meeting with the director, producers and production designers.[6] During the meeting Cline presented the results of her synthesis and translation process on viral epidemiology for the fictional Ebola-like 'Motaba' virus, including its morphology and affect on victims. At one stage the filmmakers asked her to animalize the virus by giving it a 'head and a tail' and making the non-motile entity 'writhe'. As a film professional herself, Cline understood the reasoning behind their suggestions—they wanted to give the virus 'a little personality'. In this instance, however, she felt that the film would be better served if she emphasized her identity as a scientific expert to argue forcefully against these changes.

On other occasions, she accentuated her filmmaking identity to negotiate creative moves away from scientific veracity. She had numerous meetings with special effects and make-up technicians on the visualization of haemorrhagic fever victims:

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[6] This episode is also documented in Roach (1995).

> I always make a joke about this because we had five meetings on pustules alone, because we needed the visual aspect to be right and it meant a compromise with the science right there. We had various clinical manifestations of the illness and five different stages. All of those are clearly delineated in these drawings I made. We ended up making a hybrid, almost a haemorrhaged kind of conjunctivitis sort of a thing and, yeah, we fudged it. I knew in this case it would be better if we fudged it. But that is not something that happens with haemorrhagic fever or a filovirus. I just knew we needed to make it more visual.

In these particular meetings, she highlighted her identity as an entertainment insider to let her clients know that she understood why bending science was a necessity. Interestingly, Cline's pronoun usage changed throughout our interview to reflect her multiple social identities. In the comment above she is considering herself a filmmaker, so 'we' made a decision to compromise the science for visuals. On the other hand, when Cline emphasizes her scientific identity she no longer counts herself in the filmmaking social group and it is 'they' who want to give the virus a head and tail. To navigate the transformation process, boundary spanners must move fluidly between their social identities in order to reassure filmmakers that when compromises are made for creative reasons they are still within a scientific framework. For boundary spanners like Cline and The Dox, success is achieved when the transformed product on the screen bears enough resemblance to scientific authenticity to satisfy both the scientific and the entertainment communities.

10.4 Conclusions

Currently, there are only a few individuals and organizations that could be considered boundary spanners at the science–entertainment interface. Most science consulting work still takes the form of a specialized scientific expert on a one-off project. However, my research indicates a growing trend in Hollywood towards boundary spanners as the preferred form of consultant. Several successful organizations operate using the boundary spanner approach. In addition to The Dox, these include Takeoff Technologies in Pasadena and Hollywood Math and Science in London and Los Angeles. There are also individuals whose methodology relies on an ability to work within both the scientific and the entertainment communities. John Underkoffler, for example, has a PhD from MIT's Media Lab and has established himself as one of Hollywood's pre-eminent boundary spanners. This list is certain to grow as members of the scientific community gain experience working on films.

The filmmaking community is beginning to recognize the advantages of working with a boundary spanner over working with a one-off consultant. Boundary spanners are not bound by a single scientific discipline. Since they filter scientific material, they can be incredibly flexible in their interpretations. Most importantly, boundary spanners alleviate the tensions inherent in intercultural communication by claiming their status as members of both the scientific and the filmmaking communities. Their ability to communicate within groups allows them to facilitate communication across those groups.

Gieryn (1983) shows that groups often need to maintain or reinforce the boundary between science and other social activities. This is especially important for boundary spanners, whose livelihoods depend on a belief that the cultures of science and entertainment are irreconcilable. The stronger each community perceives the boundary between these cultures to be, the more essential boundary spanners seem to be in facilitating communication.

While boundary spanners' perceived status as scientific and filmmaking experts is important for traversing boundaries, the nature of their expertise is fluid and contingent upon local conditions. They can choose to foreground one expertise or the other, depending on the social situation. When dealing with scientists, they need to rely on their scientific backgrounds for authority, but it is also important for them to amplify their status as filmmaking experts. Likewise, in filmmaking culture they must accentuate their role as scientific experts in order to meet filmmakers' demands for 'scientific accuracy'.

Boundary spanners' multiple social identities help them become embedded in the filmmaking process in a way that is not possible for one-off consultants. This position gives them oversight over the presentation of science and technology in films—which, crucially, can have a significant impact on public perceptions of science and technology.

References

Collins, H. M. & Evans, R. (2002). The third wave of science studies: Studies of expertise and experience. *Social Studies of Science*, *32*, 235–296.

Frank, S. (2003). Reel reality: Science consultants in Hollywood. *Science as Culture*, *12*, 427–469.

Gaither, L. (1996). Close-up and slow motion in Julie Dash's *Daughters of the Dust. Howard Journal of Communication*, *7*, 103–112.

Gieryn, T. (1983). Boundary-work and the demarcation of science from non-science: Strains and interests in professional ideologies of scientists. *American Sociological Review*, *48*, 781–795.

Kirby, D. A. (2003a). Scientists on the set: Science consultants and communication of science in visual fiction. *Public Understanding of Science*, *12*, 261–278.

Kirby, D. A. (2003b). Science consultants, fictional films and scientific practice. *Social Studies of Science*, *33*, 231–268.

Lewenstein, B. V. (1992). The meaning of 'public understanding of science' in the United States after World War II. *Public Understanding of Science*, *1*, 45–68.

Moore, K. (1996). Organizing integrity: American science and the creation of public interest organizations: 1955–1975. *American Journal of Sociology*, *101*, 1592–1627.

Ribeiro, R. (2007). The language barrier as an aid to communication. *Social Studies of Science*, *37*, 561–584.

Roach, M. (1995). Virus: the movie. *Health*, *May,* 78–84.

Turner, G. (1993) *Film as social practice*. London: Routledge.

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David is also exploring the collaboration between scientists and the entertainment industry, and has published in *Social Studies of Science* and *Public Understanding of Science* on that topic. He is working on a book entitled *Science on the silver screen: Science consultants, Hollywood films, and the interactions between scientific and entertainment cultures*.

Chapter 11
Situating Science in the Social Context by Cross-Sectoral Collaboration

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Abstract Research collaboration is increasingly interdisciplinary, with those working in traditional fields of science, technology, engineering and medicine recognizing the value of collaboration with those working in the humanities, arts and social sciences. This chapter explores the challenges and opportunities for communication within and from cross-sectoral research teams. The authors draw examples from researched case studies to describe how cross-sectoral collaboration positions science within the social context. They also look at how cross-sectoral communication relates to current models of science communication.

Keywords Science communication, cross-sectoral collaboration, multidisciplinary research, interdisciplinary research, social science, humanities, arts

11.1 Introduction

Collaboration across disciplines has risen in recent years, and a number of international and national initiatives are under way to increase such collaboration further. Cross-sectoral collaboration occurs when members of the science, technology, engineering and medicine (STEM) sectors collaborate with members of the humanities, arts and social science (HASS) sectors to solve common problems and reach common goals (Reback et al. 2002).

Initiatives and programmes to strengthen national economies through innovation and creativity have traditionally relied on the STEM sector to provide funding for solutions. Yet researchers such as Hjorth and Bagheri (2006) note a growing

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feeling that science alone is not responding adequately to the challenges posed by society. They point to sustainable development as an example: science treats sustainability as a project with an end point rather than an ongoing process intrinsic to everyday work involving community and industry participation and decision making. Solving many of the world's big problems—natural resources conservation, security, climate change, energy and human health—requires new approaches to problems that can only be solved through cross-sectoral collaboration between the STEM and HASS sectors.

Cross-sectoral research is responding to community, industry and government needs. In the US, the National Academies (2004) argued that cross-sectoral research is being driven by four major drivers:

- The complex nature of society
- The desire to explore problems and questions that are not confined to a single discipline
- The need to solve societal problems
- The power of new technologies

Our research with Gardner (Metcalfe et al. 2006) shows that many of these cross-sectoral collaborations are occurring in the field of science communication, in projects engaging communities, industries and governments in the process of generating innovation, new knowledge and new understandings. One of the benefits of cross-sectoral collaboration is more engaged publics and end users (SCST 2002). To be successful, engagement activities must incorporate psychological, social, cultural and institutional knowledge that shapes public attitudes to, and acceptance of, developments in science and technology (S&T) (Irwin and Wynne 1996). Supporters of public engagement argue that when knowledge of human dynamic and processes, gained through humanities and social science activities, is applied to scientific endeavours it helps with assessments of the social impacts of those endeavours. In this chapter, we show that cross-sectoral collaborations have an important role to play in situating science within the social context.

In a review of science communication over the past 25 years, Bauer et al. (2007) describe three paradigms of science communication, each of which views the divide between the general public and the scientific community in a different way:

- *Scientific literacy*—where science communication efforts aim to address a deficit in knowledge about science
- *Public understanding of science* (PUS)—where science communication efforts aim to provide the right type of knowledge to suit particular individuals, audiences or groups
- *Science and society*—where science communication efforts aim to involve groups in the research process.

Bauer et al. (2007) believe that, whereas the first two paradigms see the public as deficient in either enough knowledge or in the right kind of knowledge, the third paradigm sees scientific or technological institutions or individuals as deficient. This paradigm attempts to address the lack of knowledge flow from the public back to scientific institutions and individuals that is inherent in the unidirectional communication models criticized by Miller (2001). More participatory models of communication attempt to address that deficiency by providing a means for engaging communities 'upstream' in the research process. However, researchers such as Rowe and Frewer (2007) believe that more investigation needs to take place to determine whether this new science communication paradigm is advancing the discipline or producing better outcomes.

We believe that cross-sectoral collaborative efforts in science communication contribute to more participatory models of communication by providing ways to incorporate social concerns and negotiate the way 'scientific' problems are framed and addressed. We have found that many of the challenges and opportunities in participatory science communication described recently by science communication scholars are similar to the challenges and opportunities involved in cross-sectoral collaboration.

11.1.1 Our Research

The Australian Government has placed S&T at the centre of its economic policies, investing in them and relying on their support for competitive advantage in the global marketplace (Australian Government 2001). While policymakers and decision makers want to see an increase in public involvement in science, there is also a growing sense that some Australian publics want more say in how science is used in their societies. This is one of the reasons that the Australian Government supported the Council for the Humanities, Arts and Social Sciences (CHASS) to research cross-sectoral collaboration.

In December 2005, CHASS commissioned a project to identify successful HASS–STEM collaborations and to explore areas of research, education and practice where collaborative approaches would be useful (Metcalfe et al. 2006). The most important phase of the project involved case study research examining cross-sectoral collaborations in Australia and elsewhere. The case studies were selected to illustrate a range of variables, including different:

- Collaborating disciplines across HASS and STEM
- Scales of collaboration
- Types of collaboration
- Stages of collaboration
- Management structures
- Funding sources for collaboration
- Planned and actual outcomes from collaboration

Interviews were conducted for each case study with at least three members of the collaboration, who represented the different disciplines involved. Data gathered from these interviews were interpreted using Leximancer, a content analysis software package that constructs a thesaurus of the most frequently occurring concepts in the textual data and maps the relational distance between those concepts. Such analysis produces an accurate description of the main themes and concepts in the data and their relationship to each other. The case studies yielded information about the benefits and costs of collaboration, incentives and impediments to collaboration, and the key ingredients for successful collaboration. The results from the cross-sectoral collaborations that focused on situating science in the social context are presented in this chapter.

Through an electronic survey, Australian researchers and practitioners also identified the key ingredients of successful collaboration. The key ingredients were organized according to the main themes emerging from the data collected in the case study research and other interviews. The survey was completed by 688 people. Almost 60% of responses were from people who had collaborated in cross-sectoral projects, 24% were from people who had collaborated only within their sectors, and 16% were from people who had not collaborated at all. Most of the respondents (60.6%) were from the HASS sector, 35.5% were from the STEM sector, and 3.9% were from ‘other’ disciplines. This probably reflected the fact that the survey was initiated by a HASS sector organization.

For this chapter, we reviewed the data and information collected in the project to look specifically at the role of science communication in cross-sectoral projects.

11.1.2 Participatory Communication and Cross-Sectoral Collaboration

Recent moves towards more participatory modes of communication (citizen juries, consensus conferences and national debates) in countries such as the UK (SCST 2000) have been prompted by many factors: growing public mistrust of scientists and decision makers; increasing media coverage of scientific processes perceived to be ‘secret’; and the demand by communities to participate in decision making about how science is used (Irwin 1995).

Science communication programmes that involve collaboration across the sectors are driven by the need to solve problems at the science–society interface and the desire to develop more effective community and industry engagement processes—that is, the participatory model of science communication. However, Trench (2006) argues that, while shifts in policy and practices in recent years have encouraged activities that involve the public as ‘lay experts’ and seek their input, the one-way science literacy and PUS paradigms of communication remain the basis for many of the projects undertaken and discussed in the science communication field. Programmes and policies using those models as the underlying foundation of their work can be identified by their focus on increasing public ‘literacy’ and scientific understanding, rather than on placing science in the context of society and social processes.

Genuinely participatory models of communication recognise that intellectual disciplines and cultural activities outside science, and the insights of ‘lay experts’, can contribute to science and science communication (Trench 2006). For some researchers, social and cultural aspects are central. Cribb and Hartomo (2002) believe that the new technologies of the 21st century involve reshaping communities, industries and societies, rather than providing quick ‘fixes’ to major environmental and ecological problems. Participatory models of communication are thought to be able to situate science within the social context, because they not only take social concerns and insights into account but treat them as central to the communication process. As Bauer et al. (2007) state, intervention activities cannot be separated from the research process.

Trench (2006) believes that science communicators have come to recognise that the issues and challenges associated with situating science in the social context are shared with other disciplines, such as sociology. Bauer et al. (2007) also show that science communication is an interdisciplinary field of enquiry, with researchers from sociology, psychology, history, political science, communication studies and science policy analysis engaged in PUS investigations. These disciplines have provided science communicators with new insights and identified the limitations of current science communication practices.

Trench (2006) calls for a greater willingness within science communities to create the conditions for citizen science and scientific citizenship. One way to achieve this is through collaboration between science and disciplines that offer pathways of meaning negotiation and scientific critique. Those disciplines are in the HASS sector. Macnaughten et al. (2005) call for a social science of science, technology and society relations to advance the theory and practice of collaborations between the social sciences, humanities, natural sciences and engineering. These researchers believe that such collaborations are the key to achieving better decision making and regulation and robust debate about converging technologies, such as nanotechnology.

By incorporating social negotiation of meaning and social concerns within the science communication process, cross-sectoral collaborations can offer genuine opportunities for public participation and engagement.

An example of a cross-sectoral project of this kind is the Wellcome Trust’s SciArt Programme in the UK. This programme encourages innovative public arts projects investigating biomedical science. In 2006, SciArt offered £500,000 to groups to innovate, experiment and stimulate fresh thinking and debate in the medical and artistic fields. Anthony Woods, head of the trust’s medical humanities section, says:

> Looking at science in the social context is valid…the research affects people and society and we need to hear the public’s voice…people’s own experiences of medicine are as valid as what happens in the laboratory and we need to understand that more.

Another unusually large cross-sectoral programme in the UK is the National Endowment for Science, Technology and the Arts (NESTA). This programme was set up by an Act of Parliament in 1998 to foster the nation’s creative and innovative potential. NESTA is funded from the National Lottery and uses the interest from the lottery to support cross-sectoral collaboration projects that have the potential to enrich the nation through commercial, social and cultural outcomes. Such projects get researchers participating with each other, the general public, or both. For example, the Cape Farewell project takes teams of scientists, artists, oceanographers, journalists and teachers on a voyage to the Arctic seas. Collectively, these participants interpret and explain global warming and are able to engage a broader range of groups than scientists alone. These cross-sectoral activities acknowledge the importance of lay expertise and the knowledge of publics.

An example from the US is the University of New Hampshire's Center for Integrative Regional Problem Solving. The centre supports key programmes of the university, regional non-profit organizations, government agencies, active citizens and the northern New England community to come together and find solutions to critical regional problems, such as conflicting conservation and development needs (UNH Center for Integrative Regional Problem Solving 2006).

Cross-sectoral collaborations may act as catalysts for new projects and activities that provide opportunities for community and industry participation in decisions about scientific research and science outcomes. They offer ways to incorporate different and potentially conflicting meanings of science in the research process. Cross-sectoral collaboration can also lead to participatory critiques of the process and outcomes of scientific research.

Engaging the public and industry is increasingly cited as a mechanism for gaining support for and acceptance of S&T (SCST 2002). To be successful, however, engagement activities must incorporate the psychological, social, cultural and institutional facts that shape public attitudes to S&T developments (Irwin and Wynne 1996). Supporters of public engagement argue that applying knowledge of human dynamics and processes gained through HASS activities to STEM increases public reception and helps with assessments of the social impacts of STEM endeavours. Collaboration provides ways to manage the huge amount of knowledge that the S&T sectors have generated and will continue to generate, and ways to make sure this knowledge is usefully directed and applied (PMSEIC Working Group 2005).

11.2 HASS–STEM Collaborations and Science Communication

Over time, the HASS and STEM sectors have developed useful and productive relationships that operate on a number of levels. At the most basic, those relationships are simple and one-directional, with one sector using the tools of the other. For example, tools from the social sciences can make the physical sciences of genetics, nanotechnology and environmental science more palatable to the community. In these cases, HASS disciplines are contributing to a scientific literacy paradigm of science communication. The reverse can also be seen where creative artists gather new tools and inspiration from S&T. While these relationships may be useful and productive, they are not genuine collaborations across the HASS and STEM sectors that situate science in the social context.

True cross-sectoral collaborations require the combined efforts of one or more individuals from each sector to achieve common goals. They result in new knowledge or understandings that could not be achieved through a single sector alone. With time, they can result in newly conceptualized subject areas. Science communication is one such subject area, where the approaches and practices of many disciplines are combined.

Cross-sectoral collaborations often bring different disciplines together to solve a common problem. For example, one of our Australian case studies involved an independent working group of the Prime Minister's Science, Engineering and Innovation Council. The working group produced an integrated approach to tsunami science in Australia by bringing together experts in geosciences, meteorology and social sciences, and emergency services, community assistance organizations and related groups.

The group presented a report on discussions to the Prime Minister, setting out practical initiatives and recommendations to improve emergency management coordination, encourage collaboration and engage the community.

Other cross-sectoral collaborations aim to situate science in the social context. One case study example we researched was a water reuse project being conducted by Australia's premier research organization, the CSIRO (see Box 11.1).

Collaboration activities can also be quite complex and involve major 'integration' initiatives to build more substantial and in-depth cross-sectoral collaboration for socially situating science. For example, one case that we examined involved researchers from the Australian National University investigating and supporting a new transdisciplinary area of integration that focuses on synthesizing knowledge, information and perspectives from different sectors of society to support decision makers in various domains (public policy, business, professional practice and

Box 11.1 Recycled water acceptable to society

Determining the social, economic and technical viability of water reuse is vital for Australia's future. A major collaborative project between social psychologists, engineers, water researchers, hydrologists and the water industry is investigating water reuse in Western Australia. Reuse will only be socially and economically viable with the support of the affected communities in the state's south-west.

The project is being carried out by Water for a Healthy Country, a CSIRO National Flagship. It integrates information on water reuse technology, including social acceptability, capital and operating costs, water quality, opportunities to link with waste energy, potential scale, human health risk, environmental impact and waste discharge and management.

community activism).[1] Participatory methods of conducting research are central to this emerging discipline, supporting the view that all the stakeholders have a contribution to make to understanding issues (Bammer 2005).

Cross-sectoral collaboration that situates science in the social context is mainly funded through:

- Philanthropic support, driven by the desire for cultural and community benefits from science
- University programmes that encourage interaction across traditional disciplines and community participation
- Public exhibitions and performances that bring together a number of disciplines to better engage audiences
- Organizations set up specifically to support collaborative projects

Dedicated spaces are important mechanisms for supporting activities that situate science in the social context. Another of our case studies, SymbioticA at the University of Western Australia, brings artists and scientists together in one space that can incorporate scientific advances as well as social critiques of science that engage the public and encourage debate (see Box 11.2).

The Synapse initiative of the Australia Council for the Arts also uses residency programmes to provide opportunities for artists and scientists to work together. The Fish–Bird project (Box 11.3) is an example. According to Andrew Donovan, director of the council's Inter-Arts Office, which manages the initiative, these cross-sector collaborations contribute to situating science in the social context:

Box 11.2 SymbioticA: Exploring the ethics of biological research through art

Artists and scientists at SymbioticA—a research laboratory at the School of Anatomy and Human Biology at the University of Western Australia—are working together to explore scientific and technical knowledge from an artistic and humanistic perspective.

The laboratory enables artists to perform in vitro experiments that explore developments in S&T (particularly developments in the life sciences, such as genetic engineering) that are having profound effects on society, its values and belief systems, and the treatment of individuals, groups and the environment.

Immersed in the laboratory environment, artists are dealing with bioengineering and its controversial ethical implications from a position of knowledge. Both the artists and the scientists gain insights in the ethics and community understanding of the science and the art.

[1] See http://www.anu.edu.au/iisn/index.php

Box 11.3 The Fish–Bird project: Robotic wheelchairs interact with the public

A team of robotics designers and a media artist have developed robotic wheelchairs that interact dynamically with humans. Funded by an Australian Research Council Linkage grant and the Synapse initiative of the Australia Council for the Arts, the Fish–Bird project has not only received international acclaim for its artistic innovation in public exhibitions, but it also offers advances in wheelchair technology and monitoring systems that may be applied in a variety of hospital and aged care environments.

Fish and Bird, the two robots in the exhibit, read and react to human body language by moving about and writing text. The project encourages people to confront their own ideas about the human–machine interface.

11.3 Benefits and Costs of Cross-Sector Collaboration for Participatory Science Communication

One of the major benefits of this type of participatory science communication is finding better ways to engage the public and industry in debate, activities and projects. For example, Terry Hillman, director of the laboratory of the Cooperative Research Centre for Freshwater Ecology (in Albury, Australia), believes it is essential to involve artists in the process of engaging the community in science:

> Scientists have some particular knowledge but it doesn't give them any particular right to make the decisions more than anyone else. There needs to be an opportunity in the process of knowledge building to allow individuals to question the safety of the reliance on scientific knowledge. Theatre can allow the public to raise these questions and challenge these systems. (Quoted in Mills and Brown 2004)

Digital media is an area of collaboration directed at engaging the community by making art more accessible to the public. Digital technology collaborations have been particularly successful in engaging the public in issues of health and well-being (Sakane 2003). A new school at Stanford University is taking a collaborative approach to bringing together commercial businesses and business studies, humanities, design and engineering staff and students to focus on human-centred design (Nussbaum 2005). Traditional arts practices are also being employed for collaborative efforts focused on public engagement, such as the UK's Wellcome Trust programme, Pulse, which provides funding for performing artists to engage the public in biomedical science.

Many of the cross-sectoral collaboration participants to whom we spoke to reported benefits from involving end users in their projects to ensure greater ownership of the final outcome, service or product. Some also thought that cross-sectoral collaboration provided useful ways to engage and motivate industry.

However, participatory science communication, like all cross-sectoral activities, has high transaction costs, so the benefits of these activities need to be significant

(Irvin and Stansbury 2004). The composition of cross-sectoral collaborations means that internal science communication problems can arise when team members:

- Are widely geographically dispersed
- Have limited or no experience of working with each other
- Have no experience in collaboration across sectors
- Have a high degree of personal connection to their own sector or workplace (or both)
- Have other priorities or commitments that take precedence over the collaboration
- Have used the ‘tools’ of the other sector in the past without genuine collaboration
- Belong to organizations with rigid administrative and reporting requirements

The costs associated with these factors create the need for more time and funding to make the collaboration a success.

Team-member attrition before the project is complete is another potential cost to factor in. This problem is particularly pronounced if those people leaving are ‘champions’ for the project. As one of our case study participants stated:

> The internal champion in organisations can move on and that changes the dynamic and priorities and volume with which things are spoken about. Internally with [our collaborative group] we are trying to divorce the delivery of research from that crucial dependency on the individual.

11.4 Community Engagement

Many cross-sectoral collaborations that we examined are based on the idea that community involvement and/or engagement will lead to better outcomes. Cook’s (2006) recommendations for community involvement in collaboration are also relevant in participatory models of science communication. They include:

- Having a clear statement of purpose that is relevant to immediate local needs
- Focusing on community problems and issues
- Considering barriers to participation (e.g. attendance at meetings and costs of involvement, providing regular ongoing engagement and timely feedback)

Cross-sectoral collaborators believed that the main reasons for engaging the community were:

- To incorporate the needs of the community in the direction of scientific research
- To provide a social space for communities to access and interact with S&T
- To understand and improve new technology
- To incorporate critiques of science and new ways to negotiate the meaning of scientific and technological advances

Incorporating the needs of community was believed to be important to ensure that community trust is maintained:

> We can do all sorts of technical things that we know are safe and economically viable but if there is no community trust we have wasted our time—there are many documented

> examples. We are trying to work in the community and take their wants and desires into account. (CSIRO water reuse project)

Collaborators in this project believed that engaging the community early in the direction of scientific research will lead to better outcomes:

> One of the things that the project is looking at is management of water for aquifer recharge—it is a long way off. People like the concept but it is a long way off from being applicable to drinking water. Perhaps they are never going to drink it so we must look at uses that will be acceptable. We must come to some agreement on uses—that is in the future yet. (CSIRO water reuse project)

This type of involvement and engagement (referred to by science communicators as ‘upstream’ engagement) was believed to improve the technology by incorporating social dimensions as considerations:

> Understanding and improving new technology and the way in which humans interact through situating it in public settings [is important in our study]. Improvement of multi-sensory autonomous systems within social/public spaces [is what we are doing]. (Fish–Bird project)

The idea of spaces where community members can be engaged was a recurring theme in the case studies:

> This project is different because it takes robots out of the laboratory where general public (untrained people—different ages and social groups) have access to the robots in a social space such as museums/galleries. (Fish–Bird project)

These spaces also provide places where critiques of science could be incorporated into new ways of negotiating the meaning of scientific and technological advances:

> This is something where Australia leads the world. Bioscience has tremendous ethical problems. The whole Bioart field brings things up to the public mind. You don’t get the fear out of ignorance. Artists are addressing a lot of the problems. They make it [bioscience] more approachable for the public. The artists are independent. They are not funded by pharmaceutical companies. They provide an independent voice.
>
> It is allowing the public to engage with science less formally and perhaps provocatively. To ask questions that scientists don’t always have the time or inclination to engage with the dialogue. (SymbioticA)

11.5 Key Features of Collaborations that Situate Science in the Social Context

The key features of cross-sectoral collaborations that situate science in the social context are also described by researchers looking at participatory models of science communication. The key features common to these activities are:

- The willingness to take risks
- Identifying common issues or problems
- Developing trust in other disciplines
- Boundary spanners

11.5.1 Willingness to Take Risks

Cross-sectoral collaborative activities and participatory models of science communication both require those involved to take risks, as the outcome of the process can be unknown. Bauer et al. (2007) point to the UK GM Nation debate in 2003 as an instance where those involved were committed to achieving an outcome from public participation, but failed to do so. Government hoped for more public support for genetically modified (GM) crops and, when this did not eventuate, blamed the process of engagement for giving those critical of GM too much attention. This led to recommendations for more PUS-related activities to give the public the 'right' information and thereby change attitudes.

Groups and organizations may also be reluctant to engage in participatory modes of science communication because maintaining a positive public image can help to ensure a good citation record or ongoing funding. However, taking risks was seen to be a key feature of all the case studies we examined. Those funding participatory activities were emphasized as key groups inhibiting engagement because of their need for documented outcomes at the outset of a project:

> There needs to be more risk taking on collaborative projects on behalf of funding bodies, not forcing people to produce outcomes. Outcomes will come anyway but they discourage people from exploring and taking risks. Whoever is supporting these collaborations should be open to this. The best way of learning about things is to test and see whether they work or not. You need some room for that. (SymbioticA)

11.5.2 Identifying Common Issues or Problems

Kim (2007) reminds us that the public is not one large behavioural unit but is grouped around common problems and issues. He points to a number of studies in which collaboration between local communities and scientists has been crucial for problem solving (see Karl and Turner 2002, Roth and Lee 2002, Lee and Roth 2003). Kim recommends communicating the shared problems of science and society and their relevance in order to encourage participation. He also recommends that scientists and institutions reflect on what they can contribute to situating science within the social context, rather than focusing on problems framed by scientific research and facts.

Gorman (2004) promotes shared mental models for upstream engagement created through shared trading zones between social scientists, ethicists, scientists and engineers. He believes that social scientists may be able to represent broader society in the initial phases but need to be brought in as soon as possible.

This need to focus on a common issue or problem is demonstrated in the tsunami case study we researched:

> We were bringing a range of technical, government and institutional people together. It was a very disparate group. The collaboration showed me that disparate groups can work

> together without a big bonding period. It was important that we were clear with where we were going. (PMSEIC tsunami report)

Having space to allow for and incorporate differences was also emphasized in this case study:

> People view an issue within a university or agency perspective very differently. If you have been at international tables you see that people see things differently—they have a different lens or different set of values—not right or wrong but different. You need to allow space for that to percolate through the group. You are not going to win by being right but by bringing people with you. (PMSEIC tsunami report)

Another of our case studies highlighted the importance of ensuring that collaborators not only share the problem or issue but share a language in which to discuss it:

> There were some kinks of course—language differences for a start. The more technical language barrier. You need to find some common ground and a shared language—know what the terms mean and create a common vocabulary for the team. (Fish–Bird project)

11.5.3 Trust in Others

The need for trust in others involved in the project was highlighted in all case studies as a key feature. While it can be difficult to build or create trust, there are a number of ways it can be encouraged. For example, one case study suggested that trust is engendered more easily when members of a collaboration are already established in their own fields of endeavour:

> Having a track record in the respective disciplines gives you credibility and allows you to start at a higher level of trust than you would have otherwise. To have proven success in your own fields helps at the beginning to build trust. (Fish–Bird project)

Lamb et al. 1998 believe that a lack of trust in the contribution of other disciplines can be overcome by ensuring that all members of a cross-sectoral collaboration participate in all aspects of the project.

The issue of maintaining disciplinary boundaries can be a major problem both for participatory science models and for cross-sectoral collaborations. Some critics from the STEM sector have said there is a danger that science will be 'contaminated' by participatory activities. Some from the HASS sector have pointed to the danger that participants may become less critical of science and scientific outcomes over time:

> The notion that we might be contaminated. That we [artists] operate with scientists means that we have been contaminated by other approaches. This is the resistance for a lot of collaboration. You become something else by collaborating that can impact on your own discipline. (SymbioticA)

Members of SymbioticA refer to collaborations where participants do not set out to agree with each other as 'adversarial collaboration':

> The model we present is not working with emerging technologies but engaging with them. Artists working within the scientific environment but maintaining a critical outlook. We are not supporting the creativity of scientists nor are we a tool for science. We maintain our own research discipline and our own ways of dealing with emerging technologies. (SymbioticA)

However, such collaborations can produce direct benefits to the scientists involved by raising their awareness about how their science fits into a social context:

> It is exciting for the scientist to work with an artist, for them to step back and think about what they are doing. Also scientists do stop and think about what they are saying as well. (SymbioticA)

11.5.4 Boundary Spanners

One mechanism that groups use to overcome impediments to cross-sectoral communication is to employ ‘boundary spanners’—people who can communicate across sectors (Petronio et al. 1998). Lele and Norgaard (2005) believe that boundaries are developed and maintained around scientific communities to provide strong points of identification for members. Those communities have a strong investment in maintaining the boundaries for their own survival. For these reasons, breaking down traditional boundaries through wide-scale cross-sectoral collaboration can face some resistance. All the successful case studies we looked at included people who acted as boundary spanners within the collaborations.

Bauer et al. (2007) show that individuals with time and expertise are needed to be able to engage the public and situate science in the social context. They refer to these individuals as ‘angels’ or mediators between scientific institutions, industry, government and the public.

Many science communicators act in the role of boundary spanner within their groups or organizations to bridge boundaries and ensure their maintenance. They can reduce the transaction costs associated with cross-sectoral collaborations. The long-term sustainability of cross-sectoral initiatives requires rewards and recognition to be given by the individual disciplines involved, rather than a move to breaking down barriers between the disciplines. With the rise of cross-sectoral collaboration, the role of boundary spanners in bridging the science–society divide will become increasingly important.

11.6 Conclusion

While Bauer et al. (2007) question whether participatory science communication activities are bridging the divide between science and society, the case studies we have investigated demonstrate the usefulness of cross-sectoral collaboration in providing new ways to situate science in the social context. By providing ways to incorporate the negotiation of meaning, social values and critiques of science, these projects are providing mechanisms of public engagement and also changing the approaches of institutions and the ways in which science is conducted.

The increase in cross-sector collaboration internationally means that the importance of boundary spanners in facilitating communication and maintaining relationships in such programmes and initiatives will increase. In many situations, science communicators already fill the role of boundary spanners between researchers and the various publics. With a greater understanding of the role they play in facilitating relationships within and outside their groups or organizations, science communicators can act more responsively and ensure greater participation and cooperation.

References

Australian Government (2001). *Backing Australia's ability: Building our future through science and innovation*. Canberra: Australian Government.

Bammer, G. (2005). Integration and implementation sciences: Building a new specialization. *Ecology and Society*, *10(2)*, 6. Retrieved from http://www.ecologyandsociety.org/vol10/iss2/art6/.

Bauer, M., Allum, N. & Miller, S. (2007). What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda. *Public Understanding of Science*, *16*, 79–95.

Cook, L. (2006). *Partnerships in practice*. Canberra: Winston Churchill Memorial Trust of Australia.

Cribb, J. & Hartomo, T. (2002). *Sharing knowledge: An effective guide to science communication*. Canberra: CSIRO Publishing.

Gorman, M. (2004). Collaborating on convergent technologies: Education and practice. *Annals of the New York Academy of Sciences*, *1013*, 25–37.

Hjorth, P. & Bagheri, A. (2006). Navigating towards sustainable development: A system dynamics approach. *Futures*, *38(1)*, 74–93.

Irvin, R. & Stansbury, J. (2004). Citizen participation in decision making: Is it worth the effort? *Public Administration Review*, *64(1)*, 55–64.

Irwin, A. (1995). *Citizen science: A study of people, expertise and sustainable development*. London, New York: Routledge.

Irwin, A. & Wynne, B. (1996). *Misunderstanding science? The public reconstruction of science and technology*. Cambridge: Cambridge University Press.

Karl, H. & Turner, C. (2002). A model project for exploring the role of sustainability science in a citizen-centred, collaborative decision-making process. *Human Ecology Review*, *9(1)*, 67–71.

Kim, H.-S. (2007). A new model of communicative effectiveness of science. *Science Communication*, *28(3)*, 287–313.

Lamb, S., Greenlick, M. R. & McCarty, D. (Eds.) (1998). *Bridging the gap between practice and research: Forging partnerships with community-based drug and alcohol treatment*. Washington D.C.: National Academy Press, Institute of Medicine.

Lee, N. & Roth, W. (2003). Science and the 'good citizenship': Community-based scientific literacy. *Science, Technology and Human Values*, *28(3)*, 402–424.

Lele, S. & Norgaard, R. B. (2005). Practicing interdisciplinarity. *BioScience*, *55(11)*, 967–986.

Macnaughten, P., Kearnes, M. & Wynne, B. (2005). Nanotechnology, governance and public deliberation: What role for the social sciences? *Science Communication*, *27(2)*, 268–289.

Metcalfe, J., Riedlinger, M., Pisarski, A. & Gardner, J. (2006). *Collaborating across the sectors: The relationship between the humanities, arts and social sciences (HASS) and science, technology, engineering and medicine (STEM) sectors*. CHASS Occasional Paper No. 3, Council for the Humanities, Arts and Social Sciences, Canberra.

Miller, S. (2001). Public understanding of science at the crossroads. *Public Understanding of Science*, *10(1)*, 115–120.

Mills, D. & Brown, P. (2004). *Art and wellbeing*. Sydney: Australia Council for the Arts.

National Academies (2004). *Facilitating interdisciplinary research*. National Academy of Sciences, National Academy of Engineering, and Institute of Medicine of the National Academies. Washington: National Academies Press.

Nussbaum, B. (2005). Design's new school of thought. *Business Week Online, 1 August* http://www.businessweek.com/magazine/content/05_31/b3945421.htm?chan=search.

Petronio, S., Ellemers, N., Giles, H. & Gallois, C. (1998). (Mis)communicating across boundaries. *Communication Research*, *25*, 571–596.

PMSEIC (Prime Minister's Science, Engineering and Innovation Council) Working Group (2005). *Imagine Australia: The role of creativity in the innovation economy*. Canberra: PMSEIC.

Reback, C. J., Cohen, A. J., Freese, T. E. & Shoptaw, S. (2002). Making collaboration work: Key components of practice/research partnerships. *Journal of Drug Issues*, *32(3)*, 837–849.

Roth, W. & Lee, S. (2002). Scientific literacy as a collective praxis. *Public Understanding of Science*, *11*, 33–56.

Rowe, G. & Frewer, L. (2007). Evaluating public-participation exercises: A research agenda. *Science, Technology and Human Values*, *29*, 512–556.

Sakane, I. (2003). Toward the innovative collaboration between art and science: The task in the age of media culture through case studies in the contemporary field of media arts. *Proceedings of the IEEE Virtual Reality Conference, 2003,* 159–160.

SCST (Select Committee on Science and Technology) (2002). *Science and society*. Third report. London: House of Lords.

Trench, B. (2006). Science communication and citizen science: Is the deficit model dead? Paper presented at the 9th International Conference on the Public Communication of Science and Technology, Seoul, South Korea, 17–19 May 2006. Retrieved from http://www.pcst2006.org/Upload/WB1.PDF.

UNH Center for Integrative Regional Problem Solving (2006). *Collaboration*. New Hampshire: Durham. Retrieved from http://cirps.sr.unh.edu/Collaboration/.

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Chapter 12
From Science Communication to Knowledge Brokering: the Shift from ‘Science Push’ to ‘Policy Pull’

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Abstract Traditional (*big C*) communications in large organizations usually serve to ensure consistent over-arching messaging internally, and to the public at large. To deliver on their public-good mandate, science-based governmental institutions must do more than broadcast the department’s position. They must communicate not only broad policy directions, but also raw data, leading-edge science, general and informed layperson interpretations, and advice for action and behaviour change. Different sectors prefer to receive information and use knowledge in different ways. Science departments must engage with diverse audiences—for example, science users and decision makers, the scientific community, public organizations, and individual citizens—in ways tailored for each audience. This means paying greater attention to the changing contexts in which information is received and used, and consequently the mechanisms and relationships required to produce and transfer scientific information. For policy audiences in particular, the relevance of the science to the issues of the day, and the crucial importance of timing, underline the need for interactive knowledge brokering approaches that can deliver synergistic combinations of ‘science push’ and ‘policy pull’. The authors draw on examples from Environment Canada, as well as from the UK Department for the Environment, Food and Rural Affairs, and Land & Water Australia, to show how dedicated (*little c*) science and technology communications and knowledge brokering activities are growing in importance. The need for investment in specialized approaches, mecha-

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nisms and skill sets for knowledge transfer at the interface of science and policy is also explored, particularly in relation to the field of environmental sustainability.

Keywords '*bic C*' and '*little c*' science communication, DEFRA, Environment Canada and Land & Water Australia, environmental sustainability, knowledge brokers and brokering, knowledge transfer and translation, science communication, science–policy linkages, science push and policy pull

12.1 Introduction

In the not too distant past, researchers toiled in ivory towers, presenting findings at meetings of learned societies and publishing in obscure journals, often entombing information. As the need for stakeholder and public accountability grew, public relations and '*big C*' communications departments flourished. They trumpeted the scientific discoveries of their institutions to demonstrate the excellence or relevance of their research and, of course, to generate more funding.

In government settings, in particular, their role evolved from broadcasting or 'pushing' the scientific advances of their parent organizations to creating and ensuring consistent, overarching messaging about those institutions—both internally and to the public at large. This resulted in 'closing down' the science communications process, effectively burying uncertainty and staving off debate. One result was a loss of trust in government science: a poll in the UK showed that, while levels of trust in science itself remained stable, government (and industry) scientists were less trusted than their university or not-for-profit sector counterparts (MORI 2004).

In this chapter, we argue that the emphasis on science communication as broadcasting and the drive for consistency and simplicity in messaging do not well serve the needs of either science-based governmental organizations, or the public at large, when dealing with messy, contested issues such as sustainability. These sorts of issues require not only new modes of conducting science, but also new modes of ('*little c*') science communication.

We have seen an increasing realization that complex, contested, contextual issues like sustainability can rarely be 'solved' by traditional, hard, empirical, reductionist, positivist ('Mode 1') science. In the sustainability domain, challenges to the traditional positivist epistemology such as those of Funtowicz and Ravetz (1993), Pretty and Chambers (1993) and Gibbons et al. (1994) have been influential. A new sort of science for tackling contemporary problems was popularized by Michael Gibbons and colleagues in their proposition of the need to move from Mode 1 to Mode 2 science, or 'science in the context of its application' (Gibbons et al. 1994).

It is no longer tenable to rely on the notion of a linear progression through an orderly research process driven by scientists, to a dissemination phase driven by communication specialists, to an adoption phase in which end users (whether in policy or management) presumably apply research findings directly in their everyday activities. Rather, science must be socially distributed, application-oriented, transdisciplinary, and subject to multiple accountabilities. From a one-way linear process, science is evolving to a multi-party, recursive dialogue.

Coincident with the evolution in science, we are seeing an evolution in science communication. Traditional, *big C* broadcast models of 'pushing' science to undefined audiences are losing ground to more nuanced approaches. Typically, these recognize that different players prefer to receive science information in different ways. In fact, receptivity to new information may be more than a preference (Nisbitt and Mooney 2007)—given which, the framing, mode of communication and character of the communicator of the message have considerable influence on whether it gets through and is acted on.

Communicating science, therefore, has expanded to include *knowledge translation* in which science information is packaged to the preferences, channels and timescales of particular audiences, and *knowledge brokering* in which intermediaries (knowledge brokers) link the producers and users of knowledge to strengthen the generation, dissemination and eventual use of that knowledge. Effective science communication now includes the full spectrum of approaches from broadcast to iterative dialogue. In our contribution, we address the importance of dialogue—of linking producer and user—in ensuring that the right science gets done, that the science information gets out, and that it gets used.

The focus in this chapter is on dialogue with one particular user community—policymakers. Given the role of science in understanding environmental issues and in developing and evaluating possible solutions, policymakers constitute a key target audience for environmental science. A challenge for spanning the science–policy divide, however, is the fact that science provides one narrow window on the world, whereas policy must view the world through multiple lenses. Science is but one stream of evidence that policymakers must obtain and weigh in evaluating future courses of action. Those communicating the science need to be mindful of the crowded evidence and option space into which they are providing scientific information.

There is a vast literature in both agricultural and development extension on the adoption behaviour of farmers (see Gonsalves et al. 2005, Pannell et al. 2006). The literature on the diffusion of innovation is also well established (Rogers 2003). New work in action research and community-based health is building a base of knowledge on how health users interact with and use health evidence (Canadian Institute for Health Research, Canadian Health Services Research Foundation, and others). However, much less has been written about the adoption behaviour of policymakers—the 'demand' side of the science–policy interface—and how science can best inform policy.

Not only is the literature underdeveloped on theories about the interactions between science and policy and on the need to go beyond 'science push' to build 'policy pull', there are few descriptions of practical examples of that emergent theory put into practice. In this chapter, we showcase innovative approaches to bridging the science–policy divide in large institutional settings in Canada, the UK and Australia, based directly on the experiences of one or more of the authors:

- The examples from Canada's federal environment department focus on the development of a little c science communications model, questions about whom

to engage in strengthening links between science and policy, and some of the challenges inherent in changing roles and functions to move to Mode 2 science.
- A specific example of how to open up the policymaking process and engage a broader spectrum of participants is discussed in the context of the sustainable consumption and production goal of the UK Department for Environment, Food and Rural Affairs.
- Lessons learned on building organizational capacity to support 'knowledge adoption' to ensure that the right science is undertaken and used are presented for a research commissioning organization—Land & Water Australia.

Each of these three major sections provides a perspective on the context in which the initiatives arose, with the emphasis squarely placed on the challenges and benefits of practical implementation.

Based on our collective experience, we conclude by making the case for greater investment in knowledge transfer and brokering, and by proposing some future avenues for strengthening and consolidating the field.

12.2 The Beginnings of Knowledge Brokering in Canada

Canada's government has made strong commitments to science and technology (S&T); however, as with other countries, Canada has had its share of incidents in which, for various reasons, key policy issues have not been based on robust scientific evidence.

Crises such as the Atlantic cod fishery collapse (Hutchings 1996) and tainted blood scandal (Krever 1997) led to government-initiated dialogue on how science informs policy. For example, the Council of Science and Technology Advisors report *Science advice for government effectiveness* (CSTA 1999) outlined principles for the provision of effective science advice. The Government of Canada (2000) responded by developing the *Framework for science and technology advice,* and the *Creating common purpose* report (CCMD 2002) explored ways to improve the use of science in the development of federal policy.

A few broad initiatives were developed on the heels of these reports. For instance, a pilot course on the science–policy interface was developed by several federal departments but was not continued. In fact, few initiatives appear to have lasted, the Canadian Health Services Research Foundation[1] being a notable exception, perhaps due to its status as an arm's-length organization chartered specifically to address better use of evidence in the health sector.

The science–policy interface continues to be explored by groups within government (e.g. the 2006 Policy Research Initiative water conference[2]), related

[1] http://www.chsrf.ca

[2] Retrieved 13 October 2007 from http://policyresearch.gc.ca/page.asp?pagenm = rp_sd_water

to government (2007 PIPSC science–policy symposium[3]), and in the non-governmental (2007 *Pollution Probe* water report[4]) and academic (2007 Canadian Water Network knowledge translation planning tools[5]) communities. Strengthening the science–policy interface remains a concern for many in the federal government and those who interact with it.

Environment Canada is both a significant environmental science performer and the responsible federal authority for policy and regulation development, programme delivery, and enforcement in a range of environmental areas. This being so, the interface between science and policy is critically important in ensuring effective use of limited resources to deliver on an extensive mandate.

Environment Canada's *Science plan* (EC 2007) notes:

> Recognizing that transmitting new scientific knowledge to decision makers is a key role of government science, the [department's] S&T Branch will promote more effective communication between scientists and decision makers.

In this section, we highlight one successfully sustained Environment Canada initiative that developed into a broad departmental effort to strengthen the science–policy interface. The initiative focused on freshwater systems, but provided lessons for other science-based environmental issues.

Fresh water is an Environment Canada priority. A key federal role is providing scientific knowledge upon which decisions and sound policies and regulations for safe and secure water for Canadians and ecosystems can be based. A world leader in freshwater issues for over 30 years, Environment Canada's National Water Research Institute (NWRI) has led influential, multipartner, national scientific assessments of current and emerging threats to water quality, water quantity and aquatic ecosystem health. That scientific knowledge is used by water policymakers and decision makers at all levels of government.

12.2.1 The Evolution of 'Little c' Science Communication at the National Water Research Institute

Despite some worthy efforts in the 1990s, communicating the NWRI's considerable scientific output was until recently the responsibility of only one or two people. They engaged in routine internal reporting, with relatively little profile and no capacity for substantive science communication. In 2001, senior science managers recognized the increased importance of the Institute not only generating scientific

[3] Retrieved 13 October 2007 from www.hyper-media.ca/pipsc

[4] Retrieved 13 October 2007 from www.pollutionprobe.org/Reports/WPWS%20Final%20Report%202007.pdf

[5] Retrieved 13 October 2007 from http://cwn-rce.ca/pdfs/CWN%20KT%20Tool%20Kit%20for%20Web.pdf

knowledge, but translating and disseminating that knowledge to better inform the decision-making process, and thereby helping to resolve environmental issues of regional, national or international significance to Canada.

As a result, and in a first for Environment Canada, a new director position with equal status to NWRI research directors was filled and the science liaison function was augmented. An increased contingent of six to seven staff, most with a science background and with dedicated expertise in science writing and the links between water science and policy, was assigned to the unit. With this new profile and mandate, the Science Liaison Branch (SLB) initiated new activities targeted at better informing a multisector audience of water policy and programme practitioners. These included writing science summaries, developing internal and external newsletters, profiling national science assessments, redefining the web presence (www.nwri.ca), and undertaking selected science writing tasks in sector newsletters.

The SLB niche was carved out as one of *little c* science communication, rather than the traditional work of the far larger departmental Communications Branch. In addition, the SLB began to develop tools (mostly databases) allowing better organization of research activities and outputs so knowledge could be quickly accessed and packaged, both for routine reporting and as input to more significant programme or policy initiatives.

Quite intentionally, products and tools were developed collaboratively with NWRI researchers, resulting in raised awareness of the value of the SLB's function, greater efficiencies in responding to routine reporting requirements (yielding fewer requests and interruptions for scientists), and enhanced credibility for SLB-led products. A level of trust was built based on common goals, after which one further initiative helped in developing a more rounded knowledge-brokering unit.

12.2.2 The Science–Policy Workshop Series

In response to deaths in Walkerton, Ontario, in 2000 due to contaminated drinking water, and the resultant expectation of strengthened drinking water-related legislation and source-water protection rules, the Canadian Council of Ministers of the Environment (CCME)—composed of federal, provincial and territorial environment departments—asked the NWRI to broker a series of national workshops on water science and policy. The intent was to bring leading researchers together with policy and programme managers to provide recent science to practitioners (the policy and programme community, in all sectors), identify research needs and develop mechanisms for sustaining dialogue. The logic was that any new policy, regulatory or programme initiatives would be stronger if informed by the latest aquatic science knowledge. Because of its unique mandate, the SLB was well positioned to broker the meetings.

Five issue-specific, invitation-only science–policy workshops were originally held under the CCME 'banner' (for example, groundwater quality, water reuse and recycling). Subsequent meetings were organized under the lead of the NWRI.

In addition to supporting face-to-face discussions and networking opportunities, the SLB led development of various resource materials and workshop reports that were then more broadly disseminated to selected water research and resource managers, posted online, and presented at numerous meetings and events.

The anecdotal response was very positive; subsequently, workshop participants were surveyed to develop a metric of effectiveness for the better linking of water science with policy and programme initiatives. Ninety per cent of the policy/programme managers surveyed stated that the workshops and their products directly informed decision making about the development of a specific policy, programme, regulation, guideline, strategy or some other related management decision. Similarly, 90% of responding scientists and research managers reported that the workshops had been useful in refining their own organization's research priorities.

Although feedback suggests that the workshops were successful (Schaefer and Bielak 2006), participants viewed the sessions only as a first step. There was a clear sentiment that sustained dialogue and interaction would be essential in ensuring that science more routinely and significantly informs decision making. On this point, respondents preferred to stay networked through some form of regular electronic contact (web link and email lists), with occasional face-to-face meetings as the science developed.

These kinds of knowledge-brokering activities also received attention internally. In 2006, Environment Canada's Assistant Deputy Minister[6] of Science and Technology tasked the newly named S&T Liaison Division to broaden its mandate beyond its roots in water S&T to represent the full breadth of Environment Canada's S&T and enhance knowledge transfer within and beyond the S&T Branch.

Like many other major research organizations described in this chapter, the NWRI has made a concerted effort in the past few years to better communicate its science to targeted decision-making audiences. In some cases, bringing the science and policy communities together has been a direct and very positive experience. Nevertheless, the science–policy divide often remains, and greater effort needs to go into bridging it. One of the ways Environment Canada has sought to address the gap internally has been to understand where people actively work as intermediaries between science and policy, focusing particularly on policy analysts and their roles as translators or interpreters between the two worlds.

12.2.3 The In-between World of Policy Analysts

Until recently, considerations of the science–policy interface at Environment Canada focused largely on the role of scientists. Researchers were concerned that policy development did not make adequate use of relevant science, and often voiced

[6] See Environment Canada Organizational Chart; retrieved on 10 December 2007 from http//: www.ec.gc.ca/introec/org_chart_e.htm

frustration at the lack of feedback on how their science had been used to inform policy. Training in science communications (see, for example, STAB 2000, Bielak et al. 2002) and the science–policy interface was considered, developed and taken up positively in Environment Canada's science community. However, funding proved intermittent and insufficient: training the department's large science workforce to work more effectively at the science–policy interface is perhaps unrealistic, at least in the short term.

Over the longer term, Environment Canada and government departments around the world may find that new hires are better equipped to act at the science–policy interface as universities and professional societies react to the need, especially in environment-related fields, for graduate students skilled not only in research but also in collaboration, communications and negotiation. Initiatives such as the Aldo Leopold Leadership Program in the US are beginning to address the need for scientists to be better communicators and leaders.[7] However, they are currently doing so at the rate of 20 fellows per year. A recently introduced bill in the US House of Representatives[8] seeks to provide training in communications skills for US-trained scientists to ensure that they are better prepared to engage in dialogue on technical topics with policymakers and business leaders. However, it has yet to be approved and implemented.

At Environment Canada, we (AB, SP and KS) wondered if there was another point of influence that might allow improvements in the shorter term. At the other side of the science–policy interface are policymakers: if training scientists to better 'push' their research into the system is too slow, might training their policy counterparts be more effective? In the Canadian Government, at least, senior policy and other decision makers (such as politicians) generally do not have scientific backgrounds, and science is but one of myriad streams of evidence and opinion they must weigh in making decisions. Thus, it might be even more challenging to train policymakers and other decision makers to be good clients for science[9] than to train scientists to be better communicators.[10]

How is it, then, that *any* science crosses the great divide into policy in Environment Canada? At an internal workshop on the science–policy interface in

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[7] http://www.leopoldleadership.org

[8] See the bill to create the Scientific Communications Act of 2007 (introduced in US House of Representatives) [H.R.1453.IH]). Retrieved on 11 December 2007 from http://thomas.loc.gov/cgi-bin/bdquery/z?d110:h1453

[9] An interesting initiative in this regard is the EXTRA programme run by the Canadian Health Services Research Foundation (http://www.chsrf.ca/extra/index_e.php). EXTRA trains 24 health care managers each year to be better users of research evidence. However, the programme's target population includes nurse, physician and other health administration executives, who may have higher scientific literacy than senior policymakers and decision makers in the Canadian Government.

[10] Because of the ever-increasing S&T component in modern decision-making, it may be valuable for scientists to develop expertise in the policy domain and move directly into decision-making roles.

March 2005, staff suggested an important but, they felt, unacknowledged role for policy analysts as ‘bridgers’ between the two ‘solitudes’ of science and policy in the department. An international workshop was convened in December 2005 to consider whether ‘policy analysts’ might be the missing link between science and policy. Experts from a wide range of disciplines (including environmental science, science communication, public management, planning, knowledge management, public understanding of science, and science policy) endorsed the assessment that by bridging the ‘two solitudes’ policy analysts and other intermediaries performed a critical but under-studied role in the science–policy interface.

An attempt was initiated to better understand who carries out these intermediary roles within Environment Canada, and their background, work, challenges and place in the department. In 2007, narrative interviews were commissioned with 65 science and policy staff who were thought to perform linking or bridging functions within Environment Canada. Two workshops to analyse and validate the results from the interviews were subsequently held with other science and policy staff who were thought to be functioning in brokering roles. Participants confirmed that, despite some good practices throughout the department, the science–policy interface could still be considerably strengthened to better support environmental decision-making.

A key finding from this research was that a set of people in Environment Canada clearly identify themselves as working in the intermediary role. Although their official job titles rarely acknowledge that function, they see a core role for themselves as operating at the boundary between science and policy. One of the significant outcomes from the workshops was the formation of a nascent community of practice of intermediaries within Environment Canada.

In addition to clearly identifying this role as important to Environment Canada, participants flagged key factors affecting their ability to carry out the role. From the vantage point of the science or policy unit in which they were housed, they stressed that information on the activities and priorities of the other side was difficult to obtain. Those intermediaries based in science units reiterated frustrations expressed previously by the science community that there is little feedback about how science input to the policy process is used. Those in the policy domain struggled to know where, among Environment Canada’s 4,000 or so S&T staff, to direct a particular science question. Given the stated preference of participants and interviewees—and, according to the literature, their counterparts in other organizations—for consulting an expert over consulting published sources, the capacity to find the right expert is critical.

All noted that good working relationships are key for an effective interface. Policy analysis involves working with people as well as with information and so requires both relational and informational work. However, competencies such as facilitation and relationship building, both critical for creating trust, are important skills not often emphasized when training or hiring policy analysts.

In Environment Canada, relationships across the science–policy divide are sometimes deliberately fostered through bridging or brokering groups within science units that cultivate good ‘client’ relations. Sometimes, they result from serendipity

—chance encounters at workshops, exchanges at bus stops.[11] Often, tenure in the department is a good measure of people's networks. This factor favours intermediaries and brokers rising up through Environment Canada's science units, where tenure has typically been quite stable. In contrast, the policymaking community within the Canadian Government—like government departmental staff elsewhere—are highly mobile. Turnover in the policy ranks remains a significant challenge to strengthening the science–policy interface at Environment Canada.

In responding to the issues raised through the interviews and workshops, it is important to be mindful of the need to address both systems and people issues. Knowledge of current Environment Canada priorities and activities, and of where expertise lies, can be improved through better information systems (such as expertise inventories, databases of plain-language research summaries, and maps that align research activities with desired departmental outcomes).

Building brokering capacity will require Environment Canada to make work placements, training and mentoring available to budding intermediaries to strengthen their skills (for example, in communications, facilitation and negotiation) and to help them build effective networks on which they can draw. It might also require changing the hiring profiles of policy analysts to bring in people who already have such skills and the right mix of technical and policy backgrounds.

To drive such a shift in hiring would require increased recognition that brokering is an important role in a department, such as Environment Canada, that works in the highly complex and contested world of environmental policy. This brings us full circle to the *cri de coeur* of policy analysts at the March 2005 workshop: that their work was not acknowledged or valued.

Building recognition that brokering is a required function for Environment Canada is going to take more than exhortations and academic treatises on its value. A demonstration project to track and evaluate specific contributions of brokering to its success is currently under consideration. It will build on the learning from the narrative interviews and subsequent workshops and will use the experience and expertise of the nascent community of practice of intermediaries across the department. The evaluation component will not only document the value of brokering to the advancement of a particular issue, but also support the transfer of brokering approaches to other environmental issues that the department manages.

Environment Canada has focused over the past few years on identifying who needs to be better involved in the effort to improve dialogue between science and policy. Although the capacity of both policymakers and scientists to engage each other directly needs to be bolstered, progress is being achieved in the short term by focusing on intermediaries—those who work in between science and policy, whether individuals (such as policy analysts) or dedicated *little c* translation and brokering units (such as the S&T Liaison Division).

[11] In fact, the authors of this chapter developed their (interagency) relationships through a series of chance encounters.

12.3 Communicating into Policy Via the Evidence Base in the UK

In the UK, a small team at the Department for Environment, Food and Rural Affairs (DEFRA) experimented with novel ways to create a science–policy dialogue, designing a technique to open up the policymaking process not only to scientific evidence, but to an altogether broader array of evidence. This allowed policy teams to work as knowledge brokers and improve the dialogue at the science–policy interface. The technique focused on drawing science into policy rather than communicating it outwards, ensuring that the policy teams developed a better understanding of science's contribution to their policy goals.

Many people have attempted to describe the policy process, using analogies ranging from 'a constantly shifting jigsaw' (Levitt 2003: 14) to 'painting a water colour picture' (Kathryn Packer, then an independent consultant to DEFRA, pers. comm., October 2007). The image explored in this section comes from Parsons' (2002) critique, *From muddling through to muddling up: Evidence-based policy-making and the modernisation of British Government,* particularly the idea that Parsons draws from Schön (1983: 2), that modern evidence-based policymaking is predicated on the existence of a 'firm high ground' in the 'swamp' of policymaking; and that the task for policy is to 'map it out and occupy it' (Parsons 2002). Is this a better representation of the policy process? Does a high ground really exist? If it does, is it stable and can we map it? Do such maps have any utility in policymaking? If they do, what tools should policymakers use to create them, and how should the maps be read?[12]

Policymakers have limited opportunities to present the fullness of their work to parliamentary ministers. Their work is complicated by changes in interests and priorities brought about by the arrival of new ministers, which often have a profound impact on the work of policy teams.[13] Can policymakers produce maps that bring sufficient breadth of evidence to ministerial discussions of the policy landscape and encourage rigorous analysis of alternative interpretations, when the reality is that severe time pressures drive them towards narrow channels of problem-specific questions?

We explore these issues using a UK case study, in which 'lines of argument' were developed to help formulate the evidence strategy for sustainable consumption and production (SCP) policy. The study shows why policy's 'firm high ground' is

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[12] The focus is on Parsons' description of Schön's analysis because of the strength of the imagery, but the critique holds for other models of the policy process that assume the existence of stable areas where the supply of evidence and the demand for it are reconciled (see, for example, McNie 2007, Sarewitz and Pielke 2007).

[13] Over the period of this case study (2005 to 2007), three different people occupied the position of Secretary of State for the Environment in the UK. Each brought a different set of policy priorities, as did the new occupants of the junior ministerial positions, most of whom changed with each reshuffle.

an illusion: a snapshot map of the policy environment will fail to reflect its constantly changing nature. If more effort can be put into developing tools that reflect this mutability and can handle contradictions and multiple interpretations, the evidence base can be used to communicate complex messages from a wide variety of stakeholders *into* the policy process.

12.3.1 The Work of the Sustainable Consumption and Production Evidence Base Team

SCP is one of the four priority areas for action set out in the UK's strategy for sustainable development, *Securing the future* (DEFRA 2005) and is one of DEFRA's five strategic priorities. Central to its delivery is the vision of more effective and innovative products that respect environmental limits and leave natural resources unimpaired for future generations. This requires a major shift to deliver new products and services with lower environmental impacts across their life cycles, new business models that meet this challenge while boosting competitiveness, and new approaches to encouraging consumer behaviour change.

This presents policymakers with particular challenges in developing an evidence base for SCP. First, the long-term goals of SCP policy (a 'one planet' economy, decoupling economic growth from environmental degradation via better products, production processes and consumer behaviour change) may be far in the future and thus unclear. Second, there is very little certainty about the scale of the global impact of UK policies, the environmental limits within which we are working, or the time horizon over which policy outcomes are delivered. SCP is largely an influencing rather than a delivery programme; an important aspect of evidence development is to assess whether the current range of government policies really delivers the full SCP agenda or whether a wider range of policy instruments is needed.

The SCP team's task was to design an evidence base that reflected four key issues:

- Long-term policy goals that were—and remain—nebulous and contestable, with different interest groups lobbying for different interpretations of 'sustainability'
- The poor understanding of government's role in fostering and supporting innovation (Smith and Stirling 2006), particularly innovations that are changing the framing of environmental policy (carbon footprinting, life-cycle analysis) or its focus (wind energy, nanotechnology)
- A pan-government focus on the need to maintain analytical rigour to ensure that policy options were based on robust evidence
- A desire to open up the policy process to a wide variety of external stakeholders rather than close it down (see Rayner 2003, Jasanoff 2005, Stirling 2005)

The evidence-based policymaking movement may still be a peculiarly British concept (see Solesbury 2001), but it has matured over the past two decades and outgrown its original home in the world of medicine, moving into the social sciences and—after the BSE and foot-and-mouth disease crises in Britain in the early 1990s—into environment science and S&T studies (see DEFRA 2006, Sorrell 2007). In this process, our understanding of the relationship between evidence and policymaking has moved on from the Schönian perspective: it has adopted the idea that knowledge production, particularly in the sciences, is more distributed (see Gibbons et al. 1994).

The SCP team started with the idea that evidence for policy emerges from three types of information: data, analytical evidence, and stakeholders' views and opinions. By engaging with stakeholders in a structured way, which brings rigour to the data and to analysis, we can establish a 'line of argument' between the particular goal definition of a stakeholder group, the values inherent in that definition, and the evidence that stakeholders believe will validate their conviction that this is the path policy should take.

Different stakeholders present different lines of argument, often because they favour different approaches to the delivery of the same goals (for example, technological solutions, green taxes or cultural change), and may be selective in their use of analysis and data to support their case. In addition, stakeholders such as lobby groups, who have firm views based on a particular value set (and often strong media skills), need to have their views and the evidence on which they are based set in the context of the real breadth of evidence that surrounds every policy question. By encouraging this diversity and presenting stakeholder opinions in a structured fashion, we begin to map out the existing framings of the potential paths policy could take. The process of constructing those frames—as lines of argument—allows a mix of policymakers and external stakeholders to jointly explore the diversity of values, goals and innovation needs that permeate the complex issue of sustainability, while ensuring that discussions are based on the best available knowledge.

Lines of argument workshops (held in 2006) drew on the Cynefin knowledge management framework (Kurtz & Snowden 2003) and the 'five whys' problem interrogation technique.[14] Backcasting was used to help participants focus on the SCP policy goal of a 'one planet economy' by 2020: they were then asked to think about what would need to have happened for this goal to be achieved. This helped draw out the potential richness of the SCP policy goal, allowed alternative views to emerge, and encouraged participants to think as freely as they could about the different business and policy pathways that were being constructed.

Participants were then allowed to self-organize in small groups on the issues they deemed important, and asked to discuss and write down answers to five questions, capturing disagreements and alternative opinions in their answers to allow different lines of argument to emerge as discussion progressed. The questions were asked in strict order:

1. 'Why is this issue important?'
2. 'Why is change happening?'
3. 'Why do we need to intervene to change the impact of this change?'

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[14] See http://www.tda.gov.uk/upload/resources/pdf/f/five_whys_analysis.pdf

4. ‘Why should government intervene?’

Participants summarized the answers into a line of argument that addressed the overarching question:

5. ‘Why does (or doesn’t) government need a policy on this issue?’

This was then used as the basis for answering the question the team would use to formulate the evidence base for each potential policy path: ‘What evidence do we need to develop this policy?’[15]

Although lines of argument are very simple precursors to potential policy formulations, they allow a real two-way dialogue between the knowledge base and the policy goals, and help us to focus on the future, look for innovation gaps and explore changing values. Wind energy is a simple, hypothetical example of this: the development of cost-effective wind turbines and the rise of the green movement have contributed to wind energy’s move from being a niche issue 20 years ago to being well embedded in government policy today.

What might have happened to energy policy in the UK had a broad variety of stakeholders been involved in this sort of interactive and forward-looking policy development process 20 years ago? Might different choices have been made along the way? It is impossible to answer this in retrospect, but the SCP team worked on the principle that an open approach to developing and presenting lines of argument responded to the four issues outlined at the beginning of this section. First, it allowed multiple and often competing definitions of sustainability to coexist, valuing dissent and alternative interpretation (see Shaxson 2005). Second, the technique broadened thinking about the full range of innovations that might emerge or be needed. Third, well-defined processes were used to ensure analytical rigour, piloting workshop techniques and seeking expert advice on the robustness of the lines of argument. Fourth, the process opened up the ‘black box’ of policymaking, making it clear both to policy teams and to external stakeholders that the role of policymakers is to structure choice for decision makers based on robust evidence and analysis.

An internal evaluation of the technique concluded that it is a cost-effective yet powerful method of scoping an evidence base for policy, and for communicating *policy* questions—rather than *research* questions—to a wide variety of stakeholders. For the sustainable food agenda, the lines of argument worked effectively, moving the policy question from a narrow concentration on biodiversity to a far broader focus on life-cycle analysis, which allowed a challenge to the prevalent assumptions about the energy component of food miles (see AEA Technology 2005). Similarly, the team assessed whether the contested concept of ecofootprinting, on which the One Planet Living agenda is based,[16] should be used to underpin DEFRA’s sustainable development policy. A report commissioned after the lines of argument work (RPA Ltd 2007), used

[15] Throughout, it was stressed that evidence fulfils five functions in the policy process: it *challenges* received wisdom, *enriches* our understanding, *explains* complex issues, *confirms* what we think we know, and *scopes* opportunities for change (see DEFRA, 2005).

[16] See http://www.wwflearning.org.uk/ecological-budget

a breadth of evidence to help the SCP team conclude that 'the ecological footprint should not, as yet, be used as a headline sustainable development indicator'.[17]

Lines of argument have real value in new policy areas where there is little evidence or where policymakers need to examine how well available evidence aligns with new policy goals. They can also be used to check the coverage of the existing evidence base: even in aspects of SCP policy that had existed for several years, the team found areas where the evidence was surprisingly sparse. The method can also be used where there is a need to think more strategically about policies, where there is a need to engage with stakeholders more effectively and earlier in the policy process, or where there is uncertainty in the policy environment and the evidence is contested or open to alternative interpretations. Opening up stakeholder dialogue in this structured way helps policymakers see that challenge and alternative interpretation are inherent parts of the process of generating evidence and analysis: it ensures that participation in the policymaking process is not 'closed down' by encouraging consensus where none exists. In doing so, it ensures a real two-way communication between policy and external stakeholders.

Parsons (2002) makes the point that policymaking needs to be a process of organizational and public learning, which means understanding the reason for an alternative interpretation of the evidence: that is, is it because of uncertainty in the evidence, differing levels of knowledge, or opposing values? While the maps do not provide answers, they move us away from the situation of 'knowledge fights' (van Buuren and Edelenbos 2004). Even using simple lines of argument to structure choice for decision makers allows for a good shared understanding to develop about all the current framings that policy could take and the reasons for the differences between stakeholder groups, and clarity in the choice of policy options when the decision is made. The maps serve other purposes—they allow a deeper interrogation of the values underlying the different paths, promote a more forward-thinking approach than government might often take (Bochel and Shaxson 2007), and provide a robust analytical framework against which we can identify evidence needs to help decision takers make valid judgements.

At any one time there may be multiple 'high grounds' that represent 'better' choices for decision makers. With issues such as sustainability there will always be conflicting understandings of what constitutes 'better'—and it is for politicians, in their roles as decision makers, to judge exactly which version of 'better' to pursue. In addition, any innovation or change in values will change the topography in ways that cannot be precisely anticipated: it may raise new 'high grounds', lower existing ones, drain swamps or reveal paths that were hidden.

Though admittedly in its infancy, the lines of argument technique is able to allow for all this. It has the potential to bring rigour and sophistication to our maps, forcing us to think in more detail about the relationship between evidence, policy and the democratic process.

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[17] See http://www2.defra.gov.uk/research/project_data/More.asp?I = SD0415&M = KWS&V = footprinting&SCOPE = 0#Docs

12.4 Fomenting Synergy between Science and Policy in Australia

The Canadian and UK case studies describe various methods for improving the demand-pull on science from policy by using intermediaries and structured dialogue. The Australian case study shows how it is possible to take these further still. Improving organizational capacity and allocating resources to knowledge activities, not just knowledge products, is central to building a robust and reflexive relationship between science and policy. We need to focus less on ‘communicating science’ and more on creating a robust and durable relationship between the two communities, leading to better uptake and greater impact of knowledge more generally.

Over the past decade or so, Australia has seen an evolution in approaches to science communication that parallels developments in Canada and the UK. This has been accompanied and stimulated by changes in how the research process itself is funded, organized and managed.

The focus here is on applied research to inform more sustainable management of natural resources in Australia. In particular, this section focuses on practical measures that can be implemented to deliver more effective linkages and interactions between science and policy for complex contemporary issues, such as sustainability. The section draws on experience over the past 15 years within Land & Water Australia (LWA), an Australian Government research funding authority, in trying to organize research investments so that they deliver useful and influential outcomes for policymakers and managers of natural resources.

12.4.1 Science and Policy Down Under

LWA funded dedicated research programmes exploring the adoption of sustainability measures by landholders from the early 1990s. Yet, despite the all-pervasive influence of policy settings in determining the relative attractiveness of sustainability measures across all sectors of the economy (for example, in shaping property rights or trying to influence behaviour by offering juicier carrots or wielding smarter sticks), by 2000 LWA had not funded a single research project on the adoption behaviour of policymakers.

Like most science organizations and research funding bodies, LWA had corporate and programme-level ‘communication strategies’ overseen by a communication manager supported by a ‘communication team’ made up of ‘communication officers’. Until 2000, this effort was modest (around 3% of total expenditure) and consisted primarily of corporate public relations and publishing research results in a traditional ‘science-push’ effort.

From 2000, with a new CEO, LWA took a new strategic direction. The 2000–2005 strategic plan set five corporate objectives: leadership, influence, relevance, return on investment and accountability. All these implied a close, interactive relationship with the corporation's principal shareholder and main sponsor—the Australian Government. Given the importance of policy innovation in pursuing sustainability, the government is also a key client, just as much as the on-ground managers of natural resources.

Having set such objectives, and having identified policymakers as an adoption target in the same way that it had previously characterized farmers, it was clear that LWA also needed a communication strategy for this client group, just as it was accustomed to preparing for water authorities and farmers. It was equally clear that this strategy needed to be based on an interactive, knowledge-brokering model, rather than a traditional science-push communication effort.

12.4.2 From 'Communication' to Knowledge and Adoption

In the early 2000s, LWA became uneasy with the terminology used in the 'communications' field. Despite its interactive connotations in popular everyday usage, in the science/extension domain 'communications' is associated primarily with one-way dissemination and promotion of research outputs. Yet in order to demonstrate leadership, to be influential and relevant, LWA had to be funding good science on the big important issues. To deliver a good return on investment, knowledge generated by research had to be adopted by intended users in policy and management spheres. No matter how elegant or insightful the research project, LWA's interest, as an applied research investor, was in its uptake and eventual impact.

LWA realized that it was essentially in the business of investing in *knowledge* and its *adoption*, so it dropped 'communication' and recruited a new Knowledge and Adoption Manager. It developed a Knowledge and Adoption Strategy[18] and a new team of professionals to implement the strategy, with commitment from the corporation's board to quadruple the previous communication budget to around 18% of total expenditure by 2006.

The Knowledge and Adoption Strategy drove LWA's corporate Evaluation Strategy, because it distilled the three key questions to answer in judging overall performance:

- What knowledge assets have we generated?
- What do we know about the uptake and application of that knowledge among target client groups?
- What are we assuming or do we know about the impact of the application of that knowledge?

The second and third of these questions are more complicated and expensive to answer than the ones that precede them, with increasing attribution difficulties.

[18] See http://www.lwa.gov.au/Practice/index.aspx

Nevertheless, there is much value in being as explicit as possible on assumptions about how an investment in science will make a difference, and then to follow through to track that application.

The changes at LWA went far deeper than just changing job titles and position descriptions. With support from Dave Snowden from the then IBM Institute for Knowledge at Cambridge University and his colleagues, LWA overhauled its whole approach to managing and evaluating its portfolio of research investments (1,600 projects back to 1990). Some of the manifestations of this work included the following.

- Instead of considering research projects as 'completed' when the last research payment has been acquitted and then archiving the project files, all projects are now considered to be 'live' investments and their knowledge assets to have potential value regardless of their age, consistent with Snowden's (2002) notion of knowledge as a 'flow' rather than a 'thing'. Projects are likely to be evaluated every several years on an ongoing basis, because as much or more is learned from evaluating the adoption and impact of 10–15-year-old research projects as from very recent projects.
- Different knowledge domains (for example, local knowledge, Indigenous knowledge and strategic knowledge) are considered more explicitly in addition to formal scientific knowledge, and funding is targeted to modes of inquiry that recognize them and understand their characteristics; for example, Community Fellowships to help experienced amateurs share their hard-won lessons more widely (LWA 2006).
- The diverse ways in which knowledge is expressed (Snowden 2004a) are also recognized, and LWA has experimented with different ways of drawing out and sharing tacit, experiential knowledge among scientists, its own staff and end users of research, including techniques such as story circles (Snowden 2004b).

The lessons from this experience are discussed in more detail in Campbell (2006), Campbell and Schofield (2007), and Schofield (2005); however, some key points relevant to policy audiences are distilled very briefly here.

12.4.3 The Knowledge-Seeking Behaviour of Policymakers

When LWA started to treat policymakers as an adoption target—analogous to but different from farmers—it realized a need to know more about their knowledge-seeking behaviour. Several broad findings emerged from reviewing the knowledge-seeking behaviour of policy professionals in natural resource management agencies:

- They only know what they need to know when they need to know it, and so are generally poor at defining knowledge needs or research questions.
- They tend to be time-poor, information-overloaded people who do not read anything unless they have to.

- They have a very short term perspective driven by a reactive political context and are very responsive to parliamentary ministers' needs (which, in turn, can also be influenced by science).
- They know they need to be able to summarize information in less than a page for the minister or the minister's office, and hence tend to be averse to anything that seems too complicated.
- They default to trusted sources, often in-house, even when they know those sources are out-of-date or incomplete.
- They are rarely as skilled in using web-based tools or formal, refereed scientific sources as amateur community volunteers and non-government organizations; they tend to simply ring up the departmental library and ask 'What have we got on this?'
- They often have a jaundiced opinion of science, research, or both, believing that they are too slow and too expensive, and invariably answer questions that no one has asked, usually accompanied by requests for more funding.

Against that background, LWA developed a specific engagement strategy for policy audiences.

12.4.4 Techniques to Engage Policymakers More Productively with Science

Word limits preclude a comprehensive explanation of LWA's approaches, but some of the most successful tools included:

- Working out preferred times and places for discussing technical matters (for example, senior executives favour breakfast briefings for face-to-face interaction, and they are more likely to read emails with carefully distilled science information on Sunday night at home)
- Careful scoping of research questions with policy people at a very early stage in the research process
- 'Over the horizon' issues scanning, with a quarterly analysis presented in distilled form
- Development of specific knowledge management tools targeted to the policy-maker's daily operating environment (one click on their Windows desktop)[19]
- Targeting talent ('fast-track individuals' in middle management as well as 'key influencers') with special face-to-face briefings, invitations to events and distilled information
- Finding out who is in the minister's 'kitchen cabinet' and targeting them as key influencers (LWA keeps a register of its 100 most important key influencers constantly updated)

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[19] Such as the NRM natural resource management toolbar: http://www.lwa.gov.au/regionalknowledge_e-news

- Never breaking the ‘no surprises’ rule (while not being party to censorship)—where research findings are potentially contentious or embarrassing for the government, key senior executives or political staffers are briefed in advance, so that they can be better prepared before issues hit the media

The most important aspect in organizing policy-useful research is to get the research question right. This means investing in specific measures in close consultation with end users to elicit and articulate knowledge needs. Done well, this process develops understanding of the adoption context and consequently the design of the research process from the outset. Knowledge and adoption activities should be hard-wired into the research process throughout.

12.5 Investing in Knowledge Brokering

Knowledge brokering is typically used to refer to processes used by intermediaries (knowledge brokers) in mediating between sources of knowledge (usually in research) and users of knowledge. Knowledge brokering is usually applied in an attempt to help knowledge exchange work better for the benefit of all parties. It involves bringing people together, helping to build links, identifying gaps and needs, and sharing ideas. It also includes assisting groups to understand each other’s abilities and needs, and guiding people to sources of knowledge. This may include summarizing and synthesizing research and policy into easily understood formats and translating policy problems into researchable questions.

Knowledge brokers help to ensure relevance; that is, that research is answering the right questions and that policy stakeholders are engaged in the inquiry process and have some ownership of its outputs. They can also influence the research process by providing opportunities for stakeholders to get involved in a meaningful way. Dedicated (*little c*) science communications and targeted knowledge-brokering activities are growing in importance; we are now seeing the genesis of specialized knowledge-brokering units and job descriptions.

Such groups and individuals must be comfortable in initiating dialogue and operating in the worlds both of the scientists and of science users, be able to fashion research outputs into language that can be understood by the users, and help develop researchable questions from articulated knowledge needs and deliver the information in timely fashion. They should be trusted, valued and respected by both communities. The information they provide must be based on robust evidence, obviating attempts to blindly navigate the science and policy swamps, and thus reducing transaction costs at the science–policy interface.

To design, develop and deliver these sorts of tools, LWA invested deliberately in various forms of knowledge brokering. In fact, it now considers knowledge management and brokering to be one of its three lines of core business. The evident success of this strategy for the organization (the non-core budget of which has increased as a result, to the point that around 60% of its total expenditure is third-party funds[20]) should be a powerful incentive for others to understand the importance of an appropriate balance between science-push and policy-pull and the need to invest in dedicated mechanisms and people accordingly.

12.6 Conclusions

This chapter describes applications of an emerging model of science communications on three continents. The model goes beyond the prevalent, traditional science-push to consider the 'pull' for information from those who need it. It is clear from the literature and from our experiences that there are both a need for and clear advantages to this new mode of science communication: instead of simply getting messages across, we provide information that can readily be used in policy. It is also evident that practical application of the model is far from widespread. We need to move from theory into practice.

Timing is everything. The Canadian, UK and Australian case studies were developed separately, but all have been informed to some extent by the work on knowledge management by Dave Snowden, who frequently makes the point that knowledge is most useful *when* it is needed. For the policy environment, in particular, this means that robust, interactive, ongoing relationships between science and policy, supported by good knowledge management systems, will be more effective than traditional science communication approaches in ensuring that policy is based on the best available knowledge.

The examples we have provided are all from the environmental sustainability domain—one we have simplistically characterized as 'messy' from a policy perspective, and one where traditional science communications approaches do not work particularly well because science has no monopoly of sustainability knowledge.

In a metaphor often used at LWA, we propose that organizations 'fund the arrows, not just the boxes'. Typical organizational charts are composed of boxes connected by lines and arrows, but budgets typically allocate all funds to the boxes. Good knowledge and adoption activities do not just happen—they have to be resourced. In other words, money has to be allocated to the arrows as well as to the boxes. And the arrows should be two-way.

Resilient systems to support knowledge brokering must be put in place to make such brokering activities possible, while existing staff and new hires with the specialized skills to act as brokers will make them happen.[21] This will allow a shift from a

[20] See LWA 2005–06 annual report, retrieved on 14 October 2007 from http://downloads.lwa2.com/downloads/publications_pdf/PR061205.pdf

[21] The UK's Chief Science Adviser wrote in a recent article in *Nature* that 'for scientific advice to underpin government action, communications skills must be a much bigger part of scientific training and culture' (King and Thomas 2007).

‘products’ model, to a marketplace of products tailored to specific audiences, to iterative knowledge brokering based on ongoing, durable relations (working with the users of information on custom designs, and incorporating domains other than science).

Finally, given the interest in the emerging field of knowledge brokering for environmental sustainability, and our experience that this is a diffuse domain where the players are often working with little support, publishing in a multiplicity of forums, perhaps with few contacts in the field, we consider that it would be very beneficial to see a broader community of practice established to help bring people together. We propose the creation of a regular forum dedicated to knowledge brokering, where the community can meet and exchange information and experiences.

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References

AEA Technology (2005). *The validity of food miles as an indicator of sustainable development*. Report No. ED 50254. London: DEFRA. Retrieved on 18 October 2007 from http://statistics.defra.gov.uk/esg/reports/foodmiles/execsumm.pdf.

Bielak, A. T., Howell, G., Enros, P. & Hempel, P (2002). *Advances in developing a science communications curriculum, communications tools and best practices in the Department of the Environment, Canada*. Conference on Communicating the Future: Best Practices for Communicating Science and Technology to the Public. Washington DC: United States Department of Energy and National Institute of Standards and Technology. Retrieved on 8 October 2007 from http://www.nist.gov/public_affairs/Posters/sciencecomm.htm

Bochel, H. & Shaxson, L (2007). Forward looking policy making. In H. Bochel & S. Duncan (Eds.), *Making policy in theory and practice*. Bristol: The Policy Press.

Campbell, A. (2006). *The Australian NRM knowledge system*. Occasional paper. Canberra: Land & Water Australia. Retrieved on 10 October 2007 from http://www.lwa.gov.au/downloads/publications_pdf/PR061081.pdf

Campbell, A. & Schofield, N. (2007). *The getting of knowledge*. Occasional paper. Canberra: Land & Water Australia. Retrieved on 10 October 2007 from http://www.lwa.gov.au/downloads/publications_pdf/PR061240.pdf

CCMD (Canadian Centre for Management Development) (2002). *Creating common purpose: The integration of science and policy in Canada’s Public Service*. Action-Research Roundtable on Science and Public Policy. Ottawa: CCMD.

CSTA (Council of Science and Technology Advisors) (1999). *SAGE: Science advice for government effectiveness*. Retrieved on 13 October 2007 from http://www.csta-cest.ca/index.php?ID = 90&Lang = En

DEFRA (Department for Environment, Food and Rural Affairs) (2005). *Securing the future: UK Government Sustainable Development Strategy*. London: DEFRA. Retrieved on 17 September 2007 from http//www.sustainable-development.gov.uk/publications/uk-strategy/index.htm

DEFRA (Department for Environment, Food and Rural Affairs) (2006). *Science meets policy 2005: Next steps for an effective science–policy interface*. Report of London conference held as part of the UK’s Presidency of the European Union, 23–25 November 2005. Retrieved on 17 September 2007 from http://www.defra.gov.uk/science/publications/documents/SMP2005.pdf

DEFRA (Department for Environment, Food and Rural Affairs) (2005). *Five components of robust evidence*. Retrieved on 17 September 2007 from http://www.defra.gov.uk/science/how/documents/Wallchart.pdf

EC (Environment Canada) (2007). *Environment Canada's science plan: A strategy for Environment Canada's science*. Ottawa: Science and Technology Branch, EC.

Funtowicz, S. O. & Ravetz, J. R. (1993). Science for the post-normal age. *Futures*, *25(7)*, 739–755.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzmann, S., Scott, P. & Trow, M. (1994). *The new production of knowledge: The dynamics of science and research in contemporary societies*. London: Sage.

Gonsalves, J., Becker, T., Braun, A., Campilan, D., de Chavex, H., Fajber, E., Kapiriri, M., Rivaca-Caminade, J. & Vernooy, R. (Eds.) (2005). *Participatory research and development for sustainable agriculture and natural resource management: A sourcebook*. International Development Research Centre. Retrieved on 19 October 2007 from http://www.idrc.ca/en/ev-73443–201–1-DO_TOPIC.html

Government of Canada (2000). *A framework for science and technology advice: Principles and guidelines for the effective use of science and technology advice in government decision making*. Retrieved on 13 October 2007 from http://strategis.ic.gc.ca/pics/te/stadvice_e.pdf

Hutchings, J. A. (1996). Spatial and temporal variation in the density of northern cod and a review of hypotheses for the stock's collapse. *Canadian Journal of Fisheries and Aquatic Sciences*, *53*, 943–962.

Jasanoff, S. (2005). *Designs on nature: Science and democracy in Europe and the United States*. Oxford, UK: Princeton University Press.

King, D. A. and Thomas, S. M. (2007). Big lessons for a healthy future. *Nature*, 449, 791–792.

Krever, H. (1997). *Commission of Inquiry on the Blood System in Canada (Krever Commission) final report*. Library and Archives Canada electronic collection. Retrieved on 13 October 2007 from http://epe.lac-bac.gc.ca/100/200/301/hcan-scan/commission_blood_final_rep-e/index.html

Kurtz, C. F. & Snowden, D. J. (2003). The new dynamics of strategy: Sense-making in a complex and complicated world. *IBM Systems Journal*, *42,* 462–483.

Levitt, R. (2003). *GM crops and foods. Evidence, policy and practice in the UK: a case study*. Evidence Network Working Paper No. 20. London: Economic and Social Research Council, UK Centre for Evidence Based Policy and Practice.

LWA (Land & Water Australia) (2006). *Natural passion: Inspiring stories of practical sustainability*. Canberra: LWA.

McNie, E (2007). Reconciling the supply of scientific information with user demands: An analysis of the problem and review of the literature. *Environmental Science and Policy*, *10*, 17–38.

MORI (Market and Opinion Research International Ltd) (2004) *Science in society: Findings from qualitative and quantitative research conducted for the Office of Science and Technology, Department for Trade and Industry*. London: Department for Innovation, Universities and Skills. Retrieved on 10 October 2007 from http://www.ipsos-mori.com/polls/2004/pdf/ost.pdf

Nisbitt, M. C. & Mooney, C. (2007). Framing science. *Science*, *316(5821)*, 56.

Pannell, D. J., Marshall, G. R., Barr, N., Curtis, A., Vanclay, F. & Wilkinson, R. (2006). Understanding and promoting adoption of conservation behaviour by rural landholders. *Australian Journal of Experimental Agriculture*, *46(11)*, 1407–1424.

Parsons, W. (2002). From muddling through to muddling up: Evidence based policy making and the modernization of British Government. *Public Policy and Administration*, *17(3)*, 43–60.

Pretty, J. & Chambers, R. (1993). *Towards a learning paradigm: New professionalism and institutions for sustainable agriculture, IDS Discussion Paper DP334*. Brighton, UK: Institute for Development Studies.

Rayner, S. (2003). Democracy in the age of assessment: Reflections on the roles of expertise and democracy in public-sector decision-making. *Science and Public Policy*, *30(3)*, 163–170.

Rogers, E. M. (2003). *Diffusion of innovations*, 5th edition. New York: Free Press.

RPA (Risk & Policy Analysts) Ltd. (2007). *A review of recent developments in, and the practical use of, ecological footprinting methodologies: A report to the Department for Environment, Food and Rural Affairs*. London: DEFRA.

Sarewitz, D. & Pielke, R. A. Jr. (2007). The neglected heart of science policy: Reconciling supply of and demand for science. *Environmental Science and Policy*, *10*, 5–16.
Schaefer, K. A. & Bielak, A. T. (2006). Linking water science to policy: Results from a series of national workshops on water. *Environmental Monitoring and Assessment*, *113*, 431–442.
Schofield, N. in collaboration with Agtrans Research (2005). *Land & Water Australia's portfolio return on investment and evaluation case studies*. Canberra: Land & Water Australia.
Schön, D. A. (1983). *The reflective practitioner*. New York: Basic Books.
Shaxson, L. J. (2005). Is your evidence robust enough? Questions for policy makers and practitioners. *Journal of Evidence and Policy*, *1*, 101–111.
Smith, A. G. & Stirling, A. C. (2006). Moving inside or outside? Objectification and reflexivity in the governance of socio-technical systems. *Journal of Environmental Policy and Planning*, *9(3–4)*, 1–23.
Snowden, D. (2002). Complex acts of knowing: Paradox and descriptive self-awareness. *Journal of Knowledge Management*, *6(2)*, 100–111.
Snowden, D. (2004a). The ASHEN model: An enabler of action. Originally published in *Knowledge Management*, *3(7)*; re-edited and updated 2004. Retrieved on 10 October 2007 from http://www.cynefin.net/kbase/7_Organic_KM_1_of_3_ASHEN.pdf
Snowden, D. (2004b). Knowledge elicitation: Indirect knowledge discovery. Originally published in *Knowledge Management*, *3(9)*; re-edited and updated 2004. Retrieved on 10 October 2007 from http://www.cynefin.net/kbase/8_Organic_KM_2_of_3_discovery.pdf
Solesbury, W. (2001). *Evidence based policy: Whence it came and where it's going*. Economic and Social Research Council, UK Centre for Evidence-Based Policy & Practice (CEBPP) Working Paper 1. London: CEBPP.
Sorrell, S. (2007). Improving the evidence base for energy policy: The role of systematic reviews. *Energy Policy*, *5(3)*, 1858–1871.
STAB (Science and Technology Advisory Board) (2000), *Science Communications Framework for Environment Canada*. Ottawa: Environment Canada. Report #2. Retrieved on 13 October 2007 from http://www.ec.gc.ca/scitech/default.asp?lang = En&nav = 9670FE5C-11
Stirling, A. (2005). Opening up or closing down? Analysis, participation and power in the social appraisal of technology. In M. Leach, I. Scoones & B. Wynne (Eds.), *Science and citizens: Globalization and the challenge of engagement*. London: Zed Books, 218–231.
Van Buuren, A. & Edelenbos, J. (2004). Why is joint knowledge production such a problem? *Science and Public Policy*, *31(4)*, 289–299.

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Chapter 13
Science Advocacy: Challenging Task, Difficult Pathways

Toss Gascoigne(✉)

Abstract The practice of scientists acting as advocates in their own political cause is a relatively recent one around the world. The primary cause of their advocacy is their desire to maintain or increase funding. Despite a natural reluctance to undertake lobbying activities, science has learned that it must engage with policymakers if it wishes to maintain its influence and funding. The chapter details a number of the formal and informal methods science has used, drawing examples from the United States, Britain, Australia and Canada. It charts the emergence of science advisers to governments, either as individuals or committees. It looks at the formation of advocacy groups, and contrasts their strategy and activities with lobby groups representing non-science interests. The paper concludes that advocacy is not always a natural and easy course for scientists, but one they must undertake. The voice of science advocacy is not strong, but it is there.

Keywords Science advocacy, science lobbying, FASTS, Congressional Visits Day, Science meets Parliament

The practice of scientists acting as advocates in their own political cause is a relatively recent one around the world. The primary cause of their advocacy is their desire to maintain or increase funding.

Scientists are ambivalent about lobbying: they tend to regard such activities as crass and distasteful, but are beginning to realize they are being out-competed. In the past they had a naive faith that the value of science was self-evident and that it would therefore be automatically recognized and funded by legislators. But scientists have come to realize that, just like every other interest, science needs to make its case against competing demands for government funds—hospitals, roads, the war against terrorism, the environment and social services.

At the same time, they recognize that lobbying for funds risks contradicting the ‘disinterested’ approach science espouses, and could be seen as compromising the integrity of their work:

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> The credibility of scientists is on the line. Do we want them to serve as lobbyists? Is that good for democracy, and, finally, is it good for science? Should generals lobby for a war?[1]

To many scientists the advocacy role seems, as Daniel Greenberg put it, somehow ‘inappropriate’:

> Physicians, trial lawyers, real-estate agents, and other professionals take the political route to promote their interests. They collectively raise money and give it to favored candidates, which is what counts in electoral politics, and thereby gain politicians’ attention. But for scientists, that’s out of character. They did it once on a big scale, in 1964, when Republican Barry Goldwater’s nuclear saber rattling created alarm among the physicist alumni of the World War II A-bomb project and many other researchers. They raised significant sums and sent leading scientists barnstorming around the country to denounce Goldwater and boost Democratic candidate Lyndon Johnson. But after that, they swore off organized politics as inappropriate for the scientific community. (Greenberg 2007)

Despite that natural reluctance, science has since engaged with policymakers through a number of formal and informal mechanisms. Funding is not the only issue. Science has a strong hand to play in the evidence-based policymaking that many governments pride themselves on. At times the science can be drowned by a multitude of other voices, from self-interested industries to aggrieved communities and passionate advocates of causes. If science is to be heard, it has to compete, especially on controversial issues such as climate change, environmental legislation and the teaching in schools of ‘intelligent design’ as a competing theory on the origin of the species.

In response (and it has been a response, not an initiative), science has moved to make its voice heard in the national capitals of the world. The voice not strong, but it is there. At times science works within the executive or legislative arms of government; in other cases, it operates completely independently of government, making the first steps towards organizing itself like ‘physicians, trial lawyers and real-estate agents’.

This chapter describes the emergence of these voices, drawing on some international examples and trends, and looking at the approaches and strategies different groups have used.

13.1 Science Advisers and Chief Scientists

In the US and the UK, there were moves early in the Cold War to increase the representation of the views and expertise of the scientific community in government, to complement the more scholarly representations of groups such as the learned academies, the Royal Society and the American Association for the Advancement

[1] Nigel Cameron; retrieved from http://choosingtomorrow.blogspot.com/2007/02/triumph-for-science-or-merely-for.html

of Science (AAAS). Governments began to see the need for science advisers: senior people who were close to the President or the Prime Minister and who could be trusted to interpret science, advise on priorities and propose policy options.

In 1957, US President Dwight D. Eisenhower appointed James Killian to the newly created position of Special Assistant to the President for Science and Technology. Just as science lobby groups were later spawned by the threat or reality of funding cuts, it also took a crisis to create Killian's position: the launch by Russia of the first spacecraft, Sputnik.

The changing role of the special assistant has been described by Pielke (2007). In an article in *Nature*, Pielke claims that the power of the holder of the office has continually declined—paradoxically, as the power of science in the federal administration has increased. He ascribes this to increasing complexity and the play of numbers:

> Yet as the adviser's influence has declined, scientific and technological expertise at the highest levels of government has been triumphant. William T. Golden, investment banker, philanthropist and a chief architect of the science-adviser position, wrote in 1950 that the government could draw on 'somewhere between 20 and 200' top scientists. By 2003 there were approximately 8,000 scientists serving on about 400 federal advisory committees. Without effective mechanisms to turn advice into options, and options into action, the often heroic efforts of these scientists will amount to little more than academic exercises.

Science per se is not a matter of great interest to Presidents. It may well be part of the solution in many areas of policy, but in the end policy decisions are political rather than scientific and will be made by the President in discussion with his inner circle. While the role of the science adviser will vary depending on their relationship with the incumbent President, Pielke says that few advisers play the sort of political games that would gain them admittance to the inner circle.

He sees the position as steadily developing since 1957:

> The reality of pluralistic policy-making helps to explain why today so many issues involving science are politicized, and will continue to be so, under all future presidents. The scientific community can assist the next president by focusing greater attention on the overwhelming supply of expert advice beyond the White House that feeds into all aspects of government decision-making. In practical terms, this would mean eschewing calls to separate science from politics, and fostering instead more sophisticated ways to integrate science with the needs of policy-makers. (Pielke 2007)

Pielke suggests that the position could evolve into an in-house think tank, putting policy options to the President and eliciting from government 'policy-relevant questions that need to be addressed by scientific and technological experts'.

In 1965, not long after the appointment of the first presidential science adviser in the US, Sir Solly Zuckerman was appointed Chief Scientific Adviser in the UK, and served under both under Labour and under Conservative prime ministers.

Twenty-four years later, in 1989, Professor Ralph Slatyer was appointed as Australia's first Chief Scientist. Slatyer later recalled his response to the phone call inviting him to take up the new position:

> I had already been the chairman of ASTEC [the Australian Science, Technology and Engineering Council] and I thought the new chairman ought to continue working the way

> I had. [Senior bureaucrat Mike Codd] said, 'No, this is going to be quite different. ASTEC is outside the bureaucracy; this is inside. The person in [the Chief Scientist's] job will have access to all the Cabinet papers and will be expected to be across all of them'. He said the new [Prime Minister's Science] council would be very influential, with the prime minister and six other senior ministers involved. Also, there had been a great need for a coordination committee to bring the various bureaucratic elements together, avoid overlap and so on. 'It really is a challenge', he said. 'Why don't you do it for three years?'[2]

Complementing the Chief Scientist appointment in Australia was the creation of a powerful committee—the Prime Minister's Science Council, where cabinet ministers had six-monthly meetings with scientists.

In all three countries, these advisory positions created a pipeline for science straight to the highest political levels. They reflected the increasing importance of science in the national decision-making process, in which many problems had a scientific component. Science gained a seat at the policymaking table not because of any innate qualities, but because it was perceived as generating solutions to problems and helping to create industries, jobs and wealth.

By the 1980s, however, it was apparent to many scientists that individual advisers and government-selected committees might not be enough to protect science and its funding streams. Coalitions began to form.

13.2 Science Advocacy Groups

In 1983, the National Coalition for Science and Technology (NCST) was formed in Washington D.C., where it was the only registered lobby of scientists for science. Other groups followed, including the Council on Research and Technology (CORETECH) in 1987. Research!America was formed in 1989, 'under the realization that there was a vast deficiency in medical research funding—and that such a gap would be detrimental to Americans for years to come'.[3] Each of these groups was a coalition of industry and researchers.

Garfield (1987) describes the NCST as:

> a registered lobby representing individual scientists, universities, businesses and associations. It promotes governmental support for science and has recently concentrated its efforts on funding for the National Science Foundation and NASA.

Garfield puts these activities into context: 'Such action by scientists and their representatives would have been unheard of only a decade ago. But the crisis in funding for scientific research around the globe, as well as the qualitative change big science ushered in, has stirred many a scientist from political somnolence'.

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[2] An interview of Professor Ralph Slatyer by Dr Max Blythe, 1993. Published at http://www.science.org.au/scientists/rs.htm

[3] Research!America: http://www.researchamerica.org/history_mission

Until that time, scientists had been uncomfortable with the notion of lobbying for funding (although they had shown a readiness to raise their voices on ethical matters and issues of conscience). Garfield describes the 'innate distaste many hold for overt forms of influencing decision-makers in government'. He attributes the emergence of the new movement to new demands on the scientific community, quoting Shils (1987), professor of sociology at the University of Chicago:

> The freedom they enjoyed when research projects were small and demands for practical results were less insistent is no longer the natural and inevitable condition of scientific research. The outer world has forced itself into [sic] the horizon of scientists as never before.

One factor from this 'outer world' was the success of individual universities in the US lobbying for funds by circumventing the normal peer-review processes, and persuading powerful national politicians to earmark funds for their institutions by attaching funding proposals to other legislation. This threat to the peer-review process in the US had to be countered.

What was happening in the US in the 1980s was also happening in various forms in other parts of the world. The causes were the same: funding was under threat, the importance of science was not always appreciated by politicians making policy decisions, and there was a perceived lack of awareness in both public and policy circles of the power and capacity of science to change the course of nations.

In his article 'Scientists must learn to lobby', Eugene Garfield describes a series of activities and campaigns across Europe and the US at this time (Garfield 1987). Cuts inflicted by French President Jacques Chirac prompted 280 research directors to take out advertisements in *Le Monde* and *Le Figaro* appealing for additional funding.

A similar campaign in the UK led to the birth of a new organization, Save British Science (SBS):

> SBS was founded in 1986, following the placement of an advertisement in *The Times* newspaper. The idea came from a small group of university scientists brought together by a common concern about the difficulties they were facing in obtaining the funds for first class research.
>
> The original plan was simply to buy a half-page advertisement in *The Times* to make the point, and the request for funds was spread via friends and colleagues in other universities. The response was overwhelming.[4]

The advertisement (Fig. 13.1) appeared on 13 January 1986.

In contrast to the NCST in the US, the UK's SBS was supported largely by individual scientists, and aimed to:

> 'communicate to the public, parliament and the government a proper appreciation of the economic and cultural benefits of scientists' research', according to its literature. Its London office directed letter-writing campaigns by scientists to members of Parliament.

[4] Campaign for Science and Engineering in the UK (CASE): http://www.savebritishscience.org.uk/about/history/index.htm. (CASE was formed in 2005 as the successor to SBS.)

Fig. 13.1 Original advertisement for Save British Science

In Australia, the Federation of Australian Scientific and Technological Societies (FASTS) was formed in 1985.[5] Its birth was prompted by harsh cuts to funding for national research organizations in the 1984 budget. The Minister of Science—a science enthusiast visibly distraught at his failure to protect the funding of research—lashed out at scientists across Australia. They were wimps, he said, because they failed to muster the public support that would have enabled him to carry countervailing budget proposals through the Australian Parliament. He needed active advocates—scientists prepared to sell the value of the national investment in science to the public, the media and, ultimately, to members of Parliament.

In response to the budget cuts and the minister's statement, the Australian Academy of Science convened a meeting of leading Australian scientific societies to consider how science might more effectively present its views to politicians. The formation of FASTS was the result. It was established as a body representing working scientists (as opposed to the relatively small number of elite scientists elected to membership of the academy).

The role of FASTS, which continues to operate, is essentially political: to foster close relations between the societies; to promote a higher level of public understanding of science; and to encourage scientific dialogue between industry, government and the scientific and technological community. Its members are learned or

[5] The author was the executive director of FASTS from 1995 to 2003 inclusive.

professional societies that between them represent tens of thousands of scientists and technologists. It is funded by subscriptions from the membership, with only very modest government support to help it become established (although the Australian Government recently announced new annual funding sufficient to support two or three extra staff).

13.3 Secondments of Scientists to Government

In the US, the science community decided to take another, more direct route to policymakers. The Congressional Science Fellows programme, administered by the AAAS, was created to allow for the secondment of working scientists to Washington for periods of 12–18 months. There, they joined the staff of a member of congress, or worked in the congressional library, the congressional committee system or the bureaucracy. This programme continues today.

The scientists are funded primarily by one of the scientific societies, and the programme was (and is) administered by the AAAS:

> The Science & Technology Policy Fellowships began in 1973 with seven Fellows serving in congressional offices, providing their scientific expertise to policy-makers facing increasingly technical legislative issues. AAAS now partners with nearly 15 federal agencies, many congressional offices and committees, and nearly 30 professional scientific societies to operate the AAAS Science & Technology Policy Fellowships, which have been providing public policy education and outreach experiences for scientists and engineers for more than 30 years.[6]

The programme has grown steadily and has an annual intake of about 150 fellows chosen in a highly competitive process. Those scientists taking up positions in congressional offices (now about 35 annually) need to be comfortable with the political stance of their congressman because they may become involved in partisan activities. Scientists could visit up to a dozen offices before negotiating an arrangement with a compatible representative or senator.

The AAAS plays a training and coordinating role:

> The fellowships provide the opportunity for scientists and engineers, from recent PhD recipients to senior-level professionals, to learn about policy-making while contributing their knowledge and analytical skills to the federal government. The Fellows, representing a broad array of science and engineering fields, bring a common interest in learning about the intersection of science and policy, and a willingness to apply their technical training in a new arena. The host offices value the Fellows for their external perspectives and critical thinking skills, as well as for their technical expertise.[7]

The value of the programme is also recognized by members of congress in testimonials published on the AAAS website. Senator Edward Kennedy:

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[6] American Association for the Advancement of Science (AAAS): http://fellowships.aaas.org/01_About/01_History.shtml.

[7] AAAS: http://fellowships.aaas.org/01_About/01_History.shtml.

> The Congress is increasingly involved in public policy issues of a scientific and technical nature, and recognizes the need to develop additional in-house expertise in the areas of science and engineering. In addition, it becomes increasingly more important that the scientific and engineering communities become aware of the workings of government in these areas, and that better liaison be developed in the public interest.[8]

Other countries have shown interest in adapting the scheme to their own needs. For example, Switzerland trialed and then adopted the programme, making the first appointment in 2002. The Swiss convenor of the programme commented on the evaluation:

> Everybody is now very happy, even those who were so sceptical at the start; and that includes some of the permanent staff in Parliament. There has been a real change in attitude, so much that the secretaries of other Parliamentary Committees want to have a fellow attached to their staff.[9]

13.4 Advisory Committees and Councils

Partly because of prompting from science advocacy groups, many countries set up official advisory groups funded by government to inject science into their legislatures. Canada established the Science Council of Canada in 1966 'to advise the government on science and technology policy. The original membership was 25 appointed scientists and senior federal civil servants, later altered to 30 appointed eminent experts from the natural and social sciences, business and finance, and no civil servants'.[10] In 2007, the Canadian Government announced that it will create a new body, the Science, Technology and Innovation Council, as part of a broader effort to consolidate external advisory committees to strengthen the role of independent expert advisers.

In the UK, science expertise is found in the Parliamentary Office of Science and Technology (POST). The office was established in 1989 to help MPs examine science-based issues, and has a permanent staff of six supplemented by short-term appointments, including PhD students.

The rationale for POST is set out on its website:

> Most parliamentarians do not have a scientific or technological background but science and technology issues are increasingly integral to public policy. Parliamentarians are bombarded daily with lobbying, public enquiries and media stories about science and technology. These cover diverse areas such as medical advances, environmental issues and global communications.[11]

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[8] AAAS: http://fellowships.aaas.org/01_About/01_History.shtml.

[9] Personal correspondence, Dr Margrit Leuthold, then Secretary-General of the Swiss Academy of Medical Sciences.

[10] http://www.thecanadianencyclopedia.com/index.cfm?PgNm=TCE&Params= A1ARTA0007214

[11] Parliamentary Office of Science and Technology: http://www.parliament.uk/parliamentary_offices/post.cfm

POST writes short briefing papers and longer reports for MPs and Parliamentary committees. It organizes discussions and maintains a watching brief ('scans the horizon') for emerging issues. As well as working closely with the institutions of Parliament, POST also works with outside bodies, such as scientific societies, policy think tanks, business, academia and research funders. POST-like offices have been established in many of the Parliaments of Europe.

POST is part of the European Parliamentary Technology Assessment, a European network established in 1990 to advise Parliaments on the possible social, economic and environmental impacts of new sciences and technologies. The network defines its aim as:

> [providing] impartial and high quality accounts and reports of developments in issues such as for example bioethics and biotechnology, public health, environment and energy, ICTs, and R&D policy. Such work is seen as an aid to the democratic control of scientific and technological innovations, and was pioneered in the 1970s by the Office of Technology Assessment (OTA) of the US Congress.[12]

13.5 Advocacy and Lobbying: Strategy and Tactics

Scientists and governments have worked from a common menu in building better advisory and information mechanisms. Chief scientists, expert advisory committees and secondments of scientists to Parliamentary systems have all helped give a voice to science in the decision-making process. Although their role is not explored in this chapter, funding bodies, scientific societies and the learned academies also contribute to the advocacy of science.

The advocacy/lobbying function sits at one end of the spectrum of routes that science takes into national policymaking. So, how does the science community go about this task? Which of its subsectors and organisations play a leading part? What are its strategies and tactics? Has it had the same success as 'physicians, trial lawyers and real-estate agents'? How do its activities compare with the campaigns of major national lobby groups?

Successful advocacy is an amalgam of a number of approaches. The tactics organizations employ depend very much on the strategies they have adopted:

- Some use the media, working on the theory that the best way to pressure politicians is by mobilizing public opinion.
- Others adopt the tactic of working through grassroots mass movements, using their members to advocate for the cause by contacting local politicians. Some scientific societies or coalitions have even initiated such campaigns.
- A third approach is to take soundings of public views through polls and surveys, and present the results to politicians as evidence that this is what their constituency wants.

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[12] European Parliamentary Technology Assessment: http://www.eptanetwork.org/EPTA/about.php

- A fourth is to employ experienced consultants (often ex-politicians) to take up the cause through contacts with their former colleagues in office.
- A fifth is to change the system from within, working quietly with politicians and bureaucrats. Personal relationships are often used to set up these unheralded meetings.

David Malakoff set out other 'tools of the trade' in an article in *Science* ('Perfecting the art of the science deal'):

> Nearly 150 of the 545 members of Congress got at least one award from a science-related group over the past 18 months, according to an informal survey by *Science*. Although such 'grip and grin' events might seem ritualistic, 'everyone wants to be recognized for the good work they do', says Missi Tessier of the Science Coalition, which hands out its share of prizes. She's especially proud of a nanoscale saxophone that the coalition presented to President Bill Clinton. 'He kept it on his desk for a long time', she says. 'That can't be a bad thing'. (Malakoff 2001)

Malakoff is unenthusiastic about email campaigns, and cautious about using celebrities (because of their fees), but does recommend the following approaches:

- Feed politicians—offer them a free meal and a compelling after-dinner speaker.
- Form coalitions of interests with like-minded organizations. They can be difficult to establish and maintain, but their political power makes them hard to beat.
- Ask politicians to persuade their colleagues.

Science faces stiff competition in the national competition for funding. We can learn from the vigour and the range of activities and training offered by grassroots organizations with interests outside science. All these groups are competitors, if not directly for funding then at least for time and attention in national political circles.

The American Civil Liberties Union offers advice to its supporters through a section of its website headed 'Becoming an effective and efficient activist'. This lists actions for individuals and training and advice on how to become more effective. For example, the site suggests the best approach to take in meeting with a member of congress:

> Decide who will attend the meeting. Bringing more than four or five people can be hard to manage. Keep it small, but bring people who represent different groups that have an interest…
>
> Agree on talking points. It's tough to make a strong case for your position when you are disagreeing in the meeting! If a point is causing tension in the group, leave it out.
>
> Plan out your meeting. People can get nervous in a meeting, and time is limited. Be sure that you lay out the meeting beforehand, including who will start the conversation.
>
> Decide what you want achieve. What is it you want your elected official to do—vote for or against the bill? Make a commitment to introduce or co-sponsor legislation? Asking your legislator or his or her staff member to do something specific will help you know how successful your visit has been![13]

[13] American Council for Civil Liberties: http://action.aclu.org/site/PageServer?pagename=AP_effective_activism

The National Rifle Association (NRA) is also widely recognized as a hugely effective lobby group in the US. It offers a high-quality website with information, news and advice, including a three-hour video newscast each weekday evening to update viewers on 'what's hot and happening with your firearm freedoms'.

The NRA is conscious of the pressure it is able to bring to bear on politicians and the potential rewards from mobilizing 3 million members. Former Clinton spokesman George Stephanopoulos says, 'Let me make one small vote for the NRA. They're good citizens. They call their Congressmen. They write. They vote. They contribute. And they get what they want over time'.[14]

The NRA aims to ensure that its members call, write, vote and contribute by offering them advice on practical activities, including letter writing:

> Be Brief, Specific, & Always Be Courteous! Letters shouldn't exceed one page, and the purpose of your letter should be stated clearly in the first paragraph. If your letter pertains to specific legislation, identify it accordingly (use the bill number, if known, and the title of the bill and/or a brief description). To make sure your letter is as productive as possible, always be courteous, even if you disagree with your representative's position! Never threaten or use abusive language. This only hurts your cause.[15]

13.6 Advocacy Activities

Congressional Visits Day (CVD) began in 1994 in Washington D.C., and has been organized annually since then. The day usually brings 200–250 scientists, engineers, researchers, educators and technology executives to Washington to raise visibility and support for science, engineering and technology. The event is run by the Science–Engineering–Technology Working Group, a coalition of professional and learned societies and industry and educational institutions. In 2008, the event is expected to reach almost two-thirds of all members of congress.

> CVD is a grassroots activity designed to help scientists and engineers establish and maintain relationships with their local Representatives and Senators through visits in the Washington offices. This event is designed to show the cross-disciplinary support for federal science and technology programmes. Participants try to show the 'human face' and local impact of science and engineering issues…[It] gives us a chance to demonstrate how our own organizations affect innovation, competitiveness, the creation of a skilled and world-class workforce, national security, a healthy environment, and our economic well being.[16]

CVD was the model for an Australian equivalent, the annual Science meets Parliament Day (SmP), which was first run in 1999 by FASTS and has been held every year since (except 2004).

[14] National Rifle Association (NRA): http://www.nra.org/aboutus.aspx

[15] NRA: http://www.nraila.org/ActionCenter/GrassRootsActivism.aspx?ID=11

[16] SETCVD: http://www.setcvd.org/cvd2008/CVD08-FAQ.pdf

It is a two-day event, with the first day devoted to a discussion of strategy and tactics, and the second to individual meetings with MPs. At the first event in 1999, both sides enjoyed the meetings: the scientists found MPs interested in their work, and the MPs discovered that scientists have potential solutions to problems in such areas as the environment, energy, transport, health and agriculture.

In the Australian Parliament only about 5% of the 227 members have tertiary qualifications in science. That lack of scientific expertise can become a problem when Parliament discusses science-based issues like water, energy, greenhouse, GM food or the environment. Apart from the bureaucracies, MPs' only alternative sources of advice may be a few chosen outside experts, or interest groups (whose 'science' can be unreliable).

And, just as Parliamentarians understand little about science, scientists have little appreciation of the work of MPs. They do not have a clear idea of the political processes, or appreciate the pressures on MPs, the timescales on which they work or the number of interests they have to juggle. One function of SmP is to educate scientists about these factors in order to make them better advocates for the cause.

The second day of SmP is devoted to individual meetings with MPs in their offices, normally lasting 20–40 min. Four or five people are present: the MP, a member of their staff, and two or three scientists. Their conversation might cover the theme of the day (as prepared by FASTS), the work of the scientists, and issues nominated in advance by the MP.

Feedback on both sides has been positive. Evaluations regularly score the overall event at a little over 8 out of 10, and participants believe that the event has helped put science on the political agenda.

Meetings are optional, and about 60% of MPs choose to participate. Participating scientists pay a registration fee and meet their own travel expenses.

A variation on this theme is 'Bacon & Eggheads', a Canadian event 'bringing together Parliamentarians with experts across science and engineering, showcasing outstanding Canadian research accomplishments. Its purpose is to provide unbiased insight into topical scientific issues, within a non-partisan forum in which lobbying is not permitted'.[17]

These 90-min breakfast meetings are organized by the Partnership Group for Science and Engineering, a cooperative association formed in 1995 and comprising more than 25 national organizations, which in turn represent some 50,000 individual members from industry, academia and government.

The media can be a useful complementary force in these events, or an advocacy tool in its own right. For example, FASTS brought pressure on the Australian Government by publicizing the 'brain drain' issue. This was a significant factor in squeezing a large funding package out of the government for science and research: 'brain drain' was a term that all electors could understand. A media release set out FASTS' basic position:

[17] Partnership Group for Science and Engineering: http://www.pagse.org/en/breakfasts.htm

> Australia's peak body for science and technology said today (Tuesday) that the Monash University study on brain drain told only part of the story.
>
> Ms Jan Thomas, Vice-President of the Federation of Australian Scientific and Technological Societies (FASTS), said the study camouflaged the real issues behind the story.
>
> 'We suspect that Australia is losing its top talent, the high-potential people hand-picked for their special abilities', she said.
>
> 'These people are being snapped up by institutions overseas which can offer top facilities, good salaries and the funds to carry out research in a comprehensive manner'.
>
> Ms Thomas said Australia was simply not able to compete for talent in the hot areas of science and technology, the areas like biotechnology, mathematics and nanotechnology.
>
> 'In most areas, Australia plays in the second division', she said. 'We can't compete on salaries, we can't offer young scientists a career path, and the funds for research and infrastructure are below world standards.
>
> 'International science is intensely competitive. While Australia offers a wonderful lifestyle, top scientists will only compromise so far when it comes to working standards'.[18]

Administrations are very sensitive to media coverage. If issues like the brain drain crop up on the evening TV news and are covered by the daily newspapers, ministers will demand a solution—in this case, it was a new funding programme.

Media coverage on other issues, such as 'mad cow disease' in the UK, has also forced governments to change course. Media controversy over GM foods has forced policy modifications in many countries.

The challenge for advocacy groups is that science policy is not a 'hot button' issue, and they need to consider how their core messages can be translated into terms that mean something to ordinary citizens. 'Brain drain' made this leap. It was couched in sporting terms and appealed to national pride and competitiveness. The implication was clear: failing to adequately fund research carried an ominous economic message for Australia.

Research!America makes extensive use of polling to make its policy stances relevant to politicians. In its media releases, the organization describes itself as 'the nation's largest not-for-profit public education and advocacy alliance working to make research to improve health a higher national priority'. Research!America has been gauging public opinion on Americans' attitudes towards medical, health and scientific research since 1992, and regularly samples their views through telephone or online polls.

The organization bases its strategy on the view that opinion poll results will be a powerful force in the decisions of politicians, either directly through correspondence or representation, or indirectly through the media. Polling questions raised in 2007 included:

- How important do you think it is that the US is a global leader in scientific research? (76% nominated 'very important')
- Do you agree or disagree with this statement: 'The US is losing its global competitive edge in innovation'? (65% nominated 'agree')

[18] FASTS: http://www.fasts.org/images/news2001/july-01-brain%20drain%20study.pdf

- Would you be willing to pay $1 per week more in taxes if you were certain that all the money would be dedicated to research to improve health, or not? (67% nominated 'Yes')[19]

The Task Force on the Future of American Innovation[20] is a coalition of high-tech businesses and academic groups, including high-tech companies such as Google, Intel and Microsoft as well as the American Chemical Society, the University of California and the National Association of State Universities. Defence industry contractors such as Lockheed Martin and Northrop Grumman are also members.

The task force has taken a different approach, nominating a target (a doubling of US research budgets over the next 10 years), and inviting all major candidates in the 2008 US Presidential race to make a commitment:

> 'So far, none of the top candidates has promised to make the pledge,' officials with the task force said, although several have given promising signals.
>
> 'For example, staffers for Democratic front-runner Sen. Hillary Rodham Clinton (D-N.Y.) met with the group and expressed an interest in modifying her position, according to Glenn Ruskin, director of government affairs for the American Chemistry [sic] Society. Clinton previously had proposed a 50% budget increase for the agencies over 10 years, but groups in the task force saw that amount as insufficient'.[21]

Daniel Greenburg is not optimistic about the task force's chances of success:

> Can the care and feeding of science win support and votes for a politician?
>
> From the record of recent presidential campaigns, including the current marathon, the candidates don't think so. None among the platoon of hard-running hopefuls has paid much attention, if any, to the cries of financial need coming ever louder from researchers, particularly those dependent on the National Institutes of Health. Senator Hillary Clinton pledged all good things for science in a speech in October observing the 50th anniversary of Sputnik. Technology is endorsed on Mitt Romney's campaign website. But, these are exceptions to the customary campaign fare—rare exceptions. (Greenberg 2007)

13.7 Conclusion

The past 30 years has seen a slow dawning of awareness among scientists. They have begun to accept that they, like all other interests in our increasingly complex society, need to advocate on behalf of their subject, to point out the virtues and benefits of a national investment in science. They have witnessed the consequences of not doing so: budget cuts, truncated career trajectories, and failure to make the best use of scientific talents in solving the problems of the world.

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[19] Research!America: http://www.researchamerica.org/uploads/AmericaSpeaksV8.pdf

[20] Task Force on the Future of American Innovation:http://thehill.com/business–lobby/high-tech-business-and-academic-groups-lobby-2008-hopefuls-on-science-funding-2007-09-26.html

[21] Task Force on the Future of American Innovation.

Advocacy is not always a natural and easy path for scientists. Their world is one of hypothesis, experiment, evidence, proof—and they are puzzled by a political decision-making process that follows any less rational course. Advocacy in its own cause may be one of the hardest things science has tried to do.

References

Garfield, E. (1987). Scientists must learn to lobby. *The Scientist*, *1(12)*, 9.

Greenberg, D. (2007). Ballots and budgets. *Association for Psychological Science*, *20(10)*, November 2007.

Malakoff, D. (2001). Perfecting the art of the science deal. *Science*, *292(5518)*, 830.

Pielke Jr, R. (2007). XXX. *Nature*, *450(15)*, 347.

Shils, E. (1987). Science and scientists in the public arena. *The American Scholar*, *65*, 185–202.

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Toss Gascoigne is executive director of the Council for the Humanities, Arts and Social Sciences (CHASS) in Australia. Before that he held a similar position with a similar advocacy group in the sciences, the Federation of Australian Scientific and Technological Societies (FASTS). He is interested in the linkages between researchers and government, the methods researchers use to persuade governments to adopt evidence-based processes in determining policy, and researchers' responsibilities while doing so. Toss is the inaugural chair of the PCST Network and a life member of the Australian Science Communicators.

Chapter 14
The Epistemic Jumble of Sustainable Development

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Abstract In this chapter, the author demonstrates that the translation of scientific knowledge for the layperson is anything but a purely technical question. Besides the science, the translation must take into account the social and the political arenas. Having established this groundwork for the conceptualization of social communication, the author examines the canonical model of sustainable development as presented in the media and on websites. Using this model as an example, the chapter analyses the reduction of scientific, social and political complexity to a descriptive and symmetrically organized presentation of science, history and society, and the production of sustainability management indicators.

Keywords Environment, management, popularization, scientific communication, sustainability

In this paper, the expression 'science communication in social contexts' is used in a particular way. It does not only imply that scientific communication takes place in social and historical contexts. More important is the fact that the very definition of what is a scientific issue in the public sphere is at stake in the process of communication. Societies choose what is significant for them in science by the way they develop communicational practices: by the choice of the information, of course, but also by the form adopted in public communication.

For me, this is the main lesson we can draw from the rich and complex research during past decades into the 'popularization' of science: a set of studies in several scientific fields (for example, sociology, anthropology, communication sciences, semiotics) that we can now consider with hindsight from both social and epistemological viewpoints. Practices, on the one hand, and scientific models, on the other, have been constantly evolving during this time.

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14.1 From 'How Does It Work?' to 'What Game Do We Play?'

Researchers into science communication focused first on the means to make science understandable by non-specialists. They probably had to, in order to grasp their object, but they were soon led to consider the whole context of our communication and media system, in a kind of backwards zoom view. Indeed, as the analysis of the popularization discourse grew in accuracy, it became more and more obvious that the procedural question 'How can we translate scientific knowledge for the average man'? was anything but a purely technical question (Jurdant 1973).

Such a classical formulation of the relation between science and communication, periodically rediscovered since the publication of *Entretiens sur la pluralité des mondes* (Fontenelle 1686), presents serious drawbacks: it aims at answering questions that are not formulated. Who is supposed to take part in the communication process about science? How can the place of each actor be defined? What is the social and political logic of such a dialogue? A rather implicit rhetoric and narrative pact used to give a ready answer to those questions. In a society supposedly divided into two parts—learned and ignorant people—a go-between agent should find the most effective tools to convey science to a large audience.

In recent decades, both political evolution and scientific discussion questioned this model. The translation no longer appeared as a necessary concept, but as one historical answer among many others. It became necessary, at first, to suspect the explanation that popularization actors give of their own task; subsequently, that philosophy of suspicion was not sufficient. Idealism might have been at work here—the belief that it was possible to make pure and transparent expressions of real science (Jacobi and Schiele 1988). To reassess communication on scientific subjects, it was necessary to consider it as a constructive practice involved in a wider process: a social regulation of heterogeneous means that helps us interpret the natural and social worlds. Of course, contemporary practices are not so innovative from that point of view, since the implications of various social, ideological and cultural topics are a constant theme in popularization discourse (Jeanneret 1994). What is new is that the definition of communication as a crossroad structure is recognized, implemented in communication devices and situations, and presented as a norm in political, local, educational and cultural communication. This is what I want to discuss here, using an emblematic case: the discourse about 'sustainable development'.

Discourses about sustainability are exemplary because they give explicit justification and public visibility to the heterogeneous nature of knowledge communication and because they also show the limits of such a justification. We can point to several factors that account for this. The expression 'sustainable development', as other similar expressions (for instance, 'information society') is both hegemonic and semantically vague. This *magic phrase* can, by itself, convey some value to any discourse that quotes it (Labelle 2007). In such a context, the development of a discourse on sustainability 'transmutes' (Fabbri 2003) previous topics. It takes after 'ecology', while transforming it rather deeply. Finally, it is not only an interdisciplinary field, but it endeavours to regulate interdisciplinarity per se, and even epistemic diversity. Moreover, it promotes such regulation, not within the scientific community, but through social governance, information management and public policies.

The specific case of sustainable development gives us the opportunity to contribute to a more general question about social shaping of science communication. This paper addresses only parts of that question. First I explore how sustainability relates various types of sciences and knowledge; then I examine how the tenets of sustainable development as a revolution in thought represent science, knowledge and scientific method; finally, I try to demonstrate that the forms of communication are as important as the contents of information for the representation of science.

These indicative analyses lead me to the main point of my hypothesis. I want to argue that today the groundwork for conceptualizing social communication has been laid, and that conceptualization can now be brought to bear on the discourse of sustainable development. From this viewpoint, sustainable development, which seems at first glance to be a specialized object, in fact plays a structuring role as a global metaphor for what communication and politics are and can become.

14.2 The Environment as an Epistemic Monster

Sustainable development is in many respects the contemporary legacy of *political ecology*: a way to address environmental issues that can be formulated both in scientific terms (ecology as a discipline) and in political ones (ecology as a movement). We shall see that the canonical doctrine about sustainable development considers the environment as a part of a global question. As a theory of public policies, sustainable development is a voluntary conciliation, but as an object for media discourse, and as a normative imprecation about the future, sustainable development has taken the place of ecological affirmation. Such an ambiguous definition is part of the process we are trying to understand and is obvious in the contents of many international initiatives concerning sustainability. In the same way that the 'information society' is supposed to cover a great number of problems but is focused on computers, 'sustainable development' announces a multidimensional approach but refers to nature. The Declaration on Environment and Development (usually called 'Agenda 21') was adopted in Rio de Janeiro at the United Nations Conference on Environment and Development in 1992. Chapter 35 of the declaration, entitled 'Science for sustainable development', is entirely focused on two scientific areas. Natural sciences convey information on our ecosystem, and engineering sciences give us resources to manage it. This fits a general pattern: multidisciplinarity is the principle, natural sciences are the reference.

Ecology as a discipline was founded by Ernst Haeckel, and can be considered as a part of *natural history*, even if it cannot be dissociated from philosophical conceptions. But in the public sphere, 'environmental issues'—which are the field of *ecologists*' *discourse*—cannot be allocated to a particular discipline. The object called the environment is constantly redefined by the different actors who appropriate, interpret and express it. There is not, on the one hand, a scientific object that could be named the *real environment*, and, on the other, a trivial one that should be named the *vulgarized environment*. There is a public debate about what people must do with their environment that continuously presupposes and redefines what the environment is.

One may distinguish this case as easily from a *vulgarized discipline* like mathematics as from a *mythical discipline* like economics. Mathematicians manage obscure programmes and sometimes (rather rarely) the media try to explain them. Politicians and businessmen make decisions that affect everyday life, and they legitimate them by the invocation of an unfailing science, economics. In the field of the environment, nobody says what discipline is at stake. The actors struggle between themselves to determine what kind of knowledge is involved; there is even a struggle to decide whether scientific knowledge has to play a decisive role.

In a famous text, his first lecture (*Leçon inaugurale*) at College de France, Michel Foucault points out that scientific disciplines consider some objects neither as true nor false, but only as nothingness. Foucault writes:

> The exterior of a science is both more and less populated than one might think: certainly there is immediate experience, imaginary themes bearing on and continually accompanying immemorial beliefs; but perhaps there are no errors in the strict sense of the terms, for error can only emerge and be identified with a well-defined process; there are monsters on the prowl, though, whose forms alter with the history of knowledge. (Foucault 1971: 35)

The environment is a monster, and that is precisely the reason it is very productive in communication. Many actors pretend to be able to say what the environment is. So, the growing importance of environmental issues and conflicts is linked to the creation of political procedures grounded on communication ethics: for example, consensus conferences, public audiences and deliberative debate. Environmental questions are determined by specialized knowledge, but also defined by social and existential stakes. They are at the same time esoteric problems and common issues.

It is possible to resume that situation with three propositions that are equally valid but largely contradictory:

- As a set of technical problems involving specialized knowledge, the environment refers to precise disciplines: climate change to climatologists, nuclear energy to physicists.
- As a group of risks that must be avoided, environmental change involves a wider range of knowledge items, some of them relevant to social sciences or philosophy.
- As a political perspective that concerns the future of humanity, scholars of the environment resort necessarily to normative positions, frequently portrayed by authorities (philosophers, wise persons, religious leaders) who do not draw their legitimacy from scientific criteria, but can also be linked to the simple practice of citizen debate.

Sustainable development is the inheritor of the environmental object and of its congenital hybrid nature. But it also expresses the mutation of that object. Ecology included in sustainable development is not the same as ecology alone. The belief that the environment is only a part of a trio (ecology, society, economy) progressively became the core definition of the notion of sustainable development. I shall now examine some of the consequences of this.

14.3 The Canonical Model of Sustainable Development

The idea of sustainability was not initially defined as a catalogue of disciplines, but the dissemination of the model strengthened that representation very much.

The major historic reference of sustainability is the well-known *Our common future*, which is often referred to as the Bruntland Report (Brundtland 1987). In that declaration, the viewpoint was a conceptual one, sustainability was to be seen from the perspective of future generations, and a need to contextualize environment as a part of social life was perceived.

What is also noticeable in *Our common future* is the strong recognition of personal experience as a legitimate source of policy. Gro Harlem Bruntland writes in the introduction of the report:

> The environment does not exist as a sphere separate from human actors' ambitions and needs, and attempts to defend it in isolation from human concerns have given the very word 'environment' a connotation of naivety in some political circles.

She gives a justification for the use of the expert team involved in the elaboration of the report:

> We needed people with wide experience, and from all political fields, not only from environment or development and political disciplines, but from all the areas of vital decision making that influence economical and social progress, nationally and internationally. (Bruntland 1987)

We can now measure the distance between that programmatic declaration, written by the 'founder of discourse formation' of sustainable development, and the definition of the same object that was gradually generalized—a highly systematized and codified one. The report enumerates several disciplines, among which we recognize environmental sciences, but also development sciences (a subspeciality of economics), politics, political sciences, and a set of cultural approaches. Above all, the report does not argue a definition of disciplines, but the need to connect scientific knowledge to social context, practical stakes and political efficiency. Many of those ideas are preserved by the various actors that claim to reference the Bruntland Report, but what was initially a question of perspective and conviction progressively became one of social technology.

The research projects in which I took part analysed a wide set of productions, conceived by actors who play different roles in the process of legitimation of the discourse on sustainability: scientists, activists, industrial firms, public actors, bankers, evaluation agencies, etc. This analysis reveals the hegemony of one graphic representation of sustainability, which is reproduced here from the website of the collaborative encyclopaedia *Wikipedia* (Fig. 14.1). It can be considered to be a good crystallization of the dominant ideas of internet activists.

This schematic model embodies a kind of discourse very different from the programmatic one. We can call it the 'canonical model of sustainable development'

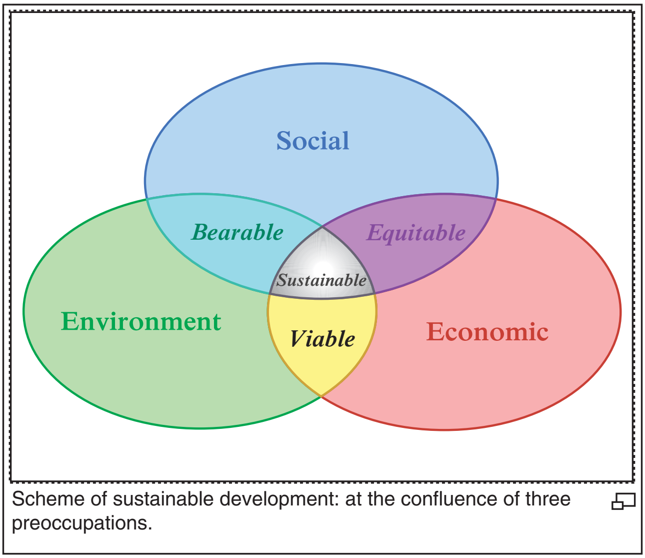

Fig. 14.1 The canonical model of sustainable development, from Wikipedia

(CMSD). It is not in contradiction to the definition of sustainability as a perspective on the future, but it gives that perspective a very peculiar form. It is this very disseminated conception of sustainability that I will examine further here—not, I make clear, the real diversity of actors and formulations, but a dominant pattern.

My detailed commentary on this diagram summarizes observations made on a wide corpus of websites in the context of a collective project with D'Almeida and Cheveigné (D'Almeida et al. 2004) and for the elaboration of this paper.

The first element to point out is the play between categories that are presented as symmetrical, though they are deeply different in their scientific status. 'Economic' is able to evoke a discipline very directly. The other notions refer either to an interdisciplinary field (environment), or to everyday experience (social). 'Sociologic' does not face 'economic'. The form of the chart places heterogeneous kinds of knowledge in equivalence. But the systematic disposition of the diagram, evoking structural theories, imposes the idea that this system is a rational one. The rigour of visual schemes absorbs the floating status of signifiers. Most interesting is the term 'social', which can be understood as a field of knowledge but also as a domain of practical experience, and even as an euphemistic expression for political conflict. Indeed, some of the analysed sites present social issues as a field of knowledge, but very few of them refer to sociology or the social sciences, as disciplines.

One could object that scientific boundaries are not the real point of this political and communicational apparatus, and that assertion is not totally false. But scientific results and scientific values are necessary to sustainability for several reasons: the crucial role of scientific guarantees in the proposed model; the presence of an explicit epistemological claim in that model; and the predilection of the actors for encyclopaedic forms of communication.

In my opinion, the three terms placed in the cross areas of the diagram express a theory of the circulation of knowledge: a theory of *triviality* in the etymologic acceptation of the term (*trivium*: crossroad of communication paths). Those adjectives (viable, equitable, bearable) look rather insignificant, but on the contrary they are crucial, because they allow circulation between different fields of knowledge. They can link together different kinds of knowledge, because they link knowledge with action. They are constructed by the same process, the suffixation of '-able', which expresses the capacity of realization. This lexical symmetry—which is not observed in the three fields, where 'environment' shows its patrimonial value by the fact that it is not transformed—strengthens the effect of regularity and rationality of the diagram.

What do those terms affirm? That knowledge resources must be confronted by makeability. But who can decide that things are makeable? It is here that scientific reference, or more precisely scientific *expertise*, will inevitably be demanded. We find such a demand in the official declarations of international conferences, as in the commercial offers of sustainability agencies, associations, firms and local polities. The Rio agenda asks for 'scientific assessments of current conditions and future prospects for the Earth system'. The international project The Natural Step puts up 'an international network of sustainability experts, scientists, universities, and businesses'.

As the three adjectives suggested, the role of the expert is central: he is the one who is able to transform speculative knowledge into a practical judgement. Science is gauged by expertise: experts are not always explicitly mentioned, but the knowledge system is entirely controlled by the criterion of ability:

- *Viable:* some economic expert can guarantee that the solution can last.
- *Bearable*: some expert on cultures or maybe on social conflicts can guarantee that people will accept the solutions adopted by managers.
- *Equitable*: some expert on law, or maybe on political philosophy, can guarantee that those solutions conform to universal principles.

It is important to notice that, from one field to another, the determination of the referential science becomes more and more uncertain, but the need for scientific assessments does not disappear.

14.4 Metascience or New Science?

Such a constant play between concepts and practical expertise places science and knowledge in a very peculiar perspective. The diagram in Fig. 14.1 is a kind of *trivial epistemology*. It is not only an attempt to organize knowledge, such as the catalogue of a library—it is a practical judgement on the role played by various fields of knowledge in a general economy of thought and action. That point is very important: on the one hand, the CMSD recognizes the diversity of knowledge principles; on the other, a unique global frame is supposed to manage this diversity. In this system, communication about science is twice contextualized: as a dialogue between specialities, and as an integration of knowledge in a unique pattern.

The epistemic principle of the CMSD, grounded on the symmetry of the fields of knowledge, resembles the hierarchic presentation of sciences proposed in the

Discours sur l'esprit positif by Comte (1844). In both cases, the apparent heterogeneity of knowledge principles—which is supposed to be a source of social anomy and political ineffectiveness—has to be reordered. In both cases, the new order lies in a radical enterprise of rethinking the rationality of action using a powerful theory: positivism in one case, sustainability in the other.

However, there are two major differences. The first is a structural one: positivism proposes a vertical hierarchy of knowledge, from mathematics to sociology, in which each step supports the one above it; the CMSD, for its part, privileges a horizontal cartography of knowledge, in which each expert is supposed to know his own territory and to respect the others'. The second difference is a philosophical one: positivism justifies its action by an examination of the nature of sciences; sustainability imposes the need of practical coordination.

But what kind of global governance will manage that division of knowledge work? The claim of the CMSD can lead to two epistemic stances. One may affirm metacognitive competence, which is necessary to conciliate and referee the competitive goals of local specialities. But one can also pretend to a specific competence, something like the *science of sustainable development*. To take a unique example, the international organization The Natural Step, a powerful NGO founded in Sweden at the end of the 1980s and internationally organized, has progressively developed a doctrine and a scientific apparatus. The organization's website proposes 'a science-based definition of what sustainability is' and announces: 'The Natural Step Framework provides a shared mental model, understanding, and common language that facilitates cooperation across organizations, disciplines, and cultures' (Fig. 14.2).

Most of the websites studied propose such a mix of two stances—metadisciplinary and disciplinary. Documentary activity is a typical expression of this project.

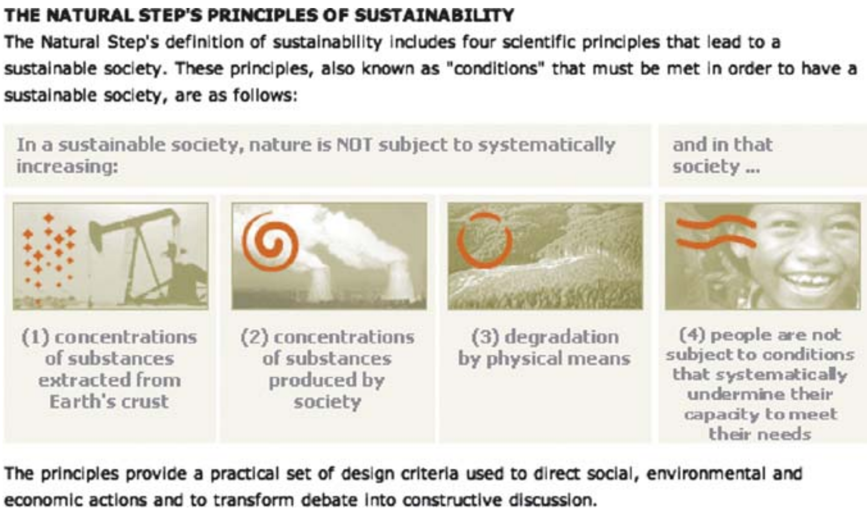

Fig. 14.2 Scientific definitions of *The Natural Step*

Websites devoted to informational resources distribute expertise and popularization, and at the same time offer a *set of principles* and a *methodology*. I have not the room here to detail completely the analysis of the wide corpus of French websites, which we called ‘the encyclopaedia of possible speech’ (Aïm and Jeanneret 2007). As pointed out by Olivier Aïm (2006), there is a very strong correlation between three contemporary trends: an object (sustainable development), a media device (the internet), and a form of publication (the encyclopaedia of references and emblematic practices). At this point of our analysis, it becomes obvious that the claim to give order to interdisciplinarity relies on a political and ideological pattern that links together information, networks and pragmatic action.

One could expect to find much polemic and many activist positions on the websites; indeed, controversies and struggle are omnipresent. But the real operations of writing and the editorial orientations of the sites are much more consensual. They almost uniformly state their purposes to be to *display* all kinds of information, to manage the *plurality* of the positions and to *educate* people about the principle of sustainability. This process leads to a paradoxical result: while the value of dialogue is constantly invoked, the same information is reproduced, from one site to another. The strength of polemic discourse is absorbed in the gesture of publishing data, and the editorial work is, in its turn, engulfed by the digital collection of countless files. In this medium as in others, the ‘curatorial enunciation’ (Gentès 2003)—of webmasters and technicians—leads the whole communicational process.

The emblematic example of that style of communication is the website of *Agora 21*, an academic and activist organization devoted to the implementation of the Rio agenda. This site, despite the very determined discourse of its managers, does not offer anything but a neutral collection of documents—a construction that reproduces, as a strange mirror, the monstrous conglomeration of disciplines and non-disciplines that can be included in the elastic notion of ‘sustainable development’. The link entitled ‘Presentation of sustainable development’ does not lead to any text, but to a list (Fig. 14.3).

The same kind of accumulation of topics can be found in the sites of international organizations, such as the International Institute for Sustainable Development.

Les documents de base par thèmes

agriculteurs	agriculture espace rural	aménagement du territoire	atmosphère	autochtones	biodiversité
biotechnologies	capacités	collectivités locales	commerce et industrie	consommation	coopération
coopération internationale	déchets dangereux solides et eaux usées	déchets radioactifs	démographie	désertification	droit
eaux douces	éducation sensibilisation	énergie	établissements humains	femmes	finance
forêt	gouvernance mondiale	îles	industrie	information	institutions
intégration	jeunes	montagne	océans	Ozone	ONG
pauvreté	santé	science	scientifiques	syndicats	techniques
tourisme	toxiques	transports			

Fig. 14.3 The definition of sustainability on the Agora 21 website

14.5 The *Zeugma* between Tradition and Methodology

These observations could suggest that there is no coherence or rationality in the perspective that the CMSD draws about the social implications of scientific knowledge. I suggest a rather different conclusion. The rationality that is claimed is not a problematic but a procedural one.

There does exist a kind of science of sustainable development, or at least a specialized knowledge about it. It relies on three main resources:

- The ability to display information of any nature, which must be considered as a technical competence.
- The grounding of the action on a doctrinal corpus that must be constantly reaffirmed.
- The development of a sophisticated methodology, based on procedures, cooperation scenarios and indicators.

In a very amazing way, this kind of discourse has some close similarities to that of clerical organizations. Frequent quotation and reference plays a decisive role in the affirmation of expertise. The tridimensional diagram of the CMSD, on the one hand, and the founders' discourses, on the other, are constantly reaffirmed. They are the fixed point, in reference to which any action and any methodological device must be evaluated. Compagnon (1979) defined 'tradition' as this form of quotation of sacred texts: the commentary is always necessary, but always dependent and inferior, compared to the original texts. This is very characteristic of the sustainability projects.

However, this anchorage on a corpus of original texts (the Bruntland Report, the Rio agenda, etc.) does not lead to an eye-opening initiatory personal journey, as it does in traditional philosophies; it conveys the solid frame that a methodology needs to be completely rational. The experts on the bearable, on the viable and on the equitable are rarely a single, isolated individual: the expert is a collective organization, structured as a scientific institute (and often called that), which is able to guarantee the neutrality of a stance and the efficiency of procedures. In that universe of design where any knowledge is supposed to show operationality and to be translated into effectiveness, the permanence of principles does not guarantee anything other than the clarity of criteria.

14.5.1 Writing Devices as Management Sciences

To pursue this hypothesis, it is necessary to analyse the changes that stylistic patterns have to undergo when they travel from the rhetorical universe of ecologist action to the procedural frame of sustainability. This is not a purely stylistic question: it embodies the norms of rationality and validity of knowledge. In the context of our collective research about environmental communication (D'Almeida et al. 2004), we could make a comparison between contemporary documents and older ones. The change from political ecology to positive action for sustainability was not only detectable in the contents of the documents. It was visible in the semiotic patterns, in the formal and visual structures of the exposed information. We could then summarize that transformation in global trends:

Ecological culture		Sustainable development format
Relief of iconic signs	→→→→→→	Discrete symbols
Set of emblems	→→→→→→	Recurrent frames
Picturesque	→→→→→→	Structural
Friendly logic	→→→→→→	Transcendent logic

Political ecology created a very rich but also rather heterogeneous iconic universe. It privileges an archetypal or even a stereotypical representation of nature. It evokes picturesque scenarios. To make a long story short, it is the public affirmation of singularities: the non-replaceable richness of natural elements, the personal experience of them, the claim of an attachment to the past.

The survey of a wide range of productions on the web reveals a regression of this iconic and traditional material. However, what we observe is not a disappearance of images but the development of another kind of imagery. The formal frame of the CMSD imposes the equivalence of every approach. It is a map of any possible knowledge: a full, global and symmetrical organization of the objects of world, history and society. The graphic design gives a coloured body to the meta-epistemic claim. All the objects, the values and the knowledge fields that are linked to different historical process and inhabited by different interests are now *summarized*, *situated* and *enclosed*. They become a part (an optional part) of a global epistemic world, characterized by a set of complementary goals and efficient regulations.

This is particularly visible in some naive expressions in the corporate documents of some firms where the methodologies of consulting on sustainability were strictly applied, such as those on the website of the French retailer Monoprix (Fig. 14.4). The diagram becomes 'business science', to use the expression adopted by Pinto (1987). The different fields of activity and knowledge are linked together by a typological conception of social and natural objects. This topography is naturalized as something you can represent, manipulate, and fit together like puzzle pieces.

In other contexts, the schematic visualization expresses the control of a complex process of operations: for example, in the toolkits of different methodologies (Fig. 14.5).

As we can see, 'sustainability science' can be defined as a new field of science, but also as a metascientific knowledge. This ambiguity is well expressed by the international campaign for a Nobel Prize in Sustainable development.[1] The proposal is to either create such a prize or to transform the Nobel Prize for Economics into a Sustainability Prize.

14.5.2 A Consensus about Management Skills?

But there is another way to analyse the specificity of this field of knowledge and communication. It is to consider that some stereotypical elements of scientific methods are used to define a practical view on political issues. A semiotic analysis

[1] http://www.sustainableprize.net

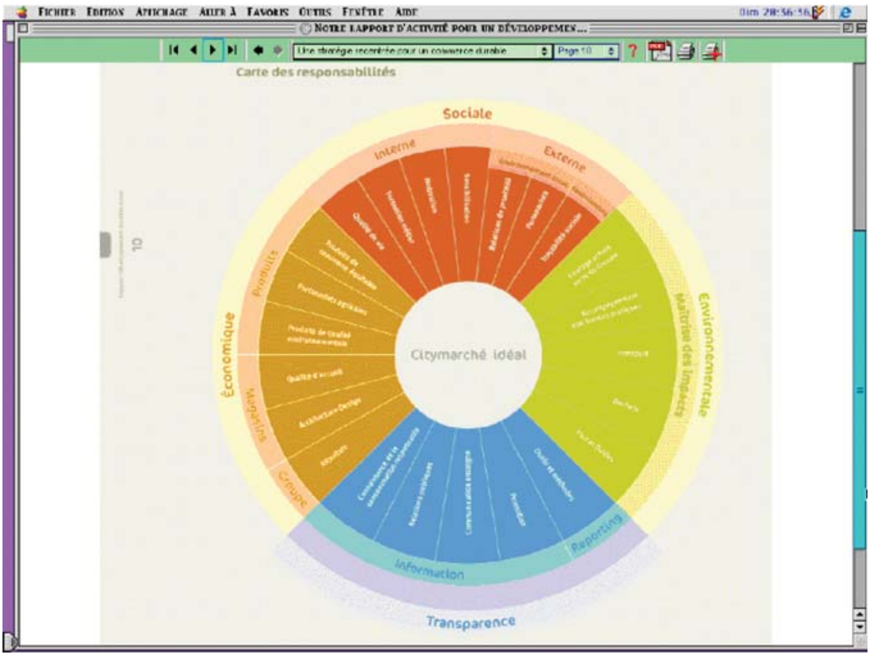

Fig. 14.4 From the Monoprix website

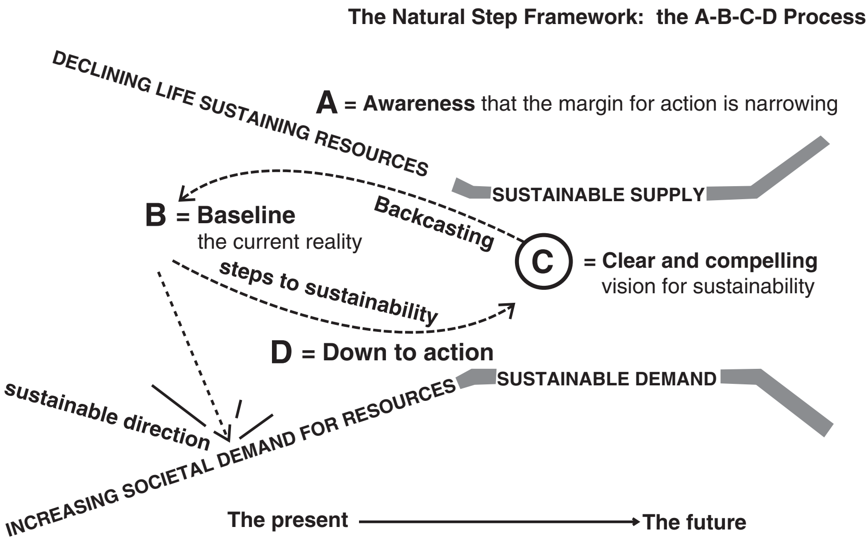

Fig. 14.5 *The Natural Step* framework

of the formal patterns of communication can guide us. The patterns reveal very clearly that the CMSD does not only organize the subjects of knowledge, but develops a form of control over the way knowledge is produced.

If we follow this path, the initial question of ‘science communication in social context’ can be enlarged. The point is not only the way communication on sustainability treats the knowledge produced in the different disciplines. It is the way some scientific patterns of communication take part (or are supposed to take part) in the public debate on political issues. Two examples are the status of or procedural approaches to decision making, and the crucial role of indicators in the public debate.

The *procedural* approach is more and more prevalent in politics. In such a political paradigm, often called ‘governance’, the legitimacy of a decision is not grounded mainly in its nature, but in the process of its elaboration, which is supposed to involve all the ‘stakeholders’. From a theoretical point of view, this conception of politics can be understood as an axiology of dialogue: it is the reason why discussion ethics, as developed by Habermas (1981), is a major influence in this field. But many researchers and observers have remarked that, far from being a normative and ideal conception of communicative action, it was rapidly implicated in a kind of ‘social technology’, to use another important concept of Habermas.

The purpose is to determine, specify and normalize the conditions of dialogue, the scenarios of interaction, and even the nature of the arguments that can be used by different actors. This technical project poses many problems. One is the limitation that such a procedural pattern imposes on conflicting ideas, sensible and testimonial expression, and popular representations. Another is that such an official representation of the processes of argument hides most of the real social communication. The point here is not to engage in this controversy, but we can bear in mind something important from it. As soon as scientists from the social sciences, such as sociologists or linguists, analyse the situations created by the procedural approach to sustainability, the objectivity of the schematic procedures vanishes. The reason for this phenomenon is clear: the procedural approaches rely on a scientific or, rather, a rational model, which is adapted to the management of technical projects. The relevance of such a conception of science is rather problematic *from a scientific point of view* (that is, from the viewpoint of the sciences that study politics, society and communication).

One of the major activities of people who manage the CMSD is the production of *indicators* of sustainability. This activity is shared among a great number of different structures, and it is a profitable business for some of them. The most spectacular example is the elaboration of the international ‘Indicators of sustainable development’ by a team of experts constituted by the Commission on Sustainable Development of the United Nations (the CD Work Programme)—a structure postulated by Agenda 21. The commission is entirely structured according to scientific models of actions, from its principles to its organization. The first lines of one of its reports expose in very explicit terms a conception of what a scientific method can be:

> Indicators can provide crucial guidance for decision making in a variety of ways. They can translate physical and social science knowledge into manageable units of information that can facilitate the decision-making process. They can help us to measure and calibrate progress towards sustainable development goals.

This principle is enacted not only in the uses of indicators, but in the way they are elaborated. To bring out measurable indicators, the commission adopts an extremely rational and explicit method: constitution of an expert group, production of methodology sheets, sessions of training, test sequences, and so on.

The different knowledge elements implicated by these technical tools are not really scientific methods, in the sense we usually give to this term; nor are they *a new science*. They resort to the methodology of management and human resources. Some of the traditional properties of science are present in these procedures: objects are measurable and ordered, propositions are explicit, processes are organized in sequences, operations can be visualized in a rational representation. Those 'knowledge tools' (which are offered in e-learning) share another property with the universe of management skills: they are not only instruments of knowledge. They link together three universes: the epistemic one (knowledge), the technical one (efficiency) and the practical one (choice).

On can wonder why ecologist activists, who are fond of verbal confrontation and conflicts, have been led to accept such a dominance of the rationality model of management skills. The most likely explanation is that they were convinced by the principle of the International Institute for Sustainable Development: 'to seek compatibility of actions rather than commonality of views'. Another reason is that, in a social context in which communication agencies have perfectly integrated 'greenwash' as a justification for business, the new activists consider the reporting on indicators as a way to impose real commitments on firms. Either way, the technical tool of indicators is supposed to oppose the lightness of words with the weight of facts.

We cannot answer that question here, but it shows the very complex relationship that has been established between the evolution of the political norms of communication, the legitimacy of different kinds of knowledge, and the conception of scientific and technical patterns of rationality.

The field of sustainable development discourses is a very rich laboratory. In it, we can understand that the reference to science activities, science practices, science results and also—perhaps mainly—to science phantasms is omnipresent in our contemporary communicational universe.

References

Aïm, O. (2006). La transparence rendue visible. Médiations informatiques de l'écriture. *Communication & langages*, *147*, 31–45.

Aïm, O. & Jeanneret, Y. (2007). L'encyclopédie de la parole possible. Édition et scénographie politique sur l'internet. *Hermès*, *47*, 69–73.

Bruntland, G. H. (Ed.) (1987). *Our common future. The World Commission on Environment and Development*. Oxford: Oxford University Press.

Compagnon, A. (1979). *La seconde main ou le travail de la citation*. Paris: Seuil.

Comte A. (1844) *Discours sur l'esprit positif*. Paris: Carilian Goeury et Dalmont.

D'Almeida, N., De Cheveigné, S. & Jeanneret, Y. (Eds.) (2004). *La place des NTIC dans l'émergence, dans l'appropriation et dans le débat autour d'un objet environnemental*. Report of research programme. Concertation, décision, environnement. France: Ministry of Ecology and Sustainable Development.

Fabbri, P. (2003). *Elogio di Babele. Traduzioni, trasposizioni, trasmitazioni*. Rome: Metelmi.
Fontenelle, C. B. (1686). *Entretiens sur la pluralité des mondes*. Paris: Blageart.
Foucault, M. (1971). *L'ordre du discours*. Paris: Gallimard.
Gentes, A. (2003). Les enjeux de l'énonciation éditoriale et curatoriale. *Communication & langages*, *137*, 88–100.
Habermas, J. (1981). *Theorie des kommunikativen Handels*. Frankfurt: Suhrkamp Verlag.
Jacobi, D. & Schiele, B. (Eds.) (1988). *Vulgariser la science: le procès de l'ignorance*. Seyssel: Champ vallon.
Jeanneret, Y. (1994). *Écrire la science: formes et enjeux de la vulgarisation*. Paris: Presses universitaires de France.
Jurdant, B. (1973). Problèmes théoriques de la vulgarisation scientifique. Dissertation, University Louis Pasteur, Strasbourg.
Labelle, S. (2007). La ville écrite par 'la société de l'information'. Dissertation, Paris, Sorbonne, 2007.
Pinto, L. (1987). Graphique et science d'entreprise. *Actes de la recherche en sciences sociales, 1969*, 93–97.

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Chapter 15
In Search of Dialogue: Staging Science Communication in Consensus Conferences

Maja Horst(✉)

Abstract Controversies about science and technology are often understood as problems of poor communication between science and society. Based on the academic tradition of studies in the public understanding of science, the chapter identifies three different models for the communicative relationship between science and its publics (the model of diffusion, the model of deliberation and the model of negotiation). The author then applies those models to the specific science communication format of the consensus conference, propagated by the Danish Board of Technology. The chapter explores how divergent expectations about the outcome of specific consensus conferences can be elucidated with the help of the three models. Depending on which model the organizers and participants subscribe to, the objective of the conference can be to enhance scientific literacy, democratic legitimation or the mediation of individual preferences. If participants do not share the same expectations about the outcome, there will be ample scope for disappointment and frustration.

Keywords Communication models, consensus conferences, controversies, democracy, expertise, negotiation

Proliferating controversies about science and emerging technologies have sparked a renewed interest in the communicative relationship between science and its publics.[1] The expectation seems to be that, if science and the rest of society communicated more effectively with each other, it would be possible to settle or even avoid some of these controversies.

In this chapter, I discuss the role of consensus conferences as one method to improve communications, starting from the question, 'How are consensus conferences

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[1] I talk about *publics* rather than *society* in order to stress the communicative aspect. I use the plural to signal that the term does not necessarily imply a specific unified public.

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expected to improve the communicative relationship between science and its public'? It should be clear from the start that there is no unanimous agreement on the answer to this question. More importantly, there is no agreement on the problem itself. Whereas many scholars and practitioners will agree that communication is a means to improve the science–society relationship, there is abundant disagreement on what should be communicated and who should be doing the talking and listening.

I structure these disagreements through a short recapitulation of the way in which different scholars in the field of public understanding of science (PUS) and science communication have perceived the communicative relationship between science and its publics. The recapitulation leads to the identification of three different models for the relationship. Each model explains the controversies about science and technology (S&T) differently and suggests different communicative solutions.

I then turn to the specific communicative format of the participatory consensus conference, as it is shaped by the Danish Board of Technology. The format has been developed as a method for participatory technology assessment and has been used in 19 countries besides Denmark.[2] After a short introduction to the conference method, I discuss how the format has been used in different ways that reflect the features of the three models for science communication. The discussion considers how the roles of experts and laypeople, the establishment of credibility in communications and the effects of a consensus conference are evaluated differently according to the three models.

15.1 Theoretical Framework

Central to discussions about PUS is that the definitions of science and its publics have been contested and that it is therefore possible to identify at least three different explanations of how problems in the communicative relationship between science and its publics have led to controversies. Two explanations have their basis in the commonly accepted distinction between two traditions of research into PUS: the traditional or positivist tradition and the critical or interpretative tradition (Durant 1999, Miller 2001, Michael 2002). In view of reservations that have been raised about critical PUS, I argue that it is possible to distinguish a third explanation or perspective.

Central to this chapter is that the three perspectives imply three distinct conceptualizations of the communicative relationship between science and its publics, as well as three different interpretations of the cause of controversies.

15.1.1 Traditional PUS: Enhancing 'Scientific Literacy'

As Robert Logan has shown, there has been a long tradition of scholarly writings on how to improve the public understanding of science by the mass communication of

[2] Retrieved on 1 November 2007 from http://www.loka.org/TrackingConsensus.html

scientific knowledge (Logan 2001). Early writings in this tradition can be dated back to the beginning of the 20th century. The normative basis of these writings was a conviction that it would improve the lives of individuals as well as their ability to make rational political decisions if pedagogical efforts were made to heighten ordinary people's understanding of science. It is obvious that this programme was closely linked to a fundamental assumption that science is a factor in social progress.

A key term in this tradition is 'scientific literacy', although its precise meaning is somewhat contested. Durant (1993) lists three different interpretations, in which the public should:

- Know a lot of scientific facts.
- Know how science works (according to the official epistemological theories).
- Know how science *really* works (according to sociology of science).

Despite these differences, the notion of scientific literacy can be seen to indicate that the public needs to meet a certain standard of knowledge in order to deal with science. Thus the notion of scientific literacy brings the figure of authority and education clearly to the fore in science communication: it is within science that the standards are set for what the public ought to know. In this way, traditional PUS presents an asymmetrical outlook on the communicative relationship between science and its publics, in line with the so-called 'transmission' model in general communication theory (e.g. McQuail 1994). It allocates a privileged place to science and scientific knowledge, just as it perceives the public to be in need of information and education.

There is often an underlying assumption about knowledge being convincing in itself: if only people were better informed, they would see that the scientific understanding of the world is the most correct one. Consequently, controversies are often explained in terms of lack of information about science. If people are sceptical about science, that is a direct result of their lack of knowledge (Weigold 2001). Settling controversies is a matter of increasing the public understanding and acceptance of science through communication. If the public is sceptical, it needs to be informed, educated or otherwise made scientifically literate. This will provide it with an increased understanding. And not only will this make people lead healthier lives and become better democratic citizens, it will also make them feel more favourable towards science and scientific knowledge.

15.1.2 Critical PUS: Democratizing Science

Over the past decade, the traditional model of PUS has been the object of much criticism, in which critics have referred to it as a 'deficit' model (Irwin and Wynne 1996). What the critics point to is the authority assigned to science and the unquestioned presumption of the superiority of scientific knowledge on the subjects of how to live a healthy life and how to make rational political choices. This leads to the subsequent definition of communicative problems as a lack of understanding—a deficit on the part of the public. It was argued that science should not be treated as an unquestioned and automatically privileged sphere of society, but as one social activity among others. Similarly, the public should not be understood as an ignorant mass but as composed of locally situated groups with valuable interpretations of the way in which S&T is developed and employed in modern society (Kerr et al. 1998, Barns et al. 2000). These studies all stress that laypeople's accounts should be brought to influence policymaking, since the technology has far-reaching consequences for all members of society.

These perspectives can be seen as parts of a broad tendency within the sociology of risk and public policy to talk about a 'democratization' of science. That tendency has been reinforced by the reverberations of the publication of Ulrich Beck's *Risk society* (Beck 1992), and his call for science to assume responsibility and become reflexive. Using terms such as 'reflexive science' or 'citizen science', this call has gained wide support within the sociology of risk (Giddens 1990, Irwin 1995, Franklin 1998). It has thus reinforced a view of science as an activity that should ultimately be externally controlled. Science should be subject to political decisions made by societal institutions, instead of developing according to its own internal logic.

These diagnoses and problem definitions point to a different perception of the way in which communication can settle controversies (Joss 2002). Rather than being a medium for the diffusion of information, the communicative relationship between science and society should be a medium for democratic engagement and the exercise of control over scientific development. It is argued that ideals of equality and informed public debate are a precondition for creating socially sustainable public policies (Schwarz 1993, Weale 2001). Critical PUS therefore presents a different perception of the communicative relationship between science and its publics, in which the central issue becomes one of reaching agreement within a community through democratic dialogue. In this way, the communication process can be seen to be asymmetrical in the opposite way to the first model. In critical PUS, the problem is not that publics don't listen to scientists, but that scientists don't listen to publics.

15.1.3 A Third Perspective: Negotiated Credibility in Networks

During recent years, however, criticism of the established critical PUS has emerged, within which we might be able to identify a third model of the communicative relationship between science and publics (Locke 1999, Miller 2001, Irwin 2006). For example, Michael points to a tendency to romanticize the public within critical PUS and depict laypeople as a homogenous entity, without any sensitivity to internal differences and conflict (Michael 2001). In opposition to this image, Irwin and Michael conceptualise the relationships between science and the rest of culture in terms of a network, or *rhizome,* which stresses discontinuity, fractures and non-linearity (Irwin and Michael 2003). This image has important consequences for the notion of science and publics (or society) as distinct spheres. As Michael has put it, 'this imagery of the rhizome suggests that there is no easy differentiation between the expert and the popular, between the scientific and the lay' (Michael 2002: 370). What counts as science is therefore also a contested question and can only be defined in context.

The perception or understanding of science by 'the publics' should thus be seen in a broader cultural context in which the diversity of publics is recognized and connections to other cultural influences and dynamics are given due consideration. Michael suggests that 'perhaps chief among such dynamics is the globalized rise of consumption' (Michael 2002: 369). Michael has elaborated on this figure of consumption as central to the meaning of PUS by emphasizing a shift from the role of citizen to the role of consumer. Members of the public are increasingly 'voting with their purchasing choices to make concerted efforts to influence policymaking' (Michael 1998: 320). Miller points in the same direction when he states that 'people will pick up the knowledge they need for the task at hand, use it as required, and then put it down again' (Miller 2001: 118).

These examples develop a notion in which the communicative relationship between science and its publics is best understood in terms of contextual networks of negotiations over usability, credibility and influence. Publics are temporal constructions of users of scientific knowledge with a plurality of ways of evaluating that knowledge, motivated by individual experiences of their own particular needs. They cannot be viewed as a coordinated community with something in common, such as a wish for the common good, or some kind of consensus. Rather, negotiations over credibility become of central importance, as socially robust knowledge is created through association (Nowotny et al. 2001).

In this perception, the relations between science and its publics are diverse, just as neither 'science' nor 'public' can be universally defined; rather, these phenomena are contextual constructs dependent on their mutual relations. This model has a distinct view of the evaluation of scientific knowledge, since robust knowledge is not identified by authority or by deliberation. Instead, credibility and negotiation are crucial in any evaluation, as robustness is determined by exploring which knowledge claims can gain most support in the form of allies, votes, or both. On the other hand, this means that public opinion is presented as volatile and heterogeneous, with different and contextual standards of usability.

15.1.4 Three Models for Science Communication

These different traditions within PUS can be seen to give rise to three different models for the communicative relationship between science and its publics, as well as three different analytical interpretations of public controversies as social phenomena. Figure 15.1 shows the crucial features of each of the models for the explanation of controversies.

Following traditional PUS, the most important feature of the communication between science and society is that it can be viewed as a means of disseminating information about science and scientific knowledge to the public. Consequently,

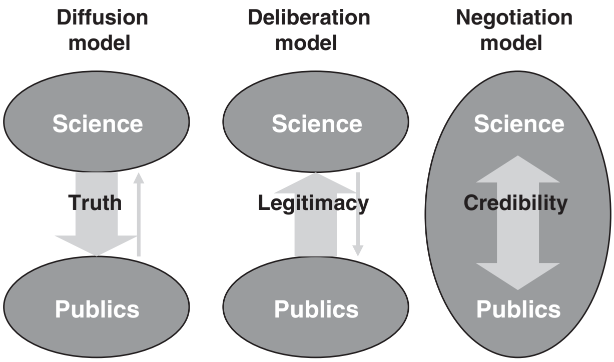

Fig. 15.1 Three models of science communication

controversies are seen in the *model of diffusion* as instances where the diffusion of information has gone wrong: laypeople have not got the message right, either because the information has been distorted or because they have not been presented with the message at all. This can make feedback processes necessary in order to understand why the public does not understand the information, but the fundamental idea in the diffusion model is that controversies arise as a result of badly conducted processes of diffusion of information and knowledge.

In critical PUS, the problem is not that the public does not listen to science, but that science does not listen to the public. In the *model of deliberation*, controversies are signs of scepticism and revolt because the sciences and their publics have become alienated from each other. Although scientific openness about progress and problems is seen as a necessary precondition for diminishing that alienation, the main task is to secure legitimacy through deliberative dialogue and democratic control over science. The direction of information is therefore basically *from* the public *towards* science, since it is science that is supposed to know and follow the consensus, which has been created in the public to serve as the basis for legitimate knowledge creation.

In the *model of negotiation*, controversies are seen as struggles in the constant negotiation over the development of technology and the changing and relational definitions of 'science' and 'publics'. The model stresses heterogeneity and adversarial mutuality, and views controversies neither as instances of badly conducted diffusions of technology nor as indisputable, normative calls to democratize science. Rather, it views them as integrated and normal features of the mutual constitution of both science and publics. Solving controversies in this model is therefore a question of reaching a provisional closure of a distribution of credibility, but that distribution will probably just lead to new controversies.

Viewed in this way, these different models can be understood as three different sets of expectations about the function of communication between science and its publics, each of which stresses different aspects. The identification of these three models is not intended to lead to a judgement about what is better or worse, but rather to a sensitivity to the implications for specific organizations of consensus conferences or other participatory exercises, as I discuss in the following sections.

15.2 Consensus Conferences

A participatory consensus conference, as developed by the Danish Board of Technology, is a meeting between experts and laypeople to discuss and evaluate a particular potentially controversial technology (Andersen and Jæger 1999). A panel of citizens without specific technical training in the field is presented with various forms of expert testimony, which enable the panel to deliberate to create a mutual consensus statement about the issue at hand (Grundahl 1995, Klüwer 1995). The consensus statement is then presented to policymakers, experts and the general public to enrich and broaden technological debate.[3] The topic has to be chosen carefully, taking into account timeliness, controversy and focus. In the Danish Board of Technology's experience, 'a good conference topic is: of current interest; requires expert knowledge, which is also available; is possible to delimit; and involves conflicts and unresolved issues regarding attitudes to questions such as applications and regulation' (Andersen and Jæger 1999: 334).

A planning/steering group is in charge of organizing the conference, including the fair selection of lay panel members and experts. The lay panel, with around 16 members, is chosen by soliciting applications from a representative sample of the general population. The panel is ideally composed to balance age, gender, education, occupation and geographical location and has a professional moderator, who also chairs the public parts of the conference. The panel members should be interested in the topic of the conference, but not have a personal or professional vested interest. The panel receives written information about the subject and the panel members meet for two preparatory weekends before the conference to prepare themselves for the discussion of the subject, including by preparing questions they want experts to answer. Experts are found by the organizers according to the questions prepared by the lay panel.

The conference itself runs over four days, with the first 1½ days used for expert statements and cross-examination of the experts by the lay panel. This part of the conference is open to the public and the media. After this, the lay panel and its moderator withdraw to write the consensus statement. On the fourth day, the consensus statement is read out to the public. Experts can suggest corrections to factual mistakes, but otherwise the statement cannot be changed. A panel of politicians is subsequently asked to comment on the statement, and it is also possible for members of the public audience to comment.

Einsiedel and Eastlick (2000) have discussed the way in which deliberation is based upon dialogue, which allows for meaning-making and reasoning. In this sense, communication is a constitutive feature of deliberation in a consensus conference, but many other forms of communication are central. Experts communicate their factual knowledge to non-experts, and lay panel members communicate among themselves to reach an understanding of the issues at stake and to write the

[3] See also http://www.tekno.dk/subpage.php3?article=468&toppic=kategori12&language=uk (retrieved on 19 October 2007).

consensus report, which is subsequently communicated to an audience of experts, policymakers, mass media and a wider public. Conference organizers communicate the objectives of the conference to stakeholders, and communicate about the procedural rules of the conference to the participants. In this way, communication is to a large degree the 'stuff' that the conference is made of—both in terms of handling the topic and the conference process itself. Externally, the conference can be viewed as a communicative tool in several ways: as a means to disseminate expert knowledge through lay opinion leaders; as a tool for citizens to communicate their preferences to experts, policymakers or each other; or as an event that focuses societal communication (via mass media and political attention) on a particular set of controversial issues.

As a Danish university researcher, I have been actively involved in three consensus conferences[4] and present in the audience of several more. On the one hand, it is my general impression that most participants are positive about the format of the conferences. On the other hand, I have found it very interesting that there are usually always some participants who criticise the exercise for being 'bad communication' in some way.

I believe that such criticism has its roots in divergent expectations about the outcome of the consensus conference, and that the divergence can be elucidated with the help of the three models of the communicative relationship introduced in this chapter. It makes a crucial difference whether the conference is seen as a tool for informing citizens about the current scientific knowledge (panel members as well as wider publics), as a means for citizens to engage in democratic dialogue about how science should be regulated according to commonly shared values, or as an opportunity for citizens to voice their political and scientific consumer choices. Basic expectations about the event shape the way it will be evaluated, and the heterogeneity of those expectations is likely to produce dissatisfaction with the outcome.

I do not argue for the refinement of the consensus conference as a communication product so that it can be used to fulfil the expectations of one or other of the three models. Rather than choosing one model as being normatively superior, I work from the premise that they are all in play, and that if we want to understand how the consensus conference works as a communicative event, we need to use them all to gain as full an understanding as possible. In the following sections, I analyse the way consensus conferences have been used for communication purposes according to each of the three models. The analysis aims to demonstrate the productive use of the conference format, but also stresses the inherent tensions and challenges between the format and the three different communication models.

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[4] In 1996, I was a member of the questioning panel in the Danish medical consensus conference on prevention of lifestyle diseases (which was not organized by the Danish Board of Technology). In 2002, I was a member of the steering group as well as an expert witness in the consensus conference on genetic testing, and in 2006 I served as expert in the consensus conference on brain science.

15.2.1 The Diffusion Model

Since the use of participatory consensus conferences has been promoted as part of the deliberative model and its criticism of traditional PUS, it might seem odd to start the discussion with examples of how consensus conferences can be used within a diffusion model. Nevertheless, diffusion of knowledge is an important part of many consensus conferences and has been the primary goal in a number of cases, for example the conferences on GMOs in France (1998) and New Zealand (2003) (Goven 2003, Nielsen et al. 2007).

The rationales for using the consensus conference format for educational purposes can be many. For example, it is obvious that the intensive learning process and the interaction between experts and laypeople can be seen as a way of improving feedback mechanisms so that experts will be able to shape their messages according to the specific needs of the audience.

However, it is necessary for organizers to remind themselves that there is no causal relationship between knowledge and opinions about science. This became clear for the organizers of the conference in New Zealand, who were operating from a distinct educational model and had a clear expectation that dissemination of more knowledge about biotechnology would lead to its greater acceptance among the lay panel (Goven 2003). This expectation was not met, demonstrating that educational efforts do not always produce a particular type of learning.

Guston (1999) has expanded on the topic of learning in an analysis of the US Citizens' Panel on Telecommunications. He observes that citizens were learning about the substantive issues of telecommunications but also about their general role as citizens because of the processual experience of the conference. He also notes that the experts were positively surprised about the citizens' substantive learning and their deliberative capabilities, so it is fair to say that the experts were also learning about the function of citizenship in relation to S&T governance. Wakamatsu (1999), Skorupinski et al. (2007) and Einsiedel and Eastlick (2000) report in similar ways on citizens' conferences in Japan, Switzerland and Canada. This suggests that the learning potential inherent in the consensus conference format can be considered important in different cultures, although the content of the learning processes might be uncontrollable and point in different directions.

An important issue in the educational use of consensus conferences is the composition of the expert panel. Agersnap et al. (1984) write about two different types: the neutral expert and the positioned expert. In the first type, the expert panel should be composed so as to cover the relevant areas of expertise, and the main communication issue for the expert is to explain without compromising scientific standards. This composition, however, could easily make controversy seem to disappear.

In the second type, the panel is composed of experts who represent particular positions or viewpoints, so the organizers have to ensure that they have included all relevant positions in the panel. The experts are expected to be more focused on persuasiveness, rhetorical capability and skills of argument in their statements, compared to a panel of neutral experts. In this context, how the role of the expert is understood and how the credibility of their expertise is established become crucially important. A quick reminder of Aristotelian rhetoric can be useful here. According to Aristotle, speakers' ethos or credibility is evaluated by the audience according to their perceived intelligence and knowledge about the subject, their general moral standing and their perceived attitude towards the audience.

A few examples from the literature can be used to demonstrate that the credibility of experts is evaluated by more than merely the factual content of their statements. In an analysis of the 1994 UK consensus conference on plant biotechnology, Purdue (1999) finds that the perceived credibility of experts was very much influenced by the way laypeople perceived the experts' interests in the field, and that profit motives in particular seemed to create distrust. Another example is Blok's analysis of the Danish consensus conference on the use of environmental economics in 2003. Here, the experts' apparent ability to take laypeople's concerns seriously was a decisive factor in what Blok calls the 'credibility economy' (Blok 2007). These examples demonstrate how the general moral *habitus* of the expert, as well as their perceived attitude towards laypeople, will have an important effect on their credibility.

It has been a specific goal in many consensus conferences to broaden the reach of the debates by diffusing the conference proceedings and the consensus statement through the media. Several analysts have commented on the degree to which particular conferences succeeded in getting media attention (Guston 1999, Einsiedel et al. 2001, Seifert 2006). It is not easy to compare these assessments, since they are dependent both on national systems of mass media and political communication and on the expectations of the individual analysts. Is any given number of newspaper articles 'poor' or 'generous' coverage?

However, it is interesting that dissemination to non-participants is often thought of as equivalent to securing media coverage, despite the fact that communication scholars have demonstrated that media coverage is no guarantee that anybody has learned anything in the long run. Among organizers of consensus conferences, it is difficult to find extended reflections on the use of mass media to disseminate the outcomes. It therefore seems that this part of the communication is guided by a rather traditional transmission model, in which communication is just a matter of 'getting the story in the media'. What this is supposed to achieve, and how, is less clear.

Seifert (2006) points to an interesting dilemma concerning media attention to the Austrian consensus conference on the use of genetic data. Because the conference was an experiment and organizers were eager to prove that the format would work, they chose subject matter that was rather uncontroversial, hoping that it would be possible for the citizens' panel to produce a consensus statement. The lack of controversy, however, meant that the mass media were not very interested in the event, and Seifert therefore concludes that the price of harmony in this case was insignificance.

It is possible to point to several cases where communication processes at consensus conferences were guided by a form of the diffusion model. The central idea was that controversies were expected to be solved through some form of education of the sceptical laypeople, facilitated by the conference format. The specific examples, however, also demonstrate that it is not so easy to control the diffusion process, and that many forms of learning can occur as a result of the consensus conference format.

Key questions include: Who decides what it is desirable to learn? How is the role of the expert configured? And how are the media used to diffuse outcomes of the consensus conference to wider publics?

15.2.2 The Deliberative Model

On a basic level, the growth of participatory consensus conferences can be understood as part of the general trend towards deliberative democracy in S&T governance (Joss 1999). Organizers, evaluators and analysts often make explicit reference to the deliberative model. However, this does not mean that the communication processes and outcomes of a consensus conference are simple and straightforward when viewed from the perspective of this model. For example, procedural standards of fairness and competence are crucial requirements for new participatory processes (Webler and Tuler 2002), but claims about procedural (un)fairness and accusations of manipulation and bias seem to be an integral element of participatory exercises such as consensus conferences (Horst et al. 2007). In this section, I will focus explicitly on issues of representation and influence in relation to the communication process of the consensus conference.

Ideally, a consensus conference is an opportunity for members of the public to form an opinion on how S&T should be developed and employed in society. But who are the people who can function as laypeople? Is it possible for them to represent 'a public', and, if so, how? As an example, Purdue notes that the organizers of the first UK conference chose to understand 'laypeople' not just as non-experts but also as people who had 'no hard position for or against'. This choice left large groups of actors in a grey field between 'lay' and 'expert'. It also positioned the laypeople in a type of 'innocent position' from which it was hard for them to challenge experts, and Purdue argues that this whole construction of 'lay' induced an 'undue deference to experts' (Purdue 1999: 88). Purdue further observes that the organizers of the conference implied that the voice of the 'real public' was heard in the conference report, in opposition to the 'spurious representations of "public opinion" generated by fevered activists'. Questions about representation are common in participatory exercises (Hagendijk et al. 2005), and raise a number of issues: Can the lay panel represent more than themselves? Should lay members 'innocently' represent a form of neutrality towards the subject of the conference? If the lay panel is supposed to represent commonly held values in the general population, how do we know whether its members are representative?

A crucial issue for organizers and analysts who subscribe to the deliberative model is whether, in practice, consensus conferences influence policymaking. Einsiedel et al. (2001) find that none of the three consensus conferences on food biotechnology in Denmark, Canada and Australia in 1999 had direct impact on political decision-making. However, those authors do not take this to be a failure of the model. Instead, they argue that ongoing experiments with consensus conferences should be seen as a kind of learning experience for society at large:

> As lay publics bring in their ways of defining issues, their experiences and their values to these deliberative approaches, such processes 'de-monopolize expertise' and recognize that ordinary people are intrinsically part of the technological project. (Einsiedel et al. 2001)

In this view, it is not the substantive outcomes in the consensus report that are the main achievement, but rather the event itself. Giving voice to citizens and demonstrating that they can take part in discursive negotiations about S&T governance is the main gain for society, demonstrated by the example of the consensus conference rather than by arguments put forward by deliberative theorists.

Nielsen et al. (2007) are sceptical about this conclusion and argue that the way in which this message (about deliberation) will be interpreted is heavily dependent on the political context in which it appears. Whether the message of a consensus conference is the ability of citizens to deliberate meaningfully depends on the dominant model of democratic legitimacy in the country in which the conference takes place. Whereas the Norwegian conference on GMOs is seen to establish an access to information about the 'shared norms, values, and concerns of the national community', the French conference was seen to allow laypeople a 'rare glimpse of the workings of Parliament' (Nielsen et al. 2007: 29). The Norwegian example can be seen to be rooted in the deliberative model, while French example also draws heavily on the dissemination model, but both exemplify situations in which deliberation is seen as a way of getting access to otherwise inaccessible information.

Direct political influence, however, is not always a stated objective of conferences. Often the exercises have been introduced as a form of experiment and have not been formally linked to the political system. Despite this lack of objective influence, it seems that participants will be disappointed if they discover that their efforts have no direct political impact, as the example of the US citizens' panel on telecommunications demonstrates (Guston 1999). If participants have spent a lot of effort in producing a statement on the regulation of complex issues, they will find it disheartening if regulators do not listen. In Western democracies, the public sphere is seen to be the legitimate source of political opinions and there is an expectation that politicians should be listening to what goes on in that sphere (Habermas 1991). It is worth considering whether the citizens' learning experience discussed above will not seem less valuable to participants if they experience a lack of recognition from policymakers, even if the experimental nature of the exercise has been clear from the outset.

The consensus conference format is primarily conceived within the deliberative model of science communication, and the general expectation is that the conference allows a public to engage in democratic dialogue about the preferred solution to controversies over science and emerging technology. The empirical examples, however, demonstrate that there is plenty of room for divergent expectations about the specific function and the communicative outcomes of a consensus conference when viewed from the perspective of this model. Central questions include: How to organise a process that all parties experience as fair? Should the laypeople represent more than themselves, and what is the basis for such a form of representation? How is the consensus conference seen to influence policy processes, and what are the consequences if no such influence can be detected?

15.2.3 The Model of Negotiation

Since the model of negotiation does not draw upon a well-established tradition in the study of PUS, as do the other two models, it is not possible to identify examples of consensus conferences that have been organized from this perspective in the way we can for the diffusion and deliberative models. Tracking through the literature on consensus conferences, however, it is possible to find examples of consensus conferences that have similarities to the model of negotiation, with its focus on negotiations about credibility between different actors with different types of interests.

In an analysis of a Danish participatory exercise in 2002 (about electronic patient records) that was similar to a consensus conference, Jensen argues that the process was very well designed for social and practical learning, but that the need to produce a consensus statement homogenized the content of deliberations in ways that were counterproductive to 'exploring and learning from multiple viewpoints' (Jensen 2005: 233). In this way, Jensen argues that the heterogeneity and diversity of viewpoints is the most important feature of consensus conferences, and that the 'incompatibilities and contradictions [in and between the positions of citizens and experts] must remain open for renegotiation'.

This analysis corresponds to the findings of Hagendijk et al., who argue that the role of the Danish Board of Technology:

> …has changed from being primarily a political advisory body to be a mediating institution. Its role is to facilitate and assess how new technologies may translate in specific contexts of human practice and decision making. In this way the Board still fulfils an important technical–practical role as a 'switchboard' used both by national/local government and industry in 'testing' controversial technological innovations. (Hagendijk et al. 2005: 50)

The mediating consultancy role ascribed to the board points to a focus on negotiation between interested parties.

In Taiwan, a consensus conference has been used to solicit information on social expectations about a profession and its professional domain (Lin et al. 2007), which demonstrates that it is possible to use the format in much the same way as political parties use focus groups to gauge values and preferences among voters in an electorate.

An interesting example of the focus on negotiated outcomes is found in Nishizawa's analysis of the Japanese consensus conference on GM crops in 2000. The conference was generously funded by the government but had a relatively restricted goal of identifying possible research topics, without the government in any way committing itself to incorporate the results of the consensus deliberations into policymaking. The lay report was characterized by relatively subtle scepticism. Through interviews with the panel members, Nishizawa finds that this was due to a very deliberate strategy of the panel. Happy about the invitation to participate in deliberative democracy funded by the government, the panel was afraid that the 'shell which had started to open after many years would close' (Nishizawa 2005: 483) if they insisted on a total ban on GMOs. The panel therefore chose to politely suggest moderate changes, rather than be seen to be too extreme and thereby jeopardize future experiments with participatory exercises. I find this a striking example of strategic communication, in which the message of the consensus report and the message of the conference at large are completely intertwined. It also reminds us that there are always several levels at which we can understand consensus conferences as communicative events.

In this perception of the consensus conference as a medium for negotiations between different parties, the identification of scientifically sound and socially robust knowledge seems to be more contextually bound than in the other two models. Socially robust knowledge is that which gains credibility during the process. Following this argument, science itself is also a much more openly contested construct. It is not possible to determine a priori or in any universal way what is to count as scientific; rather, this is a matter of context and concrete negotiations.

Viewed from the model of negotiation, a consensus conference can be seen as a way of using controversy and contestation to learn about individual consumer choices and the profile of preferences in a given sample of stakeholders, with the aim of making scientific knowledge and emerging technologies more robust and viable. Consequently, it should not be evaluated according to its educational performance or its democratic impact. Instead, the point is whether it produces new insights, relevant to the stakeholders, into a given scientific or technological subject. A crucial question is therefore whether all relevant parties have been included in the mediation process and whether the conference format supports a fruitful exchange.

15.3 Conclusion

Consensus conferences can be employed to serve different communicative objectives. Depending on which model for science communication the organizers and participants subscribe to, the objective can be to enhance education and scientific literacy, democratic legitimation or the mediation of individual preferences. None of these objectives is wrong in itself, but there is ample scope for disappointment and frustration if participants and organizers do not share the same expectations about the outcome of a given conference.

The large interpretative flexibility in the use of consensus conferences might therefore need to be narrowed when it comes to the organization of specific conferences, in order to manage the expectations of participants and prevent discontent and disillusionment. On a more general note, however, the format's interpretative flexibility might be the reason for its apparent success.

The support for experiments in 20 countries all over the world might very well stem from the fact that it is possible to see consensus conferences as a solution to controversies in all three of the identified models for science communication.

References

Agersnap, T., Jakobsen, G. & Kempinski, J. (1984). *Konsensuskonferencer i Danmark*. Copenhagen: Dansk Sygehus Institut.

Andersen, I.-E. & Jæger, B. (1999). Danish participatory models. Scenario workshops and consensus conferences: towards more democratic decision-making. *Science and Public Policy*, *5*, 331–340.

Barns, I., Schibeci, R., Davison, A. & Shaw, R. (2000). What do you think about genetic medicine? Facilitating sociable public discourse on developments in the new genetics. *Science, Technology and Human Values*, *3*, 283–308.

Beck, U. (1992). *Risk society*. London: Sage Publications.

Blok, A. (2007). Experts on public trial: On democratizing expertise through a Danish consensus conference. *Public Understanding of Science*, *2*, 163–182.

Durant, J. (1993). What is scientific literacy? In J. Durant & J. Gregory (Eds.), *Science and culture in Europe*. London: Science Museum, 129–137.

Durant, J. (1999). Participatory technology assessment and the democratic model of the public understanding of science. *Science and Public Policy*, *5*, 313–319.

Einsiedel, E. F. & Eastlick, D. L. (2000). Consensus conferences as deliberative democracy. *Science Communication*, *4*, 323–343.

Einsiedel, E. F., Jelsøe, E. & Breck, T. (2001). Publics at the technology table: The consensus conference in Denmark, Canada, and Australia. *Public Understanding of Science*, *1*, 83–98.

Franklin, J. (1998). *The politics of risk society*. Cambridge: Polity Press.

Giddens, A. (1990). *Modernitetens konsekvenser*. Cambridge: Hans Reitzels Forlag.

Goven, J. (2003). Deploying the consensus conference in New Zealand: Democracy and de-problematization. *Public Understanding of Science*, *12(4)*, 423–440.

Grundahl, J. (1995). The Danish consensus conference model. In S. Joss. & J. Durant (Eds.), *Public participation in science: The role of consensus conferences in Europe*. London: Science Museum, 31–40.

Guston, D. H. (1999). Evaluating the first US consensus conference: The impact of the Citizens' Panel on Telecommunications and the Future of Democracy. *Science, Technology and Human Values*, *4*, 451–482.

Habermas, J. (1991). *The structural transformation of the public sphere—An inquiry into a category of bourgois society*. Cambridge: MIT Press.

Hagendijk, R., Healey, P., Horst, M. & Irwin, A. (2005). *STAGE: Science, technology and governance in Europe: Challenges of public engagement*. HPSE-CT2001–50003, European Commission. Available from www.stage-research.net/STAGE/content/reports.html

Horst, M., Irwin, A., Healey, P. & Hagendijk, R. (2007). European scientific governance in a global context: Resonances, implications and reflections. *IDS Bulletin*, *5,* 6–20.

Irwin, A. (1995). *Citizen science. A study of people, expertise and sustainable development*. London: Routledge.

Irwin, A. (2006). The politics of talk: Coming to terms with 'new' scientific governance. *Social Studies of Science*, *2*, 299–322.

Irwin, A. & Michael, M. (2003). *Science, social theory and public knowledge*. Maidenhead: Open University Press.

Irwin, A. & Wynne, B. (1996). *Misunderstanding science?* Cambridge: Press Syndicate of the University of Cambridge.

Jensen, C. B. (2005). Citizen projects and consensus-building at the Danish Board of Technology—On experiments in democracy. *Acta Sociologica*, *3*, 221–235.

Joss, S. (1999). Introduction. Public participation in science and technology policy and decision-making—Ephemeral phenomenon or lasting change? *Science and Public Policy*, *5*, 290–293.

Joss, S. (2002). Toward the public sphere—Reflections on the development of participatory technology assessment. *Bulletin of Science, Technology and Society*, *3*, 220–231.

Kerr, A., Cunningham-Burley, S. & Amos, A. (1998). Drawing the line: An analysis of lay people's discussions about the new genetics. *Public Understanding of Science*, *7(2)*, 113–133.

Klüwer, L. (1995). Consensus conferences at the Danish Board of Technology. In S. Joss & J. Durant (Eds.), *Public participation in science: The role of consensus conferences in Europe*. London: Science Museum, 41–49.

Lin, C.-F., Chiang, H.-H., Chung, C.-C., Lin, T.-L., Yin, T. J. C. & Yang, C.-M. (2007). Using a citizen consensus conference to revise the code of ethics for nurses in Taiwan. *Journal of Nursing Scholarship*, 39(*1*), 95–101.

Locke, S. (1999). Golem science and the public understanding of science: From deficit to dilemma. *Public Understanding of Science*, *8*, 75–92.

Logan, R. A. (2001). Science mass communication. *Science Communication*, *2*, 135–163.

McQuail, D. (1994). *Mass communication theory*. London: Sage Publications.

Michael, M. (1998). Between citizen and consumer: Multiplying the meanings of the 'public understandings of science'. *Public Understanding of Science*, *7*, 313–327.

Michael, M. (2001). Technoscientific bespoking: Animals, publics and the new genetics. *New Genetics and Society*, *3*, 205–224.

Michael, M. (2002). Comprehension, apprehension, prehension: Heterogeneity and the public understanding of science. *Science, Technology and Human Values*, *3*, 357–378.

Miller, S. (2001). Public understanding of science at the crossroads. *Public Understanding of Science*, *10(1)*, 115–120.

Nielsen, A. P., Lassen, J. & Sandøe, P. (2007). Democracy at its best? The consensus conference in a cross-national perspective. *Journal of Agricultural and Environmental Ethics*, *20(1)*, 13–35.

Nishizawa, M. (2005). Citizen deliberations on science and technology and their social environments: Case study on the Japanese consensus conference on GM crops. *Science and Public Policy*, *6*, 479–489.

Nowotny, H., Scott, P. & Gibbons, M. (2001). *Re-thinking science—Knowledge and the public in an age of uncertainty*. Cambridge: Polity Press.

Purdue, D. (1999). Experiments in the governance of biotechnology: A case study of the UK National Consensus Conference. *New Genetics and Society*, *1*, 79–99.

Schwarz, M. (1993). The technological culture: Challenges for technology assessment and policy. *Science and Public Policy*, *6*, 381–388.

Seifert, F. (2006). Local steps in an international career: A Danish-style consensus conference in Austria. *Public Understanding of Science*, *15(1)*, 73–88.

Skorupinski, B., Baranzke, H., Ingensiep, H. W. & Meinhardt, M. (2007). Consensus conferences—A case study: PubliForum in Switzerland with special respect to the role of lay persons and ethics. *Journal of Agricultural and Environmental Ethics*, *20(1)*, 37–52.

Wakamatsu, Y. (1999). A citizens' conference on gene therapy in Japan: a feasibility study of the consensus conference method in Japan. *AI and Society*, *13(1–2)*, 22–43.

Weale, A. (2001). Deliberative democracy. Science advice, democratic responsiveness and public policy. *Science and Public Policy*, *6*, 413–421.

Webler, T. & Tuler, S. (2002). Unlocking the puzzle of public participation. *Bulletin of Science, Technology and Society*, *3*, 179–189.

Weigold, M. F. (2001). Communicating science. *Science Communication*, *2*, 164–193.

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Chapter 16
So Where's the Theory? on the Relationship between Science Communication Practice and Research

Steve Miller(✉)

Abstract There has been little, if any, research looking at how well practical science communicators are connected with the relevant research literature. Indeed, there is little—if anything—written about who makes up the science communication community. This chapter reports on a short survey of attendees at the British Association for the Advancement of Science's 2007 Science Communication conference. The survey gives some indication of what science communicators have by way of training, and what they are reading that is relevant to their professional lives. It finds that the community is relatively young and predominantly female, with generally high levels of science education. Training in science communication is less prevalent, however, and over 40% of the conference delegates who responded did not read any of the relevant journals in the field. This chapter discusses whether there may be mutual misunderstanding between science communication practitioners and social scientists who carry out research in the area. It puts forward an example of the use of research on public perceptions of risk in science communication training.

Keywords Communicating risk, science communication, training

16.1 Introduction

Take any scientific subject—chemistry, genetics, physics, zoology—or social science, and the norm is that to practise it, you should have studied it. This is generally true of the arts and humanities. It is especially true of the more applied subjects—engineering, law and medicine—or we tend to hope that it is. The safety of our buildings and transport systems, the smooth working of our justice systems, and the soundness of our health rather depend on practitioners in the field having gone through a rigorous apprenticeship that usually involves coursework, exams and

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extensive on-the-job training. And in the world of academia, the leaders in the field are expected to be first-rate teachers and prolific and influential researchers.

But when we take the area covered by the Public Communication of Science and Technology (PCST) Network—variously known as public understanding of science, science and society, science communication, public engagement with science and technology (S&T), or whatever the current moniker might be—the rules get much more lax. People tend to drift into careers that are more or less associated with PCST. At the 'top' of the academic tree there are even professors of 'public understanding of science' or something similar who have carried out no research in the area; nor have they given a single lecture on the subject. Instead, they may have written some popular science books (or several versions of the same book) or run a science festival. And while one cannot imagine that a university of any standing would appoint someone with no research or teaching record as professor in molecular biology or civil engineering, or in modern languages or criminal law, where science communication is concerned, lack of peer-reviewed publications is—(too?) often—not an issue.

Twenty-something years ago, one might have argued that it did not matter or that it was inevitable. After all, public understanding of S&T was then a new field; the push to greater scientific literacy among 'ordinary' citizens was only just gathering new momentum after a hiatus of several post-war decades. To be sure, isolated groups of sociologists, and the odd historian or two, were interested in the public faces and the public's perceptions of science, but there was nothing to make up a corpus, such as would be understood by members of mature academic disciplines. And, anyway, there were no respectable outlets for research and little opportunity for teaching.

Today, however, the situation has moved on considerably. Courses at undergraduate, masters and doctoral level are to be found across Europe, even if they are not anything like as widespread as subjects like environmental studies and, nowadays, nanotechnology. Since 1992, there have been two peer-reviewed journals in the field—*Public Understanding of Science* and *Science Communication*—that publish research that one would have thought was highly relevant to those associated with PCST and similar networks and activities.

Yet the impression remains: on the one hand are the practitioners, often with a background in the natural sciences, medicine or engineering, who organise and take part in public engagement with science activities of one sort or another; on the other hand are the researchers, usually with a background in the social sciences or humanities, writing articles for the journals, aloof from the blood and sawdust of the science communication arena. And the two just do not talk to one another. Or is that so?

This outline is all based on anecdotal evidence. That does not make it wrong, but anecdotes are slippery, and those who base their arguments on them are likely to take a tumble when the winds of real evidence blow. To date, however, there is little solid ground on which to build up a picture of the relation between research into science communication and day-to-day practice. Attempts to bring the two elements closer together have, so far, not been unqualified successes (Stocklmayer et al. 2001, Miller 2003).

16.2 A Case Study: the UK Science Communication Conference

So, what does the science communication community look like, what does it know, and what intellectual resources does it make use of?

To ask that question is to raise another: how does one define the 'science communication community'? For the purposes of starting somewhere—anywhere—this chapter defines it pragmatically and operationally, by means of a small case study of participants in the annual Science Communication conference (organized by the British Association and the Royal Society) in London on 14 and 15 May 2007. This chapter assumes that those who attended the conference felt themselves at least to be associated with science communication—they are self-selected members of the community.

The Science Communication conference often devotes one day to general issues, while theming the other; in 2007, the second day was devoted to 'climate change' and was intended to attract an audience broader than the science communication community. Over the two days, nearly 400 speakers, organizers and delegates participated in the conference. The more general 'science and society' first day was attended by 316 people. According to the organizers' own survey, the participants felt that the conference supports the community by getting people together, sharing best practice, and bringing it up to date: nearly 80% believed that the conference contributes to the 'future direction' of science communication. Attendees had clear motivations for being there.

The programme for day 1 included sessions on stem-cell research in the media, international perspectives on engagement strategies, training science communicators, and improving the image of S&T among young people. In his keynote address to the conference, British Association General Secretary Roland Jackson issued seven challenges to the UK science communication community. Appropriately for this chapter, challenge no. 6 raised the issue of bringing the academic community closer to practitioners. 'Should practical science communicators influence the research agenda?' Jackson asked.

So who was the audience, and what were they already doing as far as meeting this challenge was concerned? What follows is based on a survey of 128 participants on day 1, or 40% of the overall attendees on that day.[1]

16.3 Looking at the UK Science Communication Community

Since nearly all the questionnaires handed out were returned, our 40% sample rate is reasonably representative. While one cannot rule out some bias—ordinary delegates to the conference were easier to gain access to than speakers, and

[1] The survey was carried out by University College London students Jamie Rosen and Charlene Spagnoli under my direction.

the organizers themselves were generally too hard-pressed to fill in our survey—the results discussed in this section should give a fair snapshot of the UK science communication community.

One of the first conclusions is that the community is predominantly (69%) female. It is on the young side, with 73% between the ages of 20 and 40; 34% are 30 or under. Some 55% have been in science communication for between one and five years, and another 26% have more than five years experience. Respondents classed themselves as occupying junior positions (32%), middle-ranking positions (47%) or senior positions (21%). Senior positions were held by only 17% of the female respondents, but 30% of the men.

The conference organizers provided some information on the fields of work of their attendees over the two days:

- Professional science communication—54%
- Teaching—28%
- Scientific research—17%
- Social science research—5%
- Government and policymaking—17%
- Media and press officers 17%
- Industry and engineering—8%

From the total, it is clear that science communicators multi-task. Our survey asked for respondents to 'best describe' their connection to science communication, and found 50% professionally involved in science communication—close to the organizers' figure—of which 20% considered themselves science communication workers and 12% event or festival organizers, and 10% worked in a science centre or museum. Of the remainder, 27% said that their connection was through academia (6% were students). In both surveys, public relations (PR) or marketing accounted for 9% of respondents. In our survey, 7% called themselves 'occasional' science communicators. These figures alone show that the science communication community is highly diverse—a point that is reinforced by further analysis and to which I will return at the end of this chapter.

Where has the community come from? The simple answer is that science communicators come predominantly from science rather than from communication. Attendees were asked to give their highest level of formal science training: 87% had taken science at university, of which 24% had doctoral and 35% had postdoctoral research experience. Just two respondents said they had received no formal science training, while 11% gave up science after school. When science communicators communicate, it is clear that they know (something of) what they are supposed to be communicating about. But when science communicators communicate, how well do they understand the communication part of their metier?

Nearly two-thirds of the survey respondents said that they had received no university science communication training, although 19% had other communication training, including that involved in becoming a professional schoolteacher. (The survey assumed—reasonably as far as the UK education system is concerned—that science communication training was not given at school level.) That still left nearly half (48%) of the community with no formal training in communication. However, 30% had been trained at university in science communication (27% at postgraduate level, presumably reflecting the growth in masters programmes over the past two decades). There was even a handful claiming postdoctoral science communication training. So the picture that emerges is one of science communicators being well trained in science, but considerably less so in communication.

Gender and age make a difference to the extent of university-level training in science communication. Proportionally, 50% more women (38%) than men (25%) had received training. And there seemed to be a sharp age divide: only 17% of the over-40s had training, compared with 41% in the 20–40 age range. This latter divide could well be explained by the lack of formal science communication training in UK universities at the time when most of the over-40s were studying there.

Although the statistics become much less reliable, it is also interesting to compare respondents' levels of science communication training with their connection to science communication. Taking just those groups for which 10 or more responses were received, those working in PR were least likely to have received any science communication training (17%), followed—perhaps surprisingly—by those whose connection was through academia (19%), but 33% of PR personnel and 85% of the academics had postgraduate or postdoctoral science training.

Of those most involved in practical science communication activities, half of all event organizers had received training in science communication, as had 46% of museum workers and 31% of those calling themselves science communication workers. The corresponding figures for postgraduate or higher science training were 38%, 62% and 54%, respectively. With the exception of the science event and festival organizers, in all cases the figures tell the same story, profession by profession—among science communicators, training in science is more prevalent and extensive than training in science communication.

16.4 The Research–Practitioner Connection: Who Is Reading What?

One way to quantify the connection between science communication researchers and practitioners (in so far as they are not the same people) is to look at who is reading the relevant literature. The two peer-reviewed journals—*Public Understanding of Science* (*PUS*) and *Science Communication* (*SC*)—have been around for at least the past 15 years, and longer in other guises. Between them, they publish a reasonable cross-section of researchers in science communication, although science communication research is by no means confined to these outlets. Attendees at the conference were asked if they read these journals either regularly or occasionally: 42% read *PUS* and 36% read *SC* at least occasionally. Around 8% read one or the other regularly. But 55% *never* read either journal.

As well as the two academic journals, the British Association runs its own publication, *Science and Public Affairs* (*SPA*). While *SPA* is not reviewed in the academic sense, it is nonetheless subject to some peer scrutiny. This ‘in-house’ journal carries many articles that are relevant to the science communication community, and when it is included in the reading list the proportion of those who read none of the three drops to 42%. Respondents making up an additional 5% of the sample listed ‘other’ science communication publications, such as *New Scientist*. But that still leaves 37% reading nothing in the area of the conference they were attending and only 3% reading all three publications—*PUS*, *SC* and *SPA*—regularly.

Looking once more at gender, age and connection differences, 49% of women compared with 35% of men read *PUS*, *SC* or both at least occasionally, while the same is true of 51% of the over-40s and 43% of the 20–40 age range. Only one PR person out of 12 (an over-40s male) read the two peer-reviewed journals regularly, while 42% read *SPA*. At the other end of the scale, 62% of science centre and museum workers read *PUS*, *SC* or both. This bettered the reading rate among academics (somewhat surprisingly, just 55%) and event organizers (50%). Only 38% of the students read the peer-reviewed literature in science communication, along with 35% of science communication workers.

16.5 Benchmarking Europe: A Snapshot of the European Union

The picture that emerges from attendees at the UK Science Communication conference is that the ‘average’ science communicator is a (relatively) young and middle-ranking woman, well trained in science but less so in communication, who does not pay a great deal of attention to the relevant research literature. This tends to bear out the impression of a gap between theory and practice set out in the introduction to this chapter. From the standpoint of PCST, it would be very useful to know whether this is a uniquely British phenomenon or can be shown to be more a widely applicable characterization of the science communication community. The current literature is silent on the matter. That said, one can try to locate the UK science communication scene in a wider international context. One logical extension is to Europe, for which there have been several comparative studies. In particular, much work has been carried out either directly by the European Commission or under its auspices.

It is worth noting that this executive arm of the EU has provided a framework for much that happens at a European level through a variety of funding streams and its Science and Society Action Plan (EC 2001). Published in November 2001, the plan sets out a programme of 38 actions to bring S&T closer to European citizens, to their ‘needs and aspirations’. More than half of the actions involve science communication in one form or another under the headings of ‘Public awareness’, ‘Science education and careers’ and ‘Dialogue with citizens’. The plan places several demands on scientists to communicate directly with the public and through the media. ‘Because of their knowledge, researchers, research organizations and industry now have particular responsibility vis-à-vis society in terms of providing scientific and technological information to Europe’s citizens’, it explains.

The ‘dialogue’ aspect of the document is of particular interest, since—at the time—it marked something of a change of direction in Brussels’ thinking, from ‘deficit’ to ‘dialogue’ communication. And it drew heavily on the UK experience with ‘mad cow disease’, and the House of Lords *Science and society* report of the previous year (SCST 2000). Therefore, much of the EC thinking on science communication has a fairly familiar feel to those acquainted with the British scene: the European science communication community as a whole is working in a policy framework not that different from the UK framework.

The European Commission also carries out regular quantitative surveys of public knowledge of science and attitudes towards it, known as Eurobarometers. The 2005 figures showed that British citizens were fairly close to the average for Europe as a whole (EC 2005). In this respect, too, science communicators across Europe are working in a public ‘climate’ not too different from that of the UK.

If these assumptions are sound, it is reasonable to use the small survey of attendees at the UK Science Communication conference at least as a pointer to the wider international science communication community. But we can probe a little deeper.

In 2000, the EU decided to try to find out what its (then) 15 member states were doing to make Europe the most dynamic knowledge-based economy in the world. Various activities were to be ‘benchmarked’—compared on a country-by-country basis to see whether signs of economic success could be correlated with particular uses of S&T. Was there a ‘magic bullet’, like Nokia’s driving of the admittedly small but very dynamic Finnish economy, that could be taken up by the lumbering giants of Germany, France and the UK, or the more agriculturally based southern European states? Part way into the process, the Portuguese Minister for Science, Jose Mariano Gago, suggested that looking at efforts to ‘promote RTD (research, technology and development) culture and the public understanding of science’ might be appropriate. I chaired the working group set up to review this rather nebulous area.

The outcome of this part of the EC benchmarking activity was a report of nearly 200 pages (EC 2002), plus a further 150 pages of annexes of source information from which the report was drawn, including detailed responses by the ‘high level group’ of government representatives to questions from the working group. Much of what is contained in the report has remained unexamined and unused. ‘Benchmarking’ science-and-society activities is not an easy exercise for a number of reasons, even in the EU: the history of each member state lends a unique character to its science communication climate, governments are organized along different lines—some with more regional emphasis (such as Spain and Germany), others strongly centralized (such as France) —and the point at which issues concerning the public and science have been seen to be important also varies considerably.

Those considerations made it difficult to identify the sort of performance indicators beloved of policymakers and to pick out the ‘magic bullets’ they were looking for. Instead, the report generally contented itself with identifying ‘good practices’ that might serve as European exemplars. It was still possible, however, to see which countries were active in which area of public understanding of or engagement with science, and which were not.

At the time of the benchmarking report, the UK was seen to have a very active and well-developed science communication community across the board, with specific initiatives covering schoolchildren, ethnic minorities and women, as well as many programmes aimed at the 'general public'. British scientists also received more communication training than most of their other European counterparts, their main scientific societies were 'leading' in communication as well as in their respective sciences, and there were more funding streams than elsewhere in Europe. The UK was at least as well, if not better, provided for in terms of science communication courses at university level as France, Germany, Italy and Spain, the other large EU member states at the time. In rhetorical terms, at least, the UK was making efforts at dialogue and citizen involvement—for example, the GM Nation exercise (UK Government 2003) on the use of genetic modification for food production was just getting under way when the benchmarking report was being written.

As a whole, the UK science communication community is (or was, five years ago) probably more developed than that in any other country in Europe. In some senses, that might make the UK community a poor comparitor for measuring performance in other countries, but one can argue that the relationship between science communication theory and practice is unlikely to be more developed elsewhere than it is in the UK. If that is true, then the conclusions drawn from our small survey of attendees at the 2007 Science Communication conference about the practitioners' engagement with relevant research would probably be overoptimistic if applied to other European countries and, perhaps, globally.

16.6 Does the Research Community Make Itself 'Relevant'?

I once tried out an exercise at one of the UK's leading science festivals: give participants some key papers in the canon of science communication to read, without prior comment, and ask them what they got out of reading them that they felt was relevant and useful. Among the papers selected for group discussion were Stephen Hilgartner's critique of the dominant model (Hilgartner 1990) and John Durant's discussion of the meaning of scientific literacy (Durant 1993), which are both reasonably accessible and influential.

The result was something of a disaster: participants decided that their role was to nitpick particular quirks of the writing, rather than to try to understand what the writers might be saying that was interesting, useful or both, even if they did not entirely agree with the paper. Given that the participants had chosen to come to that session—clearly forewarned that it involved some academic reading—rather than any of the other half dozen attractions at the festival, it was rather disappointing and underwhelming. The meeting of minds between the research community, represented by the papers, and the science communication practitioners who attended the session just never happened.

Maybe part of the reason for this lies with the research community, and the possibility for misunderstanding where one is trying to encapsulate a subtle message in a few words. For example, the soirée at the 2007 UK Science Communication conference was generously hosted by the Economic and Social Research Council, the body responsible for funding research into the interactions between science and the public. But the impression that many took away from that meeting was that social scientists were somewhat dismissive of science communication as an answer to the problems besetting relationships between scientific researchers and UK citizens (Miller 2007, Rayner 2007). Given Roland Jackson's plea earlier in the day that there should be closer cooperation between the practitioner community and academic researchers, this was unfortunate: if science communication was irrelevant from the point of view of the professional research community, then the practitioner community might feel justified in giving short shrift to the researchers and all their works!

That would be a shame: there is so much of importance for practical science communication to be found in the research literature. And, for its part, the science communication community should surely be a great source of information and experience for the research community —a living laboratory in science–citizen interchanges. Mutual cooperation should yield benefits over and above those that each party individually gets from the exchange. For example, much of the *research* that gave rise to the development of a contextual approach to public understanding of science (Payne 1992, Wynne 1992, Layton et al. 1993)—and hence to the more recent 'science and/in society' approach that prevails today—was based on looking at real-life *practical* science communication scenarios, analysing them and coming up with critiques that the community has (eventually) taken on board.

I will not relate more of this rather well-known history here (see, for example, Gregory and Miller 1998, Miller 2001, Bauer et al. 2007). To complete this chapter, I will look at one aspect of how, as a science communication trainer, I benefit from research carried out by sociologically trained and experienced colleagues, and why that research is useful to science communicators who have to deal directly with the public.

16.7 Communicating Risk: What Theory Can Teach Practical Communicators

One of the key challenges for those involved in science communication—perhaps more so now than at any other time—is to discuss issues involving science, technology, medicine and *risk*. Mad cow disease, genetically modified crops, nanotechnology, nuclear power, vaccines against childhood diseases and so on all pose real or imagined risks that concern citizens in their everyday lives, their jobs, their families and their lifestyles. One approach to teaching people how to communicate risk consists of enumerating techniques to put out fires. OK, that's very practical, but it leaves lots of questions unanswered—including why the fires got started in the first place.

An alternative approach is to look at what the relevant theory and research can teach science communicators. A good starting point is Beck's (1985, 1992)

Risk society. Beck is not the easiest sociologist to read (his writing is extremely condensed), and you are obliged neither to follow him all the way through his arguments, nor to agree with all of his conclusions. But whether or not you are convinced that the new paradigm in society is inequality in the distribution of *risk* (rather than as, say, Marx would have it, inequality in the distribution of *wealth*), Beck has much to say that is of great interest to science communicators.

Writing just at the time (the mid-1980s) that the deficit approach to science communication was taking hold in the UK and elsewhere, Beck prophetically stated that citizens are not persuaded of the safety or otherwise of some scientific innovation or technological process simply by having numerical assessments of the risk associated with them—a one-in-a-million (or whatever) chance of being killed/maimed/…/slightly inconvenienced. He points out:

> Even in their highly mathematical or technical garb, statements on risk contain statements of the type *that is how we want to live* … in their concern with risk, the natural sciences have disempowered themselves somewhat, forced themselves towards democracy.

What Beck is saying is that when biotech companies offer genetically modified tomatoes that will last for weeks on the supermarket shelves, the consumer may be perfectly happy to accept company assurances that those tomatoes pose no health risk simply on account of being genetically modified. Instead, consumer resistance is due to the fact that shoppers do not want to buy tomatoes that have been on the shelves for weeks, being picked up, squeezed and sneezed over by countless other shoppers. What people want are *fresh* tomatoes: that is how *they* want to live, even if the multinationals would like them to live otherwise. And so the scientifically accurate information from the natural sciences—via the research labs of this or that biotech company—is *disempowered* and *forced towards democracy*, because it becomes just one piece of the information jigsaw, and not the deciding factor in the discussion of *how we want to live* (and eat our tomatoes).

In that sense, Beck's discussion of risk leads science communicators naturally to adopt an interactive approach to communicating about risk. In case anyone thinks that this is an argument for intellectual relativism, it must be stated that giving accurate scientific information to all concerned—such as relative risks from measles, mumps and rubella compared with those from the triple MMR vaccine—is essential, and in no way to be downplayed. But what Beck teaches is that health service workers, for example, will find themselves in a process of negotiating new knowledge rather than lecturing. Training for that role is somewhat different from training for making *ex cathedra* pronouncements.

So what else can one find in terms of research on risk that is relevant to science communication? Lots. A trawl through *PUS* nets several very useful articles, including a number of case studies covering health issues (Kahlor et al. 2002, O'Neill 2003), food safety (Frewer et al. 2002), the environment (Major and Atwood 2004) and climate change (Lowe et al. 2006).

One paper of particular interest for the process of communication is that of Weingart and co-workers on discourses on climate change (Weingart et al. 2000). Their paper talks of the need for communicators to 'translate' risk.[2] They say that risk must undergo:

- Translation into a *sequence of events*, with an unfolding narrative and its short-term and longer term consequences
- Translation into *everyday experience*, with connotations of relevance, comparison with more familiar risks, and the need or otherwise for alarm
- Translation into *concrete action*, giving rise to opportunities for intervening and developing solutions, and—increasingly into today's litigious climate—for apportioning blame

So this paper gives a clear communication strategy for the person given the task of explaining risk to their fellow citizens: tell the story, touching base with the audience, and give them some idea, at least, of what to do about it. It does not say to blind them with statistics and baffle them with complex scientific processes.

The other papers also contain key ideas on how citizens visualise risks of one sort or another—an important starting point for the 'three translations'.

16.8 Conclusions

This chapter started with a perception—that there is something of a gulf between the practical science communication community and the body of researchers—and this perception seems to stand up to investigation, at least as far as the UK is concerned. Although this clearly has to be established through proper research, it is more than likely that investigations of the community on an international level will produce similar results. But the chapter ends with examples where the mutual interplay of theory and practice can be of great benefit to both 'sides' of the equation. It is the job of organizations like the PCST Network to foster that interplay. What the UK survey also pointed up was the considerable diversity of the science communication community, so any strategy to bring theory and practice closer together must take diversity into account. Finally, another way of interpreting the UK survey is that it showed that more than half of science communicators *are* reading (some of) the relevant literature. Maybe the glass is half full, rather than half empty.

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[2] 'Translate' may not be the word most favoured by purist communication-theory sociologists to explain the process of putting a specialist subject into lay terms, but trainers find the analogy useful in a more sociologically relaxed setting.

References

Bauer, M., Allum, N. & Miller, S. (2007). What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda. *Public Understanding of Science*, *16*, 79–95.

Beck, U. (1985) (1992). *Risk society: Towards a new modernity*. London: Sage.

Durant, J. (1993). What is scientific literacy? In J. Durant & J. Gregory (Eds.), *Science and culture in Europe*. London: Science Museum.

EC (European Commission) (2001). *Science and society action plan*. Brussels: European Commission.

EC (European Commission) (2002). *Report of the expert group benchmarking the promotion of RTD culture and the public understanding of science*. Brussels: European Commission.

EC (European Commission) (2005). *Eurobarometer 224. Europeans, science and society*. Brussels: European Commission.

Frewer, L., Miles, S., Brennan, M., Kuznesof, S., Ness, M. & Ritson, C. (2002). Public preferences for informed choice under conditions of risk uncertainty. *Public Understanding of Science*, *11*, 363–372.

Gregory, J. & Miller, S. (1998). *Science in public: Communication, culture and credibility*. London: Plenum.

Hilgartner, S. (1990). The dominant view of popularization: Conceptual problems, political uses. *Social Studies of Science*, *20*, 519–539.

Kahlor, L., Dunwoody, S. & Griffin, R. (2002). Attributions in explanations of risk estimates. *Public Understanding of Science*, *11*, 243–257.

Layton, D., Jenkins, E., Magill, S. & Davey, A. (1993). *Inarticulate science? Perspectives on the public understanding of science and some implications for science education*. Leeds: Leeds Media Services.

Lowe, T., Brown, K., Dessai, S., de Franca Doria, M., Haynes, K. & Vincent, K. (2006). Does tomorrow ever come? Disaster narrative and perceptions of climate change. *Public Understanding of Science*, *15*, 435–457.

Major, A. & Atwood, L. (2004). Environmental risks in the news: Issues, sources, problems and values. *Public Understanding of Science*, *13*, 295–308.

Miller, S. (2001). Public understanding of science at the crossroads. *Public Understanding of Science*, *10(1)*, 115–120.

Miller, S. (2003). Science communication's burnt bridges. *Public Understanding of Science*, *12*, 167–182.

Miller, S. (2007). The fourth deficit? *Science and Public Affairs*, *September*, 15.

O'Neill, K. (2003). A vital fluid: Risk, controversy and the politics of blood donation in the era of 'mad cow disease'. *Public Understanding of Science*, *12*, 359–380.

Payne, R. (1992). Chernobyl reaches Norway: The accident, science and the threat to cultural knowledge. *Public Understanding of Science*, *7(1)*, 261–70.

Rayner, S. (2007). The fourth deficit?—Reply. *Science and Public Affairs*, *September*, 16.

SCST (Select Committee on Science and Technology) (2000). *Science and society*. Third report. London: House of Lords.

Stocklmayer, S., Gore, M. & Bryant, C. (Eds.) (2001). *Science communication in theory and practice*. Dordrecht: Kluwer/Academic.

UK Government (2003). *GM Nation?* Report. Retrieved from http://www.gmnation.org.uk/docs/gmnation_finalreport.pdf

Weingart, P., Engels, A. & Pansegrau, P. (2000). Risks of communication: Discourse on climate change in science, politics and the mass media. *Public Understanding of Science*, *9*, 261–283.

Wynne, B. (1992). Misunderstood misunderstandings: Social identities and the public uptake of science. *Public Understanding of Science*, *7(1)*, 281–304.

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Chapter 17
From Democratization of Knowledge to Bridge Building between Science, Technology and Society

Lise Santerre(✉)

Abstract For the past 20 years, the Quebec Government has monitored scientific and technical culture. This chapter reviews the situation, from the viewpoint of the Conseil de la science et de la technologie (the Science and Technology Council), showing how ideas about the culture have changed over that period. The changes are closely linked to scientific and technological development and the policies connected with it. Through the democratization of knowledge and the building of bridges between science, technology and society—processes that work in both directions—the official view of scientific and technical culture has been modified. Today, it is conceived as an interface, stimulating exchanges between scientists and other social actors. As a result, research is more attuned to community needs. *Perspectives STS (science, technology, society)*—a project initiated by the Science and Technology Council—illustrates this evolution.

Keywords New production of knowledge, participatory processes in the field of science and technology, relationships between researchers and civil society, science, technology and civil society, scientific and technical culture

17.1 Introduction

Over the past 20 years, through community initiatives, public support and volunteer input, Quebec has acquired a range of science communication organizations and installations, including specialist media, science camps, museums, recreational science organizations, interpretation centres and activity groups. It now boasts an impressive variety of high-quality activities to inform and raise awareness about science and technology (S&T).

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The Quebec Government has consistently supported S&T culture throughout this period. The government relies mostly on the Conseil de la science et de la technologie (the Science and Technology Council, or STC), a part of the Ministry of Economic Development, Innovation and Export Trade, for analysis and advice on ways to develop science, technology and innovation to benefit Quebec society. The *Perspectives STS (science, technology, society)* project was launched with this goal in mind.

This chapter reviews the public discourse on S&T in Quebec, tracing its main features as it evolved along with changing conditions in knowledge production, and assesses the contribution of the *Perspectives STS* project.

17.2 Scientific and Technical Culture: a New Field of Intervention

Since its creation in 1983, the STC has continuously assessed S&T cultural development. A series of measures established at the outset to stimulate the development of S&T included the creation of Quebec's first ministry for S&T, which was mandated to promote scientific culture. Scientific culture had long been part of the public discourse, but it was only in the mid-1980s that it became a genuine field of public intervention in Quebec. Table 17.1 outlines some of the highlights of the council's work.

As in other industrialized countries, science culture has become a prime focus of S&T policy in Quebec (Godin 1999: 29). The culture has varied over time, and these variations have reflected the government's priorities and action strategies.

Table 17.1 Highlights of the Science and Technology Council's Work

1984	Establishment of a Science and technology culture committee
1986	Publication of *La diffusion de la culture scientifique et technique au Québec*, a study by J.-M. Gagnon and L. Morin
	Publication of first situation report dealing with science policy: *Science et technologie. Rapport de conjoncture 1985*
1988	Publication of second situation report on the role of scientific culture in the transfer to an information society: *Science et technologie. Conjoncture 1988*
1994	Publication of third situation report entirely devoted to science culture: *Miser sur le savoir. La culture scientifique et technologique*
1997	Publication of fourth situation report describing science culture as a component of the national system of innovation: *Pour une politique québécoise de l'innovation*
2002	Publication of an overview of science culture: *La culture scientifique et technique au Québec: Bilan*
	Publication of results of a survey of science culture: *Enquête sur la culture scientifique et technique des Québécoises et des Québécois*
2004	Publication of fifth situation report devoted to science culture: *La culture scientifique et technique. Une interface entre les sciences, la technologie et la société*

17.3 Evolution of the Discourse on Science Culture

In this section, I briefly examine the development of the Quebec Government's S&T policy.

The importance of government support to promote science culture first became apparent in 1965. At that time, science was considered a public good. Science culture for the layperson encompassed a small body of scientific and technical knowledge.

This discussion resurfaced in the government's Green Paper on culture (GQ 1976) and in the *Politique québécoise du développement culturel* (GQ 1978). A draft policy on science research, published the following year, focused on 'the situation of science in the field of culture' and 'the democratic concern to generalize and facilitate citizen access to S&T information' (GQ 1979: 2).

With the publication of *Le virage technologique* in 1982, S&T culture responded to the 'technology challenge' by adding new information and communication technologies to its toolkit (GQ 1982).

In 1983, the Quebec Government established a Ministry of Science and Technology. Scientific research was seen as a catalyst for economic growth, and programmes were developed to promote S&T culture. These communication programmes show a progressive diversification into leisure projects, exhibitions, popular magazines, audio-visual projects and other forms. The development of a scientific culture was a means 'to promote access to scientific knowledge, practices and technology for as many as possible'. The science mediation and communication system pursued the objective of 'democratization and appropriation of knowledge' (MHES 1988).

Several years later, based on an evaluation of results, access to Quebec Government science culture programmes was expanded to include new social actors: schools, scientists, high educational institutions and private enterprise (Schiele et al. 1994: 28). This transfer coincided with the government's decision to further integrate research and innovation, promote collaborations between government, universities and enterprises, and nurture an industrial culture (STC 1988: 13–14).

Box 17.1 A Definition of Scientific and Technical Culture

The Science and Technology Council adheres to a very broad definition of scientific and technical culture that includes individual and societal factors. It defines this culture as the ability to appropriate a body of scientific and technical knowledge and competencies. Scientific and technical culture also includes an objective view of the reality of S&T, its methods, impact, limitations and inherent challenge. Scientific and technical culture is manifested through knowledge, competencies, representations, values, behaviour and the means applied to achieve S&T mastery, and to guide its development. (STC 2004a: 9–10)

In 1994, responsibility for scientific and technical culture was transferred to the Ministry of Industry, Trade, Science and Technology, which targeted further actions to promote careers in S&T and encourage scientists to participate in public awareness activities.

Two years later, the S&T cultural programmes were moved again, this time to the Ministry of Culture and Communications, which redefined and widened the mandate to include different forms of cultural expression. Scientific culture became part of a new humanistic approach, 'able to reconcile the sciences, human sciences and artistic creation' (Arpin 1994: 19). The stay at the Ministry of Culture and Communications was brief.

In 1997, responsibility for government S&T culture was passed to the Ministry of Research, Science and Technology. The ministry's 2001 science and innovation policy paper designated individual training and appropriation of S&T as the first of its three points of policy. Scientific and technical culture was a central focus, leading to a knowledge society (MRST 2001).

S&T culture was then transferred to the Ministry of Economic Development, Innovation and Export Trade (MEDIET), an economy-driven ministry, at a time when advances in S&T posed new social questions (particularly about the life sciences and nanotechnology). A concerned public was turning its mind to risk management, ethics and citizen participation in choosing research and development priorities.

Despite the changing discourse on S&T culture over this period, the perspective has remained clearly diffusionist. Quebec's approach has been consistent, reflecting a vision similar to that of other societies engaged in S&T cultural projects. Most Quebec Government initiatives continue in this tradition.

17.4 Public Efforts in Scientific and Technical Culture

This section describes government support for the development of scientific cultural activities, and suggests that Quebec's diffusionist approach will have positive long-term effects.

For more than two decades, the Quebec Government has funded a dedicated—even if not so generous—programme to promote S&T culture. Since the mid-1990s, total grants from the responsible ministry have averaged $4.5 million per year (STC 2004a: 109; MEDIET 2006a: 51). Very recently, the *Stratégie québécoise de la recherche et de l'innovation* earmarked a $7 million increase for the three-year budget envelope allocated to S&T culture and to the Science and Technology Ethics Committee (MEDIET 2006b: 64).

This level of commitment is not exemplary, especially considering the STC's 2004 recommendation that the government earmark an annual public investment of $12.5 million for scientific culture (STC 2004a: 96). Be that as it may, neither private funding nor the support of publicly funded volunteer resources should be underestimated; both make possible the development of Quebec's science communication system. For such a small society as Quebec, the government's contribution is significant.[1]

Rather than going to public institutions, Quebec Government assistance mainly supports small, private non-profit organizations and so-called 'major' participants whose basic mission is S&T culture. Most subsidized activities use traditional channels of dissemination—the science press and broadcast media, leisure activities and museums. Public debates are organized on science, technology and civil society relationships, notably through 'science bars' and more frequent exchanges between scientists and other groups in the population.

The general goal of Quebec's efforts within the science communication system is to increase public awareness of science, technology and their socio-economic impacts, to emphasize the importance of S&T for the growth and well-being of society, and often to encourage young people's interest in careers in S&T. Overall, however, it is difficult to say how much fruit these awareness efforts have borne among Quebecers.

Whether or not the Quebec science communication system can achieve its goals, placing S&T alongside other forms of human expression in the public space certainly makes it more visible outside the scientific sphere. For instance, the STC's 2002 overview of science culture showed significantly more S&T communication facilities in Quebec than there were 20 years ago. There has been similar growth among other groups of social actors (companies, high educational institutions, local economic development organizations, other cultural sectors, etc.), with an increasing number devoted to scientific and technical culture (STC 2002b).

Another indication of S&T's greater visibility is its increased exposure on TV and in newspapers and general interest magazines. The findings of three opinion polls on science culture in the Quebec population show a notable upswing over the past two decades (Tremblay and Roy 1985, Filiatrault and Ducharme 1990, STC 2002a). The proportion of respondents who say they are regular or fairly frequent viewers of TV science programmes rose from 46.1% in 1985 to 58.7% in 2002. The proportion claiming to read scientific articles in newspapers and general interest magazines increased from 36.5% to 54.8%.

Twenty years of promotion through a gamut of activities and communication channels, and the growing circulation of scientific information aimed at the general public, have probably made S&T a familiar part of Quebecers' daily lives.

The work of educational system, technology and innovation organizations and regulatory bodies has also been a major factor in the development of a popular scientific culture. In Quebec, these organizations include the Bureau d'audiences publiques sur l'environnement (Quebec's environmental public hearings board), the Agence d'évaluation des technologies et des modes d'intervention en santé (the agency responsible for health services and technology assessment), and

[1] This does not include Canadian federal grants to Quebec organizations or institutions located in Quebec. This level of government also participates in the science culture field; for example, it operates the Montreal Science Centre and the PromoScience programme of the Natural Sciences and Engineering Research Council of Canada.

the Commission de l'éthique de la science et de la technologie (the Science and Technology Ethics Committee). Although these organizations have varying impacts, they nonetheless function like interacting relay points disseminating messages about S&T. They complement each other in educating, informing and sensitizing the population, shaping representations and transmitting values associated with S&T. If we consider this systemic perspective, the STC assumes that the science communication system actively fulfils a need and gets positive results.

17.5 Which Level of Scientific Culture?

A look at several indicators used in recent years sheds light on the overall state of S&T culture in Quebec.

In its 2004 situation report, the STC concluded that, overall, Quebec's level of social and individual approval of S&T compares favourably with that of other societies (STC 2004a: 22).

The proportion of gross domestic product that Quebec allocates to research and development rose from 1.86% in 1991 to 2.74% in 2004, compared to a 2004 average of 2.47% for OECD countries (GQ 2007). In 2002, Quebec had 8.6 researchers per 1,000 active population, while this ratio averaged 6.3 per 1,000 in OECD countries (MEDIET 2005: 61).

Figures for recent years show Quebec's educational system performing well in terms of enrolments and graduates in the science disciplines (CETECH 2004, MEDIET 2005, MELS 2007). Women continue to make strides at university and in the workplace, although they remain under-represented in the pure and applied sciences (MERDR 2004). While there are frequent sectoral imbalances in labour supply and demand, especially in emerging or rapidly expanding sectors of industry, Quebec does not face an overall labour shortage in S&T (STC 2004b: 179).

Despite considerable criticism about the space and treatment accorded science disciplines in elementary and high school, Quebec students fare very well in national and international competitions, such as Canada's School Achievement Indicators Program (MELS 2005), the OECD's Programme for International Student Assessment (Bussière et al. 2007), and the Trends in International Mathematics and Science Study (ME 2004).

A survey of the Quebec population in 2002 also paints quite a good picture of S&T literacy at the individual level. Respondents' performance in the survey's natural sciences and engineering knowledge test (62%) compares favourably with performance in France (61%), Europe (60%) and the United States (64%) assessed in 2001 (STC 2002a: 48). In the human and social sciences, respondents averaged 67%.

Compared to Europeans, more Quebecers are interested in S&T (70.7%; Europeans 45.3%) and consider themselves well informed (56.1%; Europeans 33.4%) (STC 2002a: 4–5). In 2001, a significant majority expressed confidence in scientific development (67.9%)—slightly less than in the United States (72%) but higher than in Europe (50.4%) (STC 2002a: 15). More than half turned to mass media for science-related information, and 12% indicated that their scientific interest was a leisure activity. Around 65% had visited a science museum or establishment at least once in the previous year, the most popular being zoos, aquariums and botanical gardens (49.4%), followed by natural history museums, S&T museums and interpretation centres (45.9%).

Overall, the survey results show a good individual level of science culture, but the culture's uneven spread across the population is striking, although this unevenness is not confined to Quebec. Another notable distinction is the greater confidence and interest in science among the more highly educated and higher income earners, who often pursue many more science leisure activities and participate in more information-access activities than the others. These groups also score higher on knowledge tests. Comparisons with earlier surveys show that these inequalities have persisted over time, despite Quebec's progress in S&T development, education and communication (Tremblay and Roy 1985, Filiatrault and Ducharme 1990).

The science communication activities implemented up to now have made S&T more visible in the public place and helped to shape popular representations, but the level of S&T culture in the population does not necessarily meet expectations (Schiele 2005). In other words, it seems to have reached a threshold.

To create a more vibrant interface between science, technology and civil society, the STC now believes it must go further. It must urge the scientific community to be more open to society's needs and demands. Besides initiatives for better public understanding of S&T, recognition of its contributions and consideration of issues of concern, there is also an abiding need for reciprocal exchanges and bridge building between S&T on the one hand and civil society on the other. This is a crucial step towards a true knowledge society.

17.6 Bridge Building between Science, Technology and Society: Altering the Angle of Approach

S&T assumes even greater importance in a knowledge society. Today, it is the prime source of innovation and the major lever of socio-economic development. S&T knowledge is growing exponentially in all disciplines, and is reconfiguring its own means of production and management.

Among the most striking transformations have been the diversification of places of knowledge creation, the heterogeneous mix of participants, burgeoning exchange networks, increased contextualization of research, and greater social responsibility on the part of scientists (Gibbons et al. 1994). The research poles represented by universities, industry and government are reshaping modes of operation, questioning traditional roles and becoming more interdependent. New actors (related milieus, unions, non-governmental organizations, etc.) do their own research work and compete with the more classical institutions. Fields of knowledge are simultaneously specializing and expanding, opening up boundaries, blurring and merging. Research activities are increasingly transdisciplinary, integrating all forms of knowledge from the most basic to the most applied. The transfer and valorizing of research takes on greater importance, while the funders have greater and more pressing expectations for spin-offs from the work.

These strongly results-driven changes affect knowledge workers, who must be more open and amenable to other disciplinary fields, other forms of creation, other participants in research activities and other social groups, whether they are potential new knowledge users, representatives of pressure groups or the general public.

Scientists may have reservations about this openness, but increasing interactions between scientific communities and other social actors, and improved research outcomes to meet economic, social and cultural needs, will ultimately make it more acceptable to them. Those interactions better acknowledge social demands and spur innovation (Latour 1998: 209).

The new need for openness requires a strategy to bring science, technology and society closer together: greater public awareness of S&T culture is not enough. Quebec's current science communication efforts, while promising, leave the effort incomplete (STC 2004a: 79–85). Scientific communities are ultimately responsible for helping other groups of actors understand more fully the return on research effort, but the communication cannot be one-way. It is crucial to operate a two-way communication—a process in both directions—from S&T to civil society and from civil society to S&T. This second part of the relationship has been less discussed until now (Valenduc and Vendramin 1997).

Building bridges between scientists and other social actors requires us to recognise that other social actors also have and produce knowledge, and to be open to the needs, expectations, fears and demands of the groups affected by S&T development This is a new approach, fostering a 'retrospective informational effect' from other social actors to researchers.

This perspective remains marginal today, although some bridge-building efforts date back to the 1970s. Examples include the 'science boutique' formula begun in the Netherlands and the community-based research centres in the United States. In Quebec, the Programme Actions concertées of the Fonds québécois de recherche sur la société et la culture supports partnership programmes in areas of practice, including community groups, civil society representatives, health care organizations, education and social services networks, etc. There is also a Canadian version of this programme: CURA (Community–University Research Alliances), overseen by the Social Sciences and Humanities Research Council of Canada. France has Picri (Partenariat Institutions Citoyens pour la Recherche et pour l'Innovation), which was developed in the Île-de-France region. Both programmes are more recent.

Actions within this perspective began in research milieus rather than through scientific and technical culture organizations, and involved research and transfer activities. Bridge building is not intended specifically to disseminate S&T information, but exists in the context of co-producing knowledge and integrating it into practices.

The participation of social actors who may be less familiar with S&T production, which helps to achieve a more 'socially robust' knowledge and enriches the problematic (Gibbons et al. 1994),[2] is now in sync with research and innovation policies that valorize the work (to commercialize and integrate it into practices) and also yield spin-offs. This is the case in Quebec (MEDIET 2006b).

This wider participation brings the research closer to social requirements. As well as the discourse on the social relevance of research, partnership research programmes affect the representations and the openness of the scientists, ultimately stimulating partnership researches and knowledge transfer.

However, while we perceive greater understanding on the part of scientists about the need to be closer to other population groups (Vetenskap och Allmänhet 2003, Royal Society 2006, Alix 2007), researchers do not always grasp the benefits of bridge building. Therefore, the STC feels that government should encourage scientists to recognize social demands more fully, particularly during their training. Many high educational institutions already provide services to act on social demands.[3]

17.7 Perspectives STS: A Unique Experience

Perspectives STS (science, technology, society), a project to promote reciprocal exchanges between scientists and the eventual users of research outcomes, was initiated in 2003 by the STC in collaboration with other partners.[4] The project objectives are to:

- Encourage broader participation in determining research paths for the future.
- Put S&T into service to deal with major challenges confronting society.
- Highlight the contribution of S&T in socio-economic development.
- Develop a long-term vision of research.

The first phase of the project pinpointed major challenges Quebec would face in the years ahead. A public inquiry was launched to hear people's concerns about the future, and the results served as the basis for participants' discussions at a futures workshop. About a hundred people from a wide variety of sectors (education,

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[2] For Gibbons et al., 'socially robust' knowledge is created after scientific knowledge is empirically confirmed and proven in reality.

[3] For example, the Valorisation des innovations et du capital intellectuel (Vinci) project at the University of Montreal and the Valorist project at the University of Quebec, both of which are funded through the Intellectual Property Mobilization Programme of the Natural Sciences and Engineering Research Council of Canada.

[4] Partners include the Ministry of Economic Development, Innovation and Export Trade; Valorisation-Recherche Québec; the Fonds de la recherche en santé du Québec; the Fonds québécois de la recherche sur la nature et les technologies; the Fonds québécois de la recherche sur la société et la culture; the Association francophone pour le savoir and the Association de la recherche industrielle du Québec. Other contributors to the development of research strategies include the Ministry of Education, Leisure and Sport; the Ministry of Employment and Social Solidarity; the Ministry of Health and Social Services; Hydro-Quebec; the Agency for Energy Efficiency; and the Lucie and Andre Chagnon Foundation.

business, environment, industry, culture, etc.) participated in this exercise. They were asked to identify the major challenges for Quebec over the next 20 years.

Several months later, a consultation was held with researchers from all milieus and disciplines. Participants were asked to choose from the major challenges selected at the preceding stage. Seven main challenges were selected:

- Promote the adoption of healthy living habits.
- Use our natural resources more efficiently.
- Provide access to high-quality education for all.
- Increase the effectiveness of the health system.
- Make Quebec a leader in new and renewable energies.
- Adopt innovative actions to fight poverty.
- Target strategic niches and development priorities.

In the second phase of *Perspectives STS*, a steering committee was set up for each designed challenge. The committee included researchers and representatives from areas of practice, government bodies and potential funders. The goal was to develop a research and knowledge transfer strategy to meet the challenges. This work should be completed in the autumn of 2008.

Each strategy will be overseen and implemented by interested groups of social actors, with research funds allocated and in partnership with the areas of practice. Once the strategies have been implemented, a *Perspectives STS* report will be issued, describing the work and serving as a guide for future initiatives.

This bridge-building initiative between science, technology and society, which complements science communication efforts, reverses the trend of traditional research methods. In this regard, *Perspectives STS* reflects changes occurring in the production and management of knowledge.

From the social needs identified by the reference groups, *Perspectives STS* is trying a different form of governance of S&T development. To develop the research and transfer strategies, it is bringing together scientists, decision makers and potential users of the research results to formulate a theoretical framework, prioritize the themes, and choose target objectives and ways to implement them. The project will ultimately mandate the implementation of these strategies by teams of actors representing this same mix. *Perspectives STS* adds an original dimension to this threefold perspective, and as far as we know is the only initiative of its kind.

17.8 Conclusion

Along with other industrialized societies, Quebec has redoubled its efforts over 20 years to develop a strong research and innovation system. The government-supported science communication initiatives to enlarge the public place for S&T have contributed to the development of this system.

Current research activities are now more results-driven and emphasize integration into practices. Efforts in science–society bridge building now tend to focus on the openness of the scientific milieus to produce results more attuned to community needs.

Neither of the two efforts—communication and bridge building—replaces the other. On the contrary, they are complementary.

Today's growing number of partnerships between researchers and other social groups will enhance research activities and their results. In coming years, these exchanges could also extend to developing public policies in S&T. In Quebec, *Perspectives STS* is a precursor project for such future initiatives. Inevitably, the future lies in greater expertise and knowledge sharing.

References

Alix, J.-P. (Ed.) (2007). *Sciences et société en mutation*. Paris: CNRS Éditions.

Arpin, A. (1994). Apprendre à vivre avec la science. Closing talk at Quand la science se fait culture conference, Montreal, April.

Bussière, P., Knighton, T. & Pennock, D. (2007). *Measuring up: Canadian results of the OECD PISA study. The performance of Canada's youth in science, reading and mathematics. 2006 First results for Canadians aged 15*. Ottawa: Ministry of Industry.

CETECH (Centre d'étude sur l'emploi et la technologie) (2004). *Les travailleurs hautement qualifiés au Québec. Portrait dynamique du marché du travail*. Sainte-Foy: Government of Quebec.

Filiatrault, P. & Ducharme, J. (1990). *Le développement des sciences et de la technologie au Québec: perceptions de la population*. CRG/Acfas/UQAM/SPST, October.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P. & Trow, M. (1994). *The new production of knowledge: The dynamics of science and research in contemporary societies*. London: Sage Publications.

Godin, B. (1999). *Les usages sociaux de la culture scientifique*. Saint-Nicolas: Les presses de l'Université Laval.

GQ (Government of Quebec) (1965). *Livre blanc*. Ministry of Cultural Affairs.

GQ (Government of Quebec) (1976). *Pour l'évolution de la politique culturelle*. Working paper. Ministry of Cultural Affairs, May.

GQ (Government of Quebec) (1978). *La politique québécoise du développement culturel*. Quebec: Official Publisher.

GQ (Government of Quebec) (1979). *Pour une politique québécoise de la recherche scientifique*. Quebec: Official Publisher.

GQ (Government of Quebec) (1982). *Le virage technologique. Bâtir le Québec—Phase 2. Programme d'action économique 1982–1986*. Ministry of State for Economic Development.

GQ (Government of Quebec) (2007). Dépenses intra-muros de R-D (DIRD) en pourcentage du PIB, Québec et autres provinces ou régions canadiennes, pays de l'OCDE, Union européenne, G7 et certains pays hors de l'OCDE. Data bank of official statistics at http://www.bdso.gouv.qc.ca.

Latour, B. (1998). From the world of science to the world of research. *Science*, *280*, pp. 208–209.

ME (Ministry of Education) (2004). *Trends in International Mathematics and Science Study TIMSS 2003. Results achieved by Quebec students on the 2003 mathematics and science tests*. Quebec: Government of Quebec, December.

MEDIET (Ministry of Economic Development, Innovation and Export Trade) (2006a). *Rapport annuel de gestion 2005–2006*. Quebec: Government of Quebec.

MEDIET (Ministry of Economic Development, Innovation and Export Trade) (2006b). *Un Québec innovant et prospère. Stratégie québécoise de la recherche et de l'innovation*. Quebec: Government of Quebec.

MEDIET (Ministry of Economic Development, Innovation and Export Trade) (2005). *Tableau de bord du système d'innovation québécois édition 2005*. Quebec: Government of Quebec.

MELS (Ministry of Education, Leisure and Sport) (2005). *School achievement indicators program. Council of Ministers of Education (Canada) SAIP 2004. Quebec results in the 2004 science assessment*. Quebec: Government of Quebec, January.

MELS (Ministry of Education, Leisure and Sport) (2007). *Indicateurs de l'éducation – édition 2007*. Government of Quebec, http://www.mels.gouv.qc.ca/stat/indic07/index.htm.

MERDR (Ministry of Economic and Regional Development and Research) (2004). *Bilan de la progression des Québécoises en sciences et en technologies de 1993 à 2003*. Sillery: Government of Quebec.

MHES (Ministry of Higher Education and Science) (1988). *Énoncé d'orientations et plan de développement de la culture scientifique et technique au Québec*. Sainte-Foy: Government of Quebec, May.

MRST (Ministry of Research, Science and Technology) (2001). *Savoir changer le monde. Politique québécoise de la science et de l'innovation*. Sillery: Government of Quebec.

Royal Society (2006). *Science communication. Survey of factors affecting science communication by scientists and engineers*. London: Royal Society.

Schiele, B. (2005). Publiciser la science! Pourquoi faire? In I. Pailliart (Ed.) *La publicisation de la science. Exposer, communiquer, débattre, publier, vulgariser*. Grenoble: PUG, 11–52.

Schiele, B., Amyot, M. & Benoit, C. (1994). Le Québec: historique de la culture scientifique et technologique et bilan de l'action gouvernementale. In B. Schiele, M. Amyot & C. Benoit (Eds.), *Quand la science se fait culture. La culture scientifique dans le monde. Actes I*. Sainte-Foy: Éditions MultiMondes/UQAM/Centre Jacques-Cartier, 13–86.

STC (Science and Technology Council) (1988). *Science et technologie. Conjoncture 1988*. Situation report. Sainte-Foy: Government of Quebec.

STC (Science and Technology Council) (2002a). *Enquête sur la culture scientifique et technique des Québécoises et des Québécois*. Sainte-Foy: Government of Quebec.

STC (Science and Technology Council) (2002b). *La culture scientifique et technique au Québec: Bilan*. Sainte-Foy: Government of Quebec.

STC (Science and Technology Council) (2004a). *La culture scientifique et technique. Une interface entre les sciences, la technologie et la société*. Situation report. Sainte-Foy: Government of Quebec.

STC (Science and Technology Council) (2004b). *L'avenir de la main-d'œuvre hautement qualifiée. Une question d'ajustements*. Advisory report. Sainte-Foy: Government of Quebec.

Tremblay, V. & Roy, J. (1985). *Sondage d'opinion en matière de science et technologie*. Government of Quebec.

Valenduc, G. & Vendramin, P. (1997). *La recherche scientifique et la demande sociale*. Namur: Fondation travail-université ASBL, Union of International Associations.

Vetenskap och Allmänhet (2003). *Dialogue between researchers and the public. How researchers view public and science, 2003—interview survey*. Report 2003: 4, Stockholm.

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Chapter 18
Bringing Science to the Public

Jan Riise(✉)

Abstract Public understanding of science as a top-down model is slowly being replaced by dialogue and direct contacts between scientists and the public. More often than in the past, research funding organisations demand that communication plans, including plans to communicate with the public, are part of project proposals. The chapter examines how these changes have been reflected in recent public science events. Scientists' public participation forms the basis not only for direct dialogue, but also for trust and an opportunity to 'negotiate' what is presented. Science events, such as science festivals and science cafés, have proven to be excellent meeting places. They are 'neutral ground', on which people do not have to go out of their way to approach science. Many activities demonstrating basic science can be categorized as 'science is fun', but the challenge is to find formats and presenters for 'new' science (that is, ongoing or recently finished research projects). The author evaluates recent science events, particularly for their success in attracting young people, and examines the importance of venue selection.

Keywords Dialogue, science cafés, science events, science festivals, science in society

This photo shows Peter Eriksson, a successful Swedish professor and stem-cell and neurology scientist, talking to passers-by on crowded Nanjing Road in central Shanghai about the latest findings in his field of interest. He gives a 'short course in neurology', shows pictures on the giant screens and answers questions about the amazing regenerative functions of the human brain. People take a break from their Saturday shopping to talk to him and his colleagues from Scandinavia, who are visiting Science and Technology Week 2007 in Shanghai.

This is what we call 'street science', and it is an interesting example of how social situations can be the basis for dialogue, learning and communication about science.

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Sadly, Peter Eriksson died unexpectedly in August 2007, at the age of 48 years. This chapter is dedicated to him and to all his wonderful colleagues, without whom we communicators would have nothing to say.

In this chapter I argue, from a practitioner's point of view, for the following propositions:

- It is important for trust, sympathy and dialogue that scientists participate personally in the communication of science.
- Science events, such as festivals and science weeks, offer excellent opportunities for such dialogue, by marshalling expertise not only in communication but also in event management.
- The spatial dimension is important; the choice of meeting place contributes to the achievement of the objectives of the event or activity.
- These meeting places for public communication of science could be considered when developing strategies for communicating 'new' science.

With my limited practitioner's knowledge about ongoing studies in the field, my references may be far from complete and often anecdotal or based on personal observations. Still, for whatever it is worth, this is the story.

18.1 Emerging Trends in Science Communication

Two important trends in science communication have become visible in recent years.

First, communication has moved from a rather simple and one-way information or promotion of science process to a more complex operation in which 'inclusion', 'learning', 'dialogue' and 'participation' are key terms. The idea of 'public understanding of science', which was to be achieved by the top-down distribution of correct and well-produced information from the scientific community, often through the so-called ‘deficit model’, has been subordinated or abandoned. A growing insight that communication is about negotiating, a process from which both sides get something, is more and more accepted. Negotiation is also the basis for trust—the most valuable key to creating and maintaining the relationship (Miller and Gregory, 1998).

Second, science communication as a task has changed from being a sort of optional extra to something that is to be planned and accounted for from the very beginning. Research funding organizations now demand communication plans as part of funding applications. The European Commission’s 7th Research Framework Programme does not consider funding unless plans for communication or dissemination of the project’s expected results are included from the start.

However, the incentives for scientists to engage in science communication activities are more diverse and personal; those activities are more than simply a necessary and mandatory hassle that has to be dealt with to win funding for important projects. Many scientists take part in communication with personal interest and great joy.

At the same time, formats for science communication have had to be developed and tested. The internet has made new ways of communication available, from downloadable lectures, shows and experiments to podcasting. New forms of direct, person-to-person communication have developed, two of which are science cafés and science events (such as science festivals and science weeks).

18.2 Scientists’ Participation

A key characteristic of science cafés and science events, which separates them from other forms of science communication, is the participation of scientists. There is no interlocutor, mediator, adapter or translator—no journalist, editor, exhibition designer or anyone else—in between the scientist and the expected audience. While science communication often benefits from such mediation, face-to-face events are different.

The presence of the scientists opens up a real dialogue, a two-way communication. There are no filters, no explainers, no translation errors or mistakes. The public gets to meet someone who is actually involved in what he or she is presenting, for better or for worse.

This dialogue forms the basis for negotiation, creating an opportunity for the audience to contribute to the meaning of the presentation, whether it is an exhibition or an experiment. A Swedish study among young visitors to a science centre concluded that this ‘space for negotiation’ is crucial for teenagers to the exhibition—if they have the authority to interpret the message themselves, their interest increases.

There are various reasons for scientists to participate in science communication (for example by allocating time for interviews by journalists, producing public presentations of their research or taking part in a science event). There are also a number of reasons for *not* doing it.

In the UK, a survey carried out by the Royal Society shows that a large proportion of the scientists interviewed saw their role as explaining and promoting the public understanding of science. Almost two-thirds thought that the relevance of science to everyday life was the most important issue. They also saw a need to profile their own field of research and its institutions.

According to the British scientists, the barriers to science communication were mainly the time away from research work and, to some extent, the disapproval of their colleagues and peers for engaging in science communication.

Incentives for doing science communication were mainly budgetary—to attract more research funding to their institutions. Additional funding and support for science communication would have a positive effect on scientists' interest in taking part in communication activities, but increased support, coordination and training from professional communicators would also be welcome (Royal Society 2006). A similar study has been carried out at Cornell University in the US, and another one is about to be undertaken among Swedish scientists.

It has been suggested that scientists' fears of negative repercussions in peer reviews after engaging in popular science communication may be exaggerated. However, I suspect that a simple bibliometrical study could show that researchers who take part in popular science activities are also the best funded and most often cited.

The need for support and training for participating scientists is well understood by science event organizers. Almost all can tell a story about a bad presentation by a brilliant researcher who happens to be a poor presenter. Unfortunately, an event organizer can also create bad experiences, for presenters and for audiences, by not taking into account the presentation skills, talent and interests of the scientist. While many successful scientists and science communicators made their first public presentations at a science festival or a science week, the selection of participants for such events has not always been as careful as it should have been.

Professional science communication events often provide various forms of support and guidelines for selection. A study by the European Science Events Association (Rebernik et al. 2005) lists a number of ways to ensure high professional standards among presenters at science festivals and science weeks. Most important is a matching process to assign presenters to the types of activities they are best suited to; the next most important is support and opportunities for training and practising.

Many science festival and science week organizers offer training for communication. In Sweden and Denmark, a programme developed at Stanford University in the US has been used successfully. The training scheme, called 'Elevator talks', includes the step-by-step refinement of a presentation until it takes 30 s and can be understood by a 17-year-old student. The programme was presented at the Communicating European Research conference in Brussels in November 2005, and the presentation was documented for the proceedings of the event (Claessens 2007).

18.3 Meeting Places for Dialogue

A science café is an informal setting on neutral ground and a social situation that is easy to understand and part of many people's everyday lives. The concept is simple: a scientist presents his or her research, the audience can ask questions, and the interaction is facilitated by a moderator, who might be a science journalist or someone else with an interest and some knowledge of the subject to be discussed—no PowerPoint, no formulas, no blackboard, no 'lecture' in a traditional sense.

The cafés have been most successful in many places, not least in the UK and in other European countries. Growing numbers of science cafés are being arranged, and new venues and cities are being added. The British Council supports the development of science cafés in many countries by sending prominent researchers from the UK. In some cases, the cafés are the starting point for the development of other science events, such as in Bulgaria, where the first science festival was arranged in 2007, coinciding with the European Commission's 'Researchers' night' and a science café.

Science events, such as science festivals and science weeks, have grown rapidly during the past two decades. Many have emerged in Europe, but there have also been many in Asia, Africa and the Americas. The British Association for the Advancement of Science has a history of annual public meetings going back to 1831, but there are many local events in the UK in addition to the British Association's Festival of science.

In other European countries, science weeks and science festivals have been established with local, regional or national bases. In Norway, the *Forskningsdagene* ('research days') cover the entire country and are funded by the national research council. Science days in Freiburg, Germany, are targeted directly at schoolchildren and are arranged in a large hall at the Europa-Park, a theme park in Rust, outside Freiburg.

The same sort of location is used in Madrid, but for a broader audience, at the Feria de Madrid. The Catalan Science Week offers activities across Catalonia, while the Slovenian Science Week takes place in Ljubljana only. In Göteborg, Sweden, many city venues are used: shopping malls, parks, museums, churches, and an old warehouse for a temporary science centre.

The method is the same: literally, to 'bring science to the public' by using new and unusual venues and formats, such as the shopping centres, railway stations and cinemas, as well as presentations in the form of 'physics shows', science theatres or just short talks and discussions in the street.

Although these science events have been established and developed independently, many of them share similar objectives and aims. The main goals are often described in terms such as 'raising the awareness of science and technology among the general public' and 'interesting young people in science and a possible academic career'.

In addition to these goals, there are usually also local, regional or national goals connected to the events, such as:

- To establish relationships across scientific sectors (Danish Science Week)
- To highlight connections between research, innovation and industry (Norwegian Science Week)
- To humanise science and bring it closer to society (Catalan Science Week)
- To make people realise that the country's position in Europe depends on its standards of education and science (Poland, Lower Silesian Festival of Science)
- To contribute to the marketing of the city as a city of events (Göteborg Science Festival, Sweden)

The various science festivals and science weeks work under very different budgets and funding arrangements, and with differing experience in marketing and organization. The successful outcome of an event depends to a large degree on how it is organized.

The European Science Events Association's study emphasizes the need for different competencies in event organization, such as marketing, management and accounting as well as learning and communication. In practice, the way events are organized varies: some have scientific boards, whereas others employ scientists in the organization. However, all share a major task in maintaining a very close relationship with the scientific community (Rebernik et al. 2005).

18.4 The Importance of the Venue

Another key characteristic of science events is the spatial and social dimension of the communication; the context in which the communication takes place matters. The choice of venues is what separates science events from other forms of science communication. Museums and laboratories can invite people to come and visit, but the potential audience has to be interested enough to find its way to the premises. Science communication events, on the other hand, can reach those who happen to pass by or who become intrigued by a particular experiment or a demonstration. This is done through the use of unusual places or the unusual use of scientific institutions.

Typical science event locations include streets, shopping malls, railway stations, cafés, libraries and theme parks. The advantages of choosing such 'everyday' places are many:

- The audience doesn't have to search for science.
- The audience doesn't feel threatened by an unfamiliar environment, or even uncomfortable.
- The communication process becomes more equal, as it takes place on 'neutral' ground.

At the International Science Festival in Göteborg, Sweden, the evaluations made during the events in 2002 and 2004 included a number of questions about the venues. The festival's activities were then divided into four different 'arenas' for the analysis.

The first is the 'lecture activity', which includes films, debates and workshops—all held in some kind of lecture hall, auditorium, museum or library, and not necessarily at the home institution.

The second is the festival's temporary 'science centre', an old warehouse that is transformed into a very basic science centre where participating organizations and university departments set up their own hands-on exhibits.

The third arena is the shopping mall, one of northern Europe's largest, with a constant flow of potential visitors. The festival occupies a space of a few hundred square metres in one of the main indoor streets for exhibitions, short lectures and demonstrations.

Finally, there is the 'Science in the Park' tent, open from noon to 7 or 8 p.m. The tent arena offers workshops, short presentations, demonstrations and discussions.

Some activities are scheduled, such as a talk at 12.30, while others are more loosely organized, such as 'meet the researchers between 12 and 6 p.m.'

The evaluations gave overall pictures that were very positive for the festival: four out of five visitors wanted to come back next year and indicated that they would recommend a visit to their friends.

The visitor demographics reflected the city's in a general sense. There was a larger proportion of adults with an academic education compared to the city's average, and people older than 55 were also over-represented. Similar findings have been made at several other science communication events, so this is not surprising.

The large difference between the arenas was interesting. While the adult academic group was over-represented in the lectures arena, it was significantly less well represented in the workshop and park arenas. The arena in which the visitor demographic reflected the population as a whole was the shopping centre.

The temporary science centre attracted a large number of schoolchildren, but this was largely due to the workshop's role in the schools programme. A significant number of visits by entire classes were pre-booked.

The Science in the Park tent showed the most encouraging outcome: the proportion of young people under the age of 24 was significant. Moreover, some of the suburban parts of the city (usually regarded as not so 'academic'), seemed to be over-represented (Pousette 2004).

The venues did not have comparable programmes, and we do not know to what extent an activity attracted its visitors regardless of location. Nevertheless, it seems likely that place and format have an impact on the visitor profile, and the concept of different arenas has introduced a new dimension to the development of the Göteborg Science Festival.

Science communication events such as this have an educational component, in that they create informal learning situations, as opposed to the formal learning systems in schools. In some respects, this event's activities are similar to those of science centres and museums. These include the displays, demonstrations and exhibits that invite people participate in hands-on experiences—the differences being that the festival's activities occur as temporary exhibits in places like shopping malls and parks, and that the scientists normally participate.

The encounter between visitor and exhibit has been studied from the educational point of view, to determine how well the scientific message is conveyed. The interactions between teenagers and exhibits at one of Sweden's science centres were examined, and the conclusion was that the teenagers—normally reluctant to visit science centres—wanted to have the right to interpret and to 'contribute to the meaning of the activity'. For them, the exhibits and the place should also be 'places for developing social identity' (Fors 2006).

These findings may support observations (not statistically proven) that science event activities like those in the park in Göteborg, where people are allowed to approach the activity at their own speed and level of interest, may be an important way to encourage people's interest in science and technology.

The conclusions from Göteborg are supported by similar observations elsewhere, and the findings provide input for a further discussion about the potential of science communication events to reach targeted groups and audiences, such as young people. They also point to the need for continued development of tools for evaluating science communication activities.

18.5 Public Communication of 'New' Science

Science communication events have tended to concentrate on particular aspects of 'science' (Rebernik et al. 2005):

- Basic knowledge as a starting step to sophisticated research, with a 'learning' objective
- 'Science for fun', in the form of shows, contests and presentations
- Science on an academic level, mostly in the form of lectures, debates, laboratory practice and workshops
- Science as an integral part of our culture, including the humanities and arts as substantial parts of the programme
- 'New' science—the most recent progress in science and technology

There are significant differences between European science events. Some, like the science days at the Europa-Park outside Freiburg in Germany, focus on the informal learning objective, while others, such as the Feria de Madrid, have more of 'science for fun' profile. However, events based on a mix of elements are becoming the norm.

Science communication event organizers have become increasingly aware of the need to develop presentations of 'new' science—recently published scientific results, or even interim reports from ongoing projects—and this focus is a growing trend. One reason for this is that more scientists now participate in communication events, partly because many research funding organizations now require the inclusion of communication plans in funding proposals. When researchers participate in events, their natural choice of subject is their own field of research and recent work relevant to them.

The European Commission has developed this trend further (at least in Europe) by arranging some well-attended conferences for research projects funded under the 6th Research Framework Programme. Another conference is being planned for 2009 for projects funded under the 7th Research Framework Programme. The research project groups have been invited to Brussels to present recently finished or ongoing work. By taking part in the conference, they also get to exchange experiences, best practice and ideas about how to communicate science. Science centres, publishers, journalists, broadcasting companies and science event organizers have been invited and have proposed sessions for the participating research groups. Contributions to the most recent of the two conferences arranged so far have been published (Claessens 2007).

References

Claessens, M. (Ed). (2007). *Communicating European research*. Utrecht: Springer.

Fors, V. (2006). *The missing link in learning in science centres*. Luleå, Sweden: Luleå University of Technology.

Miller, S. & Gregory, J. (1998). *Science in public*. New York: Plenum.
Pousette, A. (2004). *Utvärdering av allmänhetens program vid Vetenskapsfestivalen*. Göteborg, Sweden.
Rebernik, P., Bohm, M., Fikus, M., Lerch, J., Lotzman Dahl, A., Riise, J. & Smith, A. (2005). *Science communication events in Europe*. Vienna: EUSCEA (European Science Events Association), ISBN 91–631–7888–5.
Royal Society (2006). *Science communication: Excellence in science*. London: Royal Society.

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Appendix
The PCST Network

An International Network on Science Communication

Why Does Science Communication Matter?

Since the second half of the last century, science and technology have been undergoing tremendous expansion. There are more scientists and engineers working today than the total number who have lived and died since the dawn of history.

At the same time, scientific and technological developments have given humankind increasing and even frightening power. We master atomic reactions and release huge amounts of energy; we modify or imitate natural processes and affect life on Earth; we travel faster and faster, even beyond our planet; and our activities affect the whole biosphere. Science and technology are everywhere in our daily lives, and they raise many questions: what are their long-term effects on our lives, on our societies, on the Earth?

It is no surprise that the public communication of science and technology has gained importance and recognition. On one hand, most people consider that the public is not sufficiently represented when it comes to decisions about science and technology. On the other hand, scientists worldwide are more and more willing to engage with the public about their research work. Science and technology communication is believed to increase public involvement and the quality of the decision-making process for research and technological applications, which can have far-reaching effects.

As a result, increasing budgets and resources are devoted to science communication and popularization, and many innovative forms of dialogue between science and society are being explored worldwide.

What Is the PCST Network?

The International Network on Public Communication of Science and Technology (PCST) was born in 1989 after the first International Meeting on Public Scientific Communication in Poitiers, France. The 130 participants from 14 countries decided to meet again to discuss the public's growing need for more information about scientific and technological matters and all issues and developments concerning science communication.

The aim of the network is to multiply opportunities for exchange and cooperation among researchers and professionals who work in the many diverse but complementary fields of PCST. The network especially intends to facilitate these interactions internationally. People may be inspired by foreign innovations and find solutions abroad to common problems.

What Does the PCST Network Offer?

The aims of the PCST Network are:

- To foster PCST and dialogue among people interested in PCST, leading to cross-fertilization across professional, cultural, international and disciplinary boundaries
- To encourage discussion of practices, methods, ethical issues, policies, conceptual frameworks, economic and social concerns, and other issues related to PCST
- To link practitioners of PCST, researchers who study PCST, and scientific communities concerned with PCST
- To link those people, from different cultures and countries worldwide, in developed and developing parts of the world, concerned with PCST
- To sponsor international conferences, electronic discussions and other activities related to PCST
- To administer an international electronic discussion for PCST practitioners and researchers.

PCST Conferences

The PCST Network organizes a major international conference every second year or so, as the list of past events shows:

- 1989: Poitiers, France
- 1991: Madrid, Spain
- 1994: Montreal, Canada
- 1996: Melbourne, Australia
- 1998: Berlin, Germany
- 2001: Geneva (CERN), Switzerland
- 2002: Cape Town, South Africa
- 2004: Barcelona, Spain
- 2006: Seoul, South Korea

The next conferences will take place in the Øresund region (Sweden and Denmark) in June 2008 and in India in 2010.

An average of 600 participants attend the two-yearly PCST conferences. Each event is a showcase of the best practices and the latest research on science communication, delivered through hundreds of papers, communications, posters, debates and plenary lectures. Proceedings are available for most of these events, and a book was published in 2006: *At the human scale: International practices in science communication*.[1]

PCST Electronic Discussion List

The PCST discussion list welcomes postings from people interested in the public communication of science and technology. The list now has close to 1,000 participants.

To subscribe to the list, visit http://pcst.mailmanlist.net.

Subscribers are automatically members of the PCST Network.

PCST Academy

The PCST Academy is responsible for the creation of the documentary basis of the PCST discipline. Its main task is the drawing up of reports on particular matters in the field of communication and social understanding of science.

PCST Structure and Membership

The PCST Network operates through a scientific committee led by an executive committee. The scientific committee is composed of about 25 world-leading experts in science communication.

PCST Network activities interest the following categories of people:

- Science journalists
- Science museum and science centre staff
- Academic researchers who study aspects of PCST
- Scientists who deal with the public
- Press and public information officers of scientific institutions
- Science theatre directors
- Anyone engaged in science communication interested in these issues

[1] Edited by Donghong Cheng, Jenni Metcalfe and Bernard Schiele (in collaboration with Michel Claessens, Toss Gascoigne and Shi Shunke), Science Press, Beijing, 2006.

For more information about the PCST Network, visit http://www.upf.edu/pcstacademy/PCST_Network.

Toss Gascoigne
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