Edited by
Patrick BARANGER and Bernard SCHIELE

Science communication today

International perspectives, issues and strategies

Journées Hubert-Curien
Nancy 2012

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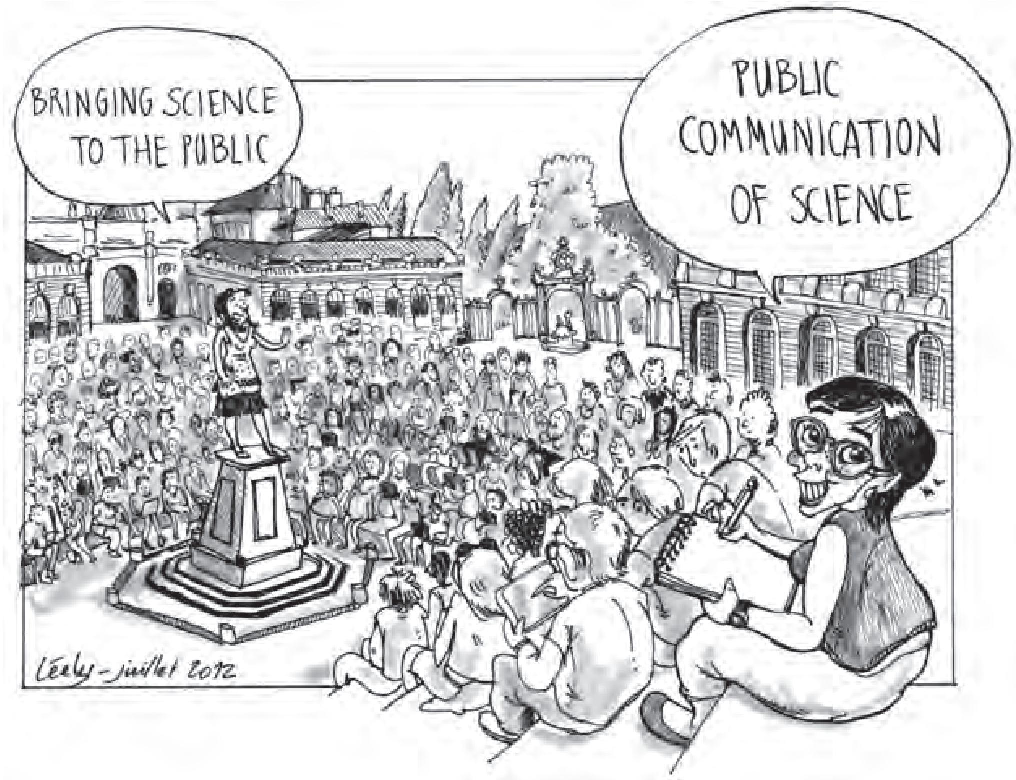
Edited by Patrick Baranger and Bernard Schiele

Foreword by Jean-Yves Le Déaut

Illustrations by Aurélie Bordenave



UNIVERSITÉ DE LORRAINE

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Foreword

Jean-Yves Le Déaut

AT THE BEGINNING of this century, knowledge has never been so developed, but confidence in progress has waned. We are not living anymore in one of those glorious times for science and technology, and history has left a somewhat idealized remembrance: the first sparks of the Renaissance in the Netherlands or in northern Italy, along with the invention of printing; the development of major shipping companies; the flowering of the creative genius of Leonardo da Vinci; the technical voluntarism of Colbert and Vauban at the end of the 17th century; the Age of Enlightenment characterized by the encyclopaedia of Diderot and d'Alembert; positivism and the constitution of the industrial base of Europe at the end of the 18th century in England, and then in the rest of Europe and in the United States; the quest for material prosperity, generalized in the postwar period; the euphoria of the Thirty Glorious Years and finally, at the very end of the 20th century, the computer and biotechnology revolutions.

For each of these periods, one should look more closely and separate the myth from the downsides.

Contested progress

Today, the scientific landscape varies.

There is an increase in confusing social fears, given the risks.

Science has gradually become the 'not enough thought step' of politics. Science and technology change the way we live and leave their footprint worldwide, but the scientific project does not appear to be included anymore in a civilization project. Indeed, progress is no longer perceived as a required step inherited from the philosophy of the Age of Enlightenment or as an essential tool to fight poverty, conservatism and inequalities. It must be admitted that progress has not benefited all equitably, since 2 billion people still face food and energy scarcities and do not have access to medical care or drugs. Progress is thus seen as ambivalent, generating wellbeing but also social, environmental and economic cliffs.

From there, this sense of loss of confidence in science that some call obscurantist reflux. Historically, obstacles to progress originated in religion (and creationism still has some believers in the United States today), but the current trend seems to sacralize nature and accelerates the transition from knowledge to its application.

In the current world, where communication is ubiquitous, science often finds itself in the dock. It is questioned, contested and challenged like never before.

The necessary assessment of scientific choices

In 1983, the French Parliament, aware of these new questions in society, established the Parliamentary Agency of Scientific and Technological Choices Assessment (OPECST), a bicameral body composed of 18 members and 18 senators. It reacts on scientific or technological issues before the legislative process, helping to define content in certain areas, as happened with nuclear waste management, nuclear safety, bioethics regulation and the preparation of new laws on the environment. The agency is also involved on the same issues after the legislative process, in a monitoring function of the French Parliament. It held numerous hearings after the nuclear accident in Fukushima.

The OPECST uses its role as intermediary between the political world and the scientific community. It informs, holds hearings, clears some misunderstandings, offers compromises, explains and justifies, and its impartiality guarantees credibility. It is, in fact, an instrument of science communication.

Controversies are not invented by science, but they come from the use we make of science. The ‘mad cow’ disease crisis was due to changes in the production of animal feed. The tragedy of asbestos and the refusal of some manufacturers to modify the use of some fibres despite information on the dangers was another case. As far as genetically modified organisms are concerned, the questions asked by public opinion highlighted important chunks of information not known or not taken into account by the experts.

Nowadays, public opinion requires the ability to question policymakers on the economic, social and environmental consequences of industrial innovations. In this context of suspicion, it is the role of scientific objectivity in the decision-making process that is the subject of controversy. The end of the 20th century was characterized by a crisis of expertise, following health crises (contaminated blood, mad cow disease, asbestos) and the multiplication of scientific controversies and technologies (genetic modification, electromagnetic waves from mobile phones or antennas, nanotechnologies).

This is why we have developed our hearings in the Parliament to examine transparent, public, collective and contradictory expertise. The process has become more collective. The question of expertise is then linked to the very political question of organization, and we need to open the process of public expertise (national conferences, national debates) and to focus on national, European and international levels but also on regional and local ones.

Innovation to the test of fear and risk

My last report of January 2012, co-published with Claude Birraux[1], on innovation to the test of fear and risk, was designed to explore the options that could be implemented so that science is not permanently put in the dock. We can consolidate our proposals around three ideas:

- To fight against disaffection, scepticism and collective ignorance, we advocate the introduction of the popularization of science and technology by teaching the scientific method at school and enhancing scientific and technical information in the media by training mediators and science journalists. In the long term, it is necessary to reorganize education in order to reactivate the

1. *L'innovation à l'épreuve des peurs et des risques*, report of the Parliamentary Agency for Scientific and Technical Choices Assessment (Rapport de l'office parlementaire de l'évaluation des choix scientifiques et technologiques), n$^{o.}$ 4214, 24 January 2012.

desire to innovate, teaching the beneficial virtues of failure, which are the strengths of future-oriented societies.

- In the mid-term, we need to bridge the gap between higher education, research and innovation. This is a task I am very much involved in, at the end of 2012, as part of a mission entrusted to me by the Prime Minister in connection with a broad process of consultation with stakeholders.
- Finally, in the short term, we must maximize the leverage effect of the essential public support for innovation. This is a key issue in budget discussions in these times of cuts to fight against the deficit in all western countries.

The conditions of the debate on 'science and society'

Building the dynamism of an economy through support for innovation is certainly a long-term undertaking, because it basically depends on the evolution of science communication methods, which has been at the centre of the debate about 'science and society' that has gradually widened since the 1980s.

This debate has highlighted a legitimate need for transparency, with which all new legislative adaptations in France will comply. I give as examples the institutionalization in 2006 of a pluralistic working group to develop a three-year plan for radioactive waste management, and the creation in 2008 of an economic, ethical and social committee within the High Council on biotechnologies.

But transparency only makes sense for a well-informed public. Transparency and knowledge are two inseparable conditions. Therefore, citizens and social actors must be allowed to participate in decisions on scientific and technological issues. They require scientific culture to be put again at the centre of our concerns and the state to play a major role in dissemination.

The OPECST plays its role, having recently launched a study on possible modalities of further action in this area using different means: education, public consultation and media communication.

Science must be a priority in a modern country that places youth at the centre of its priorities. If a country no longer believes in its future, that is a recipe for disaster. Our fellow citizens urge policymakers to prepare for the future. Their specific requirements are ambitious. Science must enable them to achieve knowledge advancement, to better understand the social and cultural facts, to better understand the world they live in and to create jobs, while protecting them from health, financial and economic crises and preserving the planet, without policymakers really realizing those demands. Science took a major role in democratic life; it must find a more important role in political life. To do so, it is essential to reconcile ethical science and society. It means sharing science so that it becomes a perennial element of our culture.

It is not surprising that most of the contributions in this book head in that direction and stress the need, at the international level, for a better dissemination of scientific culture.

As far as I am concerned, supporting a society of knowledge and knowledge as a whole must be a founding element of the principle of progress, but citizens remind us that this progress should be controlled and cautious.

They remind us that the duopoly of the expert and the political leader has outlived its usefulness, and that now the decision-making process must include the expert, the decision maker and the uninitiated.

Jean-Yves Le Déaut
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for Scientific and Technical Choices Assessment

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The Scientific Committee

The members of the Scientific Committee of the fourth *Journées Hubert Curien* were:

- **Bernard Schiele**, Chair, Professor at the Inter-University Research Center on Science and Technology, University of Quebec at Montréal (Canada)
- **Patrick Baranger**, Conference General Secretary, University of Lorraine (France)
- **L. Anathea Brooks**, Executive Office, Natural Science Sector & Unesco Biodiversity Initiative (UNESCO)
- **Claude Burlet**, Member of the National Ethics Advisory Committee, Honorary President of the University Henri Poincaré, Nancy (France)
- **Serge Chambaud**, Director of Scientific and Technological Culture at the Conservatoire national des arts et métiers, Paris, and Director of the Musée des Arts et Métiers, Paris (France)
- **Michel Claessens**, Director of Communication at ITER, Caradache (France), former Director of Communication, Directorate-General of Research at the European Commission, Brussels
- **Ulrike Felt**, Professor of Sociology of Science, University of Vienna (Austria)
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- **Claudie Haigneré**, President of Universcience, former Minister of State for Research, former astronaut (France)
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- **Halil Sykja**, Professor of Theoretical Physics, University of Tirana (Albania).

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French scientific illustrator **Aurélie Bordenave** (a.k.a. **Léely**) works and lives in Paris. She designs science popularization books for children and publishes regularly in the astronomy magazines *Ciel & Espace* and *Science & Vie Junior*. Léely loves sketching on the fly, and has produced many travel diaries and news reports in the form of drawings, besides publishing regularly in fanzines. She is also a member of Collectif Stimuli, a group of scientists and artists. To learn more about her activities, visit her website (illustrasciences.fr) or find her on Twitter (@LeelyDessin).

Contents

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Abbreviations and acronyms

CAST	China Association for Science and Technology
CRISP	China Research Institute for Science Popularization
DST	Department of Science and Technology (India)
EU	European Union
GDP	gross domestic product
GMO	genetically modified organism
HSRC	Human Sciences Research Council (South Africa)
IKS	indigenous knowledge system
IPCC	Intergovernmental Panel on Climate Change
NCSTC	National Council for Science and Technology Communication (India)
NGO	non-government organization
OECD	Organisation for Economic Co-operation and Development
OPECST	L'Office parlementaire d'évaluation des choix scientifiques et technologiques (France) (Parliamentary Agency of Scientific and Technological Choices Assessment)
PCST	public communication of science and technology
PR	public relations
PRC	People's Republic of China
R&D	research and development
S&T	science and technology
UK	United Kingdom
US	United States

Introduction

Patrick Baranger and Bernard Schiele

THIS BOOK reports on the work of the fourth *Journées Hubert Curien*, which took place in Nancy, France, from 2 to 7 September 2012. The theme of the conference was: 'Mediation of sciences: International perspectives, challenges and strategies'. In addition to the talks given by the researchers gathered for the occasion, 17 keynote speakers were invited to share their views with all those interested in the public diffusion of science. To broaden the audience, widen the scope of the discussion and thus enrich the debate, this book brings together the 17 main conference presentations.[1]

The fourth *Journées Hubert Curien* had four main objectives:

- *To remind us that universities and research centres are dynamic places engaged in the mediation of science*. This is contrary to the misconception that sees them as isolated and withdrawn.
- *To promote and stir up public involvement*. The evolution of the relationship between science and society has led to their increasing integration, to the point that contemporary society (the so-called 'knowledge society') is showcased as their natural and homogeneous endpoint. Science is today at the heart of culture: it not only transforms values, but also transforms the organizational patterns of society. It is thus unavoidable that the public, concerned with the issues and debates brought about by the relationship between science and society, wants an active part in it.
- *To rethink ways of interacting with the public and come up with new ones*. Until now, national and regional policies on science valorization and promotion have mainly targeted the

1. The papers presented at the conference can be found at http://www.jhc2012.eu

actions of actors on the periphery of the scientific field. Actors in science and technology have been challenged or mobilized only indirectly. However, there is a public demand for a direct dialogue with researchers because the impact of science on society raises ethical, political and economic issues – issues whose importance is now on par with the advancement of knowledge.

- *To interact in a world where the rules of the game have changed*. Because cyberculture multiplies the interactions between information producers and users *ad infinitum*, it makes of anybody a mediator among other mediators. In the globosphere, everyone is simultaneously on an equal footing and in opposition to everyone else.

These four objectives were set down by the members of the scientific committee after a two-year reflection, which can be broadly summarized in the following way.

The evolution of modern societies is characterized by the growing integration of science and technology. The impact of the development of knowledge and of its applications in all daily activities conjures up new representations. Those representations bear witness not only to the transformation of the relationship of science to the world but also to the transformation of the idea we have of the world. From them stem complex issues for societies, their organizations and their citizens.

The relationship between science, technology and society is thus at the heart of contemporary debates. This is why questions about the publicizing of science and technology, strategies of mediation and modes of public participation recur. Until now, however, government attention has mainly been focused on the actions of actors on the periphery of the scientific field. This explains the emphasis on the development of science museums, in all their forms, the media interests served by science journalism, and the wide array of associations and organizations dedicated to valorizing and promoting to various audience groups. Science and technology actors were called upon or mobilized only indirectly, reinforcing the widespread misconception of a science community isolated, withdrawn and unable to talk to anyone who is not a member.

This conference wanted to remind us that universities and research centres are lively places engaged in the mediation of science. Because science is a central value of modern societies, the need to share knowledge remains and ways to communicate science and technology are now raised in a new way.

Science communicators were once convinced of the need to bridge a knowledge gap between those who know and those who do not by translating specialized jargon into simple and accessible terms. That 'deficit' model of communication does not withstand scrutiny. Research over the past 40 years has demonstrated that there is no single public, but a diversity of publics, and that they are not as ignorant as was commonly assumed.

In addition, the media have recast the actors, turning upside down the relationships between scientists, politicians, journalists, experts and activists. Now, as soon as they participate in the media, they are on an equal footing with and in opposition to each other.

The topic of this book is the mediation of science in an environment where the rules for communicating science and technology have changed. The need for a dialogue between knowledge producers and their audiences, for whom the ethical, political and economic issues raised by research and its impacts are most important, is now as important as the advancement of knowledge itself. The real question is how to reach ambivalent audiences who are at the same time convinced of the benefits of science and technology but wary of their impacts. Nowadays, those audiences simultaneously subscribe to the worldview of science and criticize it.

An international comparative approach is needed. The knowledge, policies and practices of different nations enrich our global comprehension through a mirror effect. For that reason, the keynote talks presented in this book reflect 17 different perspectives, each related to a different background.

The edited papers published here can be organized along four axes.

1st axis: Purposes and issues

In most nations today, scientific research remains poorly understood, poorly perceived and sometimes frowned upon. A number of research fields and technoscientific choices are strongly questioned, debated, criticized and even rejected. The steadily increasing disaffection for training and careers in science and technology indicates a recomposition of the role and importance of science within contemporary society.

What are the issues for governments and research institutes? How to deal with the ambivalence of public opinion? How to respond? What is the content of national strategies drafted in different national contexts to respond to this problem? How to explain different national policy choices? What are the preferred and mobilized forms of science mediation?

The keynote talks of Claudie Haigneré (France), John Durant (United States), Gauhar Raza (India), Carmelo Polino (Argentina), Patrick Baranger (France) and Ren Fujun (China) investigate these purposes and issues in differentiated and differentiating social, historical and national backgrounds.

2nd axis: Audiences

Which audiences are the sponsors targeting? Whom do they actually reach? How do we identify them?

Research on cultural practices offers alternatives to the classical 'young' or 'general' audience categories used by professionals. By highlighting different relationships, newer categorizations mark out new types of audience. Reading habits, TV preferences, media uses, cultural outings, amateur activities and so on all reveal new audiences. For example, research into museums now differentiates between visitors and visits, the latter being characterized by *in situ* behaviours by visitor/s who attend alone, as part of a couple, with a few friends or in a larger group. Each combination reflects specific modes of knowledge appropriation.

Consider some of those questions:

- How can we conceptualize the audiences for mediations developed by university and research institutes?
- To which audience do we allocate high school students? Are they young or adult?
- Do schoolchildren have the same expectations (and do we have the same goals for them) when they are 'captive' in a school group that they do when they attend alone, or with their families?
- As an audience for research institutes, are university students a specific audience, a privileged one, or both?

- How do these audiences perceive scientific research and how do they see themselves in relation to that research?
- What is the expected role of these different audiences – passive or active?
- How well do they play that part?

Bernadette Bensaude-Vincent (France), Gauhar Raza and Surjit Singh (India), Hester du Plessis (South Africa) and Jenni Metcalfe (Australia) tackle these issues.

3rd axis: Actors

To whom do universities and research institutes delegate the mediation of science? Their internal communication services are often mobilized to conceive, organize and implement actions of mediation. To what is that mediation of science closest? Communication? Cultural services (a scientific culture alongside an artistic and humanistic culture)? Innovation and research promotion?

The place of the mediation of science in the organisational flowchart of a research institute tells us not only the purpose of mediation but also its importance. Furthermore, research institutes may create employment opportunities for mediation professionals, while universities may offer degrees in science communication.

Do all laboratories, research centres and universities engage in mediation? To what extent?

Research institutes often partner with science centres, science museums, associations, media, companies and so on, but do they have specific demands, objectives and working arrangements for their partners? How do institutes engage their researchers in communication activities, and do researchers play their part?

Public communication of science is one of the official missions of researchers, but are they actually involved in it? What recognition do they get for being involved? How do they perceive research and its place in society? What image of science do they project, and how is that see by 'public opinion'? How do they see themselves, and what image of science would they like to project?

Beyond their university training in science communication, and beyond their engagement in research, what part of researchers' professional identity is constituted by science communication? Are they up to the task, or do they need additional training?

Fabienne Crettaz von Roten (Switzerland) and Martin W. Bauer (United Kingdom) tackle the issue of actors.

4TH AXIS: THE FORMS OF MEDIATION

After the 'deficit' model and 'contextual' model eras, the mediation of science seems to be looking for new paradigms.

The shift from 'public understanding of science' to 'public engagement with science' does not resolve questions about modes of action. We are looking for new forms of engagement, and therefore for new forms of public debate. Are those new forms shaped in any way by the research institutes that mobilize them?

Is the issue of the 'general public's' confidence in or suspicions about scientific research more acute when research institutes engage in mediation? Do researchers and communicators work together? Will both jobs eventually be done by the same actor? Can, or must, new forms of social networks create new modes of mediation. How? To what extent?

Which tools, structures and resources can be mobilized by laboratories, research centres and universities for science communication?

Ulrike Felt and Maximilian Fochler (Austria), Michel Claessens (Belgium), Jan Riise (Sweden) and Maja Horst (Denmark) tackle the challenges facing mediation.

In conclusion, Bernard Schiele (Canada) puts forward five aspects that characterize the relationship between science and society today. Few of them have parallels in previous decades, precisely because science and technology have transformed our world.

The Declaration of Nancy

The fourth *Journées Hubert Curien* reasserted the essential part that citizens must play in decisions that affect them and their future by launching the Nancy Declaration[2] (see box).

2. Adopted by the participants gathered in Plenary Assembly.

Science and Society: Nancy Declaration

Science and technology are today part of our daily lives and our modernity, even if the public has some difficulty coping with the transformations of our world, which is becoming more and more technology-oriented and is rapidly changing. Today, almost every political, social or economic debate links to scientific and technological challenges.

However, citizens feel 'left aside' because they believe that scientific research and its applications are discussed and decided without involving them, and scientists have the impression that they are increasingly unheard and unlistened to.

Many countries have undertaken, with real success, activities in science communication and mediation to promote public engagement, through democratic debates, on collective challenges. The aim is also to build trust and strengthen the links between science, technology and society.

Participants in the *Journées Hubert Curien* international conference on science communication, who met in Nancy (France) from 4 to 7 September 2012, call on research stakeholders and decision-makers to

Strengthen the links between science, technology and society and value the role of citizens in science

In order to achieve this goal, it is necessary to support, with adequate means, the structures involved in science and technology mediation and communication, which obviously include universities and research organisations, but also media, social networks, science centres and museums, centres for scientific culture etc.

Participants in the fourth *Journées Hubert Curien* call for the following:

- **Citizens are key actors in research and innovation:**
  – because research developments, including their applications, implications and questions, must be communicated and discussed with the public;
  – because the distinctions between scientists and citizens are no longer relevant, as they all contribute to social decisions;
  – because solutions to current grand challenges are not only of a technological nature, but also require social, political and economic decisions;
- **The education of citizens and the future generations in science and the scientific method is an indispensable component of democratic citizenship at national and global levels;**
- **Stimulating the interest of young people for science studies and careers is vital for the sustainable and harmonious development of the economy;**
- **Science mediation is an integral part of scientists' jobs, so it deserves to be fully acknowledged and rewarded during their professional careers.**

– Nancy, 7 September 2012

Science et Société : Appel de Nancy

Les technosciences font aujourd'hui partie de notre quotidien et de notre modernité, même si le public, de son côté, suit avec difficulté les transformations d'un monde de plus en plus technologique et en évolution rapide. La plupart des débats politiques, sociaux, économiques… sont colorés par des enjeux scientifiques et techniques.

Considérant que la recherche et ses applications sont discutées et décidées sans eux, les citoyens se sentent « laissés pour compte » ; et les scientifiques ont l'impression de n'être pas toujours entendus ni même écoutés.

Beaucoup de pays entreprennent, avec d'évidents succès, des actions de communication, de médiation scientifiques et d'incitation à l'engagement par le débat démocratique sur les enjeux collectifs afin de raffermir la confiance et les liens entre science, technique et société.

Les participants des « Quatrièmes Journées Hubert Curien », réunis à Nancy du 4 au 7 septembre 2012, appellent les décideurs et acteurs de la recherche à

resserrer les liens entre la science, la technique et la société et valoriser le rôle du citoyen dans la science

Pour cela, il convient de soutenir avec des moyens appropriés les structures de médiation et de communication des sciences et techniques, dont font partie les universités et organismes de recherche eux-mêmes, les média et réseaux sociaux, les musées et centres de science, les centres de culture scientifique, etc.

Les participants des « Quatrièmes Journées Hubert Curien » appellent à prendre acte que :

• Les citoyens sont des acteurs à part entière de la recherche et de l'innovation :

– car les développements de la recherche, ainsi que leurs applications, implications et questions doivent être communiqués et débattus avec le public ;

– car le cloisonnement entre scientifiques et citoyens n'a plus de sens, chacun contribuant aux choix de société ;

– car les solutions aux grands défis actuels ne seront pas seulement technologiques, mais engagent des choix socio-politico-économiques ;

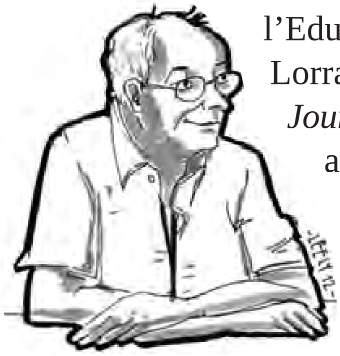
• L'éducation aux sciences et à la méthode scientifique du citoyen et du futur citoyen est indispensable au plein exercice de la citoyenneté démocratique au niveau national et global ;

• Le retour des jeunes vers les formations et les carrières scientifiques et techniques est vital pour le développement harmonieux et durable de nos économies ;

• La médiation des sciences est partie intégrante du travail des scientifiques et, à ce titre, mérite d'être reconnue et valorisée tout au long de leur carrière.

– Nancy, le 7 septembre 2012

The authors



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Part 1

Opening remarks

1

Scientific research in our society: knowledge, confidence and citizenships

Claudie Haigneré

Good evening, everyone.

I am delighted and very honoured to speak to you this evening to launch Les Journées 2012 Hubert Curien, which are devoted to the question of scientific communication. As president of Universcience, and like all leaders of science centres, it is a question that is at the heart of our concerns, together and in synergy with the producers of knowledge – the researchers.

How to convey scientific knowledge to all, whatever age or level of education? How to make it understandable without altering it? How to translate it without betraying it? How to reconcile rigorous explanation, approach awareness and creative presentation?

Answering these questions requires time and passion. My work often brings me to speak in front of various audiences, discussing issues of scientific research. Within this framework, I would like to tell you a story. A little while ago, last April, I attended a symposium organized by the OECD, a venerable institution known worldwide for the quality of its analysis and the legitimacy of its reflections. The topic was of the most importance: ‘Responses to crises and optimization of the dialogue between science and policy’.

But what astonished me was the wording of the question: straight away, the dialogue is established between the scientific and the political. It is true that in the resolution of a crisis these two protagonists play specific roles: the scientist brings his or her expertise;

the policymaker makes a decision and takes action. But what about the rest of the population? Cannot the vast majority of the others, whom we call civil society or public opinion, express themselves?

For the conference's organizers, this was apparently not an issue, or at least not when formulated that way. The only question that arose was when and how should we communicate with the public to better contain a crisis.

Civil society is *de facto* excluded from the dialogue aiming to find a solution. Citizens would only be receivers, receiving more or less obediently, more or less indulgently, expert information and decisions taken by the scientific and political communities.

If this approach surprised and shocked me, is not because it is 'politically incorrect'. It is above all because it seems anachronistic, archaic and therefore dangerous for our democracy. Why?

No doubt, this is largely due to the digital revolution. One of the consequences is that today, with the new means of information and communication, each individual is likely to challenge established powers.

- They can question the expertise of the scientist: with the internet, citizens can not only access a great mass of data, but also be producers of expertise – from the most rigorous to the most misleading.
- They can question decisions and political action: new social networks can create a global public opinion likely to mobilize for the best – or for the worst.

Today, whether we like it or not, civil society is no longer one parameter among others, but a stakeholder that needs to be taken into account. The question that should concern the scientific and political elites is how to optimize the dialogue between scholars, politicians and citizens. This is precisely the reason why I wanted my talk to deal with *knowledge*, *confidence* and *citizenship*.

Knowledge first. Nowadays, we live in what is called a knowledge society. The raw material of this society is grey matter – research, knowledge and the application of that knowledge. The major challenge, for all countries wishing to ensure sustainable growth and development, is to invest sufficiently in research and innovation.

But while the impact of scientific research and technological developments plays a major role in our daily lives, science seems paradoxically distant and reserved for the elite.

‘What’s the problem with that?’ one may ask. What could be more normal, after all, with science more and more complex and only a handful of experts able to master the ins and outs and high-stakes issues that affect society. During a dinner, everyone has an opinion about a cultural event but very infrequently about a recent scientific development, unless it is part of a controversy. Anyway, one could add, what the public is interested in is having a computer that works, not knowing how the computer actually works.

I would answer that the problem with the remoteness of science goes along with a wider misunderstanding, mistrust, or even rejection of the results of research. To come back to the information flows that overwhelm us today, is not the issue here to try to promote cultural education on science, issues and research methods?

Moreover, the digital revolution has enabled the proliferation of information until it causes dizziness. On the internet, the proliferation of scholarly expertise is matched by the proliferation of so-called secular counterexpertise.

The challenge is no longer to know how a computer works, but how to sort out data that appear on the computer. How to transform raw data so that it becomes relevant information? How to acquire reliable knowledge and assimilate it as an individual, as opposed to rejecting it out of despair or imperfect understanding?

How to fight against information overload? Overload information? How to become critical enough to separate the wheat from the chaff?

The trust of citizens in science people is not obvious anymore. And without trust, it is not only the development of the knowledge society that is threatened but, more seriously, the foundations of our democracy.

Don’t get me wrong – I am not nostalgic for the Golden Age of positivism! But I think that part of this distrust is rooted in the feeling of a growing part of the population that it is excluded from the debate. The more one feels excluded, the more wary one gets when listening to speeches or to solutions built behind closed doors. And the more suspicious one feels, the easier it is to oppose.

How to prevent democracy from becoming ‘this pathetic belief in the collective wisdom of individual ignorance’, to quote the cynical formula of Henry Louis Mencken, the American satirist of the early 20th century.

Today, we need to find how to include citizens in the dialogue between researchers and policymakers, and to define how to give citizens the proper means to take part in the democratic debate on scientific and technical issues.

Quite a lot to get through! Where to start? And then, how do we ensure that citizens exercise their power wisely and responsibly in an informed democracy? How to avoid seeing them taking the power of expertise by substitution or a power of decision in contrast? To act of course, but in which direction?

Researchers and decision-makers must empower citizens to ask, request, question. I do not mean freedom to spontaneously question or react – that is not enough. I'm talking about institutional responsibility on issues and questions from citizens.

This means, of course, to *open the discussion to citizens* and especially to *give them a seat around the table*. But for the power of questioning to find its logic, certain conditions are necessary: two preconditions and one condition inherent in the dialogue.

The first precondition is for the scientific community to honestly answer citizens' questions. An honest answer is a *transparent* answer, free from conflict of interest. An honest answer is a *complete* answer, delivered in its entirety, certainties and uncertainties all together – certified facts, unknown facts and controversies alike. Politics must be the guardian of scientific integrity and researchers' independence, to protect them both as much as possible against general suspicion and researchers' own temptations.

The second precondition, so that this questioning power can be exercised in a relevant and useful manner in an increasingly complex and uncertain world, is for the political community to educate citizens *to science* and *through science*. This dual role is well known in the field of research, but still not well enough recognized by schools: a new science education is just as important as a cultural education to science and technology.

Finally, one last condition for the dialogue is the ability to listen to and take into account *contextual*, *philosophical* and *political* values – to listen to the meaning for others – because listening through those filters of values is important.

Immediately, one thinks about the role of schools. That role is indeed decisive, and the responsibility for it is overwhelming, but did you know that our children acquire more than 90 % of their knowledge outside school, from family, friends, books and video screens. *Nature* magazine has called this ‘learning in the wild’, for it is outside the framework established by national education systems.

Indeed, we are here in Nancy to discuss this: in the dissemination of scientific knowledge, researchers also have responsibilities. They have what is almost a moral obligation to extend their knowledge beyond their laboratories, outside the circle of peers or insiders. Research in translating knowledge into an understandable language is perilous but imperative, today even more than yesterday. One has to add *conversation* to understanding. We must share the language and refer to a common culture to have a conversation.

Knowledge is also acquired in our science centres. At Universcience, we develop the desire to know by building new forms of communication – more imaginative, more creative and especially more participatory, more attractive and more embodied. The communication formats we develop are turned towards *empowerment*, a word that hardly translates into French.

To empower is to make available the means to understand, so that people can then take part in debates about scientific and technical issues to develop co-created solutions through the emergence of a collective intelligence, hopefully in the sense of a collective wisdom. Ownership. Emancipation. Then discussion.

And the new tools of communication and information can become powerful means to enable the emergence of this collective intelligence and empowerment – a form of collective wisdom that would go along with individual emancipation.

But I am not naive. I know for a fact that there will always be people who prefer approximate or even far-fetched theories to rigorous demonstrations. There will always be people who seek to discredit the results of research produced by the community of scientists, spreading doubt where there should be none. And I also know that, unfortunately, those people are not all simple citizens – sometimes they are unscrupulous researchers. It would be dreaming to believe that improving access to knowledge could eradicate controversies, defiance and rejection of scientific progress.

But I do believe in the *power* of education. I do believe that it is by giving to many the desire to learn, the right to know and the chance to get involved that we can deeply restore the trust between researchers, policymakers and citizens.

A lifeline for democracy, as Hubert Curien, the former visionary and pragmatic Minister of Research, so well understood. He knew the importance of setting up European research based on actions. He knew also the importance of European scientific cooperation: the European Science Foundation and the European Space Agency are his legacy. But he was also deeply convinced science should be open to citizens. You surely know that Hubert Curien is the father of the great national science festival which has taken place all over France since 1991. But you may not know that he had this idea after opening the Ministry of Research's gardens to the public – a successful initiative.

Here is a great mission for us science explainers and ambassadors: working together to make science a familiar and soothing garden where everyone takes pleasure in walking around, recharging their batteries, and marvelling at the sights!

The author

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Part 2

Opening conferences

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Beyond the ivory tower: The changing role of universities in their communities

John Durant

> The term has a rather negative flavor today,
> the implication being that specialists who are so deeply drawn
> into their fields of study often can't find a lingua franca
> with laymen outside their 'ivory towers'. Moreover, this problem
> is often ignored and instead of actively searching for a solution,
> some scientists simply accept that even educated people
> can't understand them and live in intellectual isolation.
> – 'Ivory Tower', Wikipedia entry,
> accessed 27 March 2012

Abstract: The ivory tower is both a synonym for the idea of the university and a metaphor for cultural isolation and irrelevance. For many, the very idea of the university has the twin connotations of rigour and remoteness, of intellectual brilliance utterly divorced from the realities of everyday life. While the pejorative associations of the ivory tower are readily mobilized on behalf of straightforward anti-intellectualism, they may also serve as a call to arms on behalf of a more positive vision of the roles and responsibilities of the university in its community. At a time when the pressures on the university – to teach, to research, to fundraise and more – have never been greater, we should not lose sight of the fact that the university is a vital part of the wider culture in which – for good or ill – it is embedded. At a time of great richness in forms of public outreach and engagement internationally, I argue that the best interests of the university are served not by withdrawing from the wider community, but by more actively reaching out to embrace it.

Keywords: research university, informal science outreach, science gallery, science festival.

UNIVERSITIES – and more especially, research universities – have a unique and important role to play in science communication.[1] In itself, this proposition is neither new nor (I hope) particularly contentious. Research universities have long recognized various kinds of responsibility to the wider community. At least since the 19th century, for example, research universities have offered outreach activities aimed at school students and/or adults; many have constructed museums that open their doors to the general public; and some have gone further yet, organizing ambitious programmes of part-time instruction for adults who are not enrolled as full-time undergraduate or postgraduate students but who nonetheless aspire to learning at the tertiary level.[2] In recent years, some research universities have also made significant strides towards providing learning opportunities online, and there is currently a great deal of interest in 'massive online open courses' (MOOCs) that allow many thousands or even hundreds of thousands of people to take university courses at little or no cost to themselves.[3]

The principle that research universities have responsibilities for teaching and learning that go far beyond their own full-time students

1. By 'research university', I mean here simply a university that is research active, in the sense that it expects its faculty to undertake original research and scholarship in their various fields of expertise. Research universities almost invariably teach at both the undergraduate and the graduate levels, since a great deal of their research effort (especially in the scientific disciplines) is conducted with the assistance of graduate students, who are themselves in a process of learning the art of original investigation.

2. I am particularly mindful of the long and honourable tradition of liberal adult education in the United Kingdom, since that is where I first 'cut my teeth' as a science communicator: first, in the Department of Extra-Mural Studies (now the Department of Adult Continuing Education) at the University of Swansea, and then in the Department for External Studies (now the Department for Continuing Education) at the University of Oxford. For a historical analysis of the liberal adult education movement in the UK, see Fieldhouse (1996). For a recent account of one prominent American university's substantial efforts in the same general area, see Shinagel (2009).

3. For more than a decade, my own university, the Massachusetts Institute of Technology, has been posting entire course curricula online in an initiative known as 'Open Courseware' (http://ocw.mit.edu/index.htm). Today, it is becoming heavily invested in edX, a consortium of American research universities that is putting free courses online at a rapid pace (http://www.edx.org/).

is, therefore, well established. In recent years, however, research universities have added to their traditional responsibilities in continuing education an increasingly important range of contributions to informal science outreach. Again, the roots of this sort of work go rather deep. For example, research universities have long offered occasional public lectures on a wide variety of subjects, and they have also developed museums (usually based around research and teaching collections) that are open to the wider public. In recent years, however, there has been a great deal of innovation in how research universities go about informal science outreach. Gone are the days when they contented themselves with offering occasional public lectures, together with access to museum galleries designed principally to serve the interests of researchers and university students. Today, research universities are developing many different forms of informal science outreach, from ‘citizen science’ projects that enable non-professionals to contribute actively to research, right up to full-blown science festivals that may engage tens of thousands of people in the work of the university. These new approaches are, I suggest, a response to real needs and interests at the interface between science and society, and they represent a huge opportunity for the larger field of science communication.

To understand the importance of the research university as an institution of informal science outreach, it is necessary to appreciate two key facts. First, across the developed (and, increasingly, the developing) world, research universities support a very large fraction of the total research and development (R&D) undertaken in society. Thus, in its latest *Science and engineering indicators* report, the United States National Science Foundation states that ‘Universities and colleges performed $54.4 billion of R&D in 2009 … This was almost 14 % of total U.S. R&D spending that year, making academia the second-largest performer of U.S. R&D.’ At 14 % of total R&D, academia would seem to be trailing a long way behind the business sector, which accounted for 71 % of R&D in the United States in 2009. However, a very large fraction of business sector R&D is focused on the ‘D’ part of R&D, and very little of it is focused on basic research. Indeed, *Science and engineering indicators 2012* tells us that universities and colleges ‘continue to occupy a unique position in U.S. basic research. They are the primary performer of U.S. basic research (53 % in 2009), while also training the next generation of researchers’ (NSF 2012).

To the crucial role that universities play in the conduct of research (and especially basic research) must be added a second fact, namely that universities employ the vast majority of scientists who may be said to be involved in the conduct of 'disinterested' research. By this, I mean simply that many university scientists still conduct research with funding from a variety of governmental and/or non-profit funding sources, under terms that give them (the researchers) no vested financial interest in the outcomes of their work. A very large fraction of university research is publicly funded. Returning to the National Science Foundation's *Science and engineering indicators 2012* report, for example, we find that 'Academic institutions also rely much more extensively than the business sector on external sources of funding, particularly the federal government, at about 60 %, to support the R&D they perform' (NSF 2012). If to federal funding support we add funding support obtained from charitable trusts and foundations and from other non-profit sources, we will find that the overwhelming majority of university research projects are being conducted for public rather than private benefit. In the most basic sense, these projects are designed to add to the stock of human knowledge in ways that will benefit humankind.

The prominent place of universities in disinterested scientific research has multiple implications for informal science outreach. If we wish to introduce audiences to modern science, there are few better or more obvious places to which to turn than the research universities. Here we will find not only a large number of professional researchers, but also the great majority of trainee researchers – undergraduate, graduate and postdoctoral students who occupy the lowermost rungs of the professional ladder of research science. Here, too, we will find a degree of openness and an awareness of social responsibility, which are equally important in persuading researchers to invest time and effort in public outreach. In my experience, dependence on what Americans like to refer to as 'taxpayer dollars' (that is, public funding) helps to convince many research scientists of the importance of explaining their work to non-professional audiences. I have lost count of the times that I have heard a professional scientist preface a talk for a general audience by saying something to the effect that 'You're paying for what I do; you deserve to know what it's all about.'

These features of university research science are obvious strengths in the field of science communication. Professional science communicators are indispensable to our field – among other things, they are (or should be) experts in the dynamics of the relationship between science and society, in programme development and facilitation, and in public presentation; but, on their own, professional science communicators cannot provide everything that is needed to engage non-scientists effectively with the world of research. In particular, they cannot (by definition) provide first-hand accounts of recent or current scientific investigations. If we want audiences to get better acquainted with the realities of scientific research – with how work is done in particular fields, and what it feels like to do such work, as well as with what has been learned and what remains to be understood, at any given point in time – then some sort of direct engagement with researchers is more or less essential.

This is where research universities have found their distinctive role in informal science outreach. From the very beginning of the modern movement for what used to be called 'public understanding of science' (now more commonly referred to as 'public engagement with science'), there has been a deserved emphasis on mobilizing professional scientists in the service of informal science outreach. I recall well the many different initiatives that were launched in this area in the UK after 1985. For example, there was the Michael Faraday Prize of the Royal Society of London, awarded annually from 1986, for excellence in communicating science to UK audiences. Alongside it, there were multiple incentives for scientists to engage in outreach, including communication requirements built into research grants, fellowships for scientists to spend time working in the media, prizes for popular science books, and more. The early public understanding of science movement in the UK had several objectives, but the one area in which it was most obviously and tangibly successful was in motivating and mobilizing professional scientists to be more active in informal science outreach.

Partly as a result of these and related efforts, the past couple of decades have witnessed a plethora of new initiatives in informal science outreach on the part of research universities. Older university museums of science and technology, for example, have been extensively revamped as outreach organizations. At their largest and grandest – one thinks, for example, of the Manchester Museum at the University of Manchester, and of the Musée des Arts et Métiers, the museum of the Conservatoire National des Arts et Metiérs, in

Paris – such museums are major visitor attractions offering unique access to the fruits of scientific and technological research. More typical, however, are somewhat smaller university museums that have also been able to develop as major platforms for informal science outreach. Across Europe and North America (not to speak of other regions of the world), institutions as diverse as the Medical Museion at the University of Copenhagen, the University Museum of Natural History at the University of Oxford, and the Museum of Texas Tech University in Lubbock, Texas, offer widely contrasting approaches to informal science outreach.

And research universities' efforts in informal science outreach have not been confined to museums. Building on a legacy of annual science conferences that dates back to the early Victorian period, the British Science Association (formerly the British Association for the Advancement of Science) has built the British Science Festival into one of Europe's largest annual celebrations of science, engineering and technology. This festival moves to a different university city each year; but there are other independent science festivals, such as the Cambridge (UK) Science Festival, that are based firmly within single research universities.[4] In the US, annual science festivals are now established in more than a dozen towns, cities and states, including Arizona, Cambridge (Massachusetts), Las Vegas, New York, North Carolina, Philadelphia, San Diego, San Francisco, St Petersburg, Seattle, Washington DC and Wisconsin. In the main, these are highly collaborative initiatives, but a significant proportion of them are coordinated and produced by research universities – including the Bay Area Science Festival (University of California, San Francisco), the Cambridge (Massachusetts) Science Festival (MIT), and the North Carolina Science Festival (University of North Carolina).[5]

At least as significant as the quantity of informal science outreach currently being offered by research universities is its increasingly wide creative range. Gone are the days when the preferred format

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4. For details of the British Science Festival, see http://www.britishscienceassociation.org/british-science-festival; for details of the Cambridge (UK) Science Festival, see http://www.cam.ac.uk/sciencefestival/.

5. Details of the rapidly expanding science festival scene in North America can be obtained from the Science Festival Alliance, a National Science Foundation initiative that exists to support the growth of science festivals in the US. See http://www.sciencefestivals.org.

for museum gallery displays was a collection of artefacts arranged in glass cases; now, university museums offer a great variety of exhibition formats and styles, in which hands-on interactive and multimedia exhibits, gallery demonstrations and art – science installations are all commonplace. Gone, too, are the days when the preferred format for scientists' outreach was the set-piece 50 or 55 minute public lecture, followed by a few desultory questions. Increasingly, scientists are now asked to engage in dialogue – with presenters in set-piece interviews, with one another in panel discussions and with audiences in an almost bewildering variety of conversational forums. The availability of web communications has meant, too, that an increasing number of outreach events now have 'second lives' – as webcasts, podcasts, videocasts and so on.

Two examples must suffice to give some sense of the creative diversity of what research universities are doing today in the area of informal science outreach. In the mid-2000s, Trinity College Dublin opened a new facility that is part science museum, part art gallery, part event venue. Describing itself as 'A place where ideas meet and opinions collide', the Science Gallery eschews permanent collections and instead provides special exhibitions and a rich array of events, talks, debates and workshops. Recent exhibitions have titles like *What If …: Future Form, Future Function; Biorhythm: Music and the Body; Human +: The Future of our Species;* and *Hack the City: Take Control*. Accessing the Science Gallery's website on 24 November 2012, I read: 'This week at Science Gallery: Create a New Science Gallery, Scare the Daylights out of Yourself, and Robots in Dementia Care'.[6] The Science Gallery bears comparison by turns with some of the more creative science centres, but also with institutes of contemporary art. Above all, it seems to be about facilitating conversations at the interfaces between science, technology, art, design and culture. And the concept seems to be working: earlier this year, Science Gallery Director Michael John Gorman announced an initiative 'to develop a Global Science Gallery Network with leading universities located in urban centres worldwide'. The aim, apparently, is to establish eight Science Galleries worldwide by 2020.[7]

6. http://sciencegallery.com.
7. http://sciencegallery.com/international.

Turning from public science galleries to public science events, it is exhilarating to see what is being cooked up these days in the world of science festivals. The US Bay Area Science Festival was launched with a bang in 2011. Presented by the University of California (San Francisco) on behalf of a broad coalition of Bay area scientific, cultural and educational organizations, the first Bay Area Science Festival offered a breath-taking range of activities and events, including a *Sci-Crawl* of bars, pubs and clubs in the mission district of San Francisco, *Mima la Scienza!*, in which Bay area students pantomimed science concepts to students attending the Genoa International Science Festival in Italy, and *Discovery Days at AT&T Park*, where more than 20,000 people enjoyed a day of interactive exhibits, experiments, games and shows at the baseball stadium that's home to the San Francisco Giants. What was the theme that united the 100+ events at multiple locations in this first Bay Area Science Festival? According to Festival Director Kishore Hari, interviewed on Comcast's 'Newsmakers' TV channel in June 2011, 'I think science and technology are the underpinnings of the culture here. So in the same way we celebrate art, and music, and food through festivals, I think it's time we celebrate science.'[8]

The point here is not any one gallery, festival, activity or event; rather, it is the sheer exuberant variety of outreach initiatives involving university scientists that are now on offer on both sides of the Atlantic. Today, there is an obvious cultural demand for direct access to scientists who are prepared to talk engagingly about their and their colleagues' work. 'Visible scientists'[9], like Brian Cox in the UK (Manchester University) and Brian Greene in the US (Columbia University), produce successful trade books and TV shows, make regular media appearances and take an active part in informal science outreach initiatives – Greene, for example, is co-organizer with his partner Tracy Day of the highly successful World Science Festival in New York City.[10] More widely, science (and scientists) are finding places in the club scene, in storytelling events and even

8. Kishore Hari, interview with Comcast 'Newsmakers' TV taped 13 June 2011. Retrieved 24 November 2012 from http://www.youtube.com/watch?v=o6CoPaiZKmo.

9. The term 'visible scientist' was coined by Rae Goodell (1977), who wrote about an earlier period, but it fits the current scene very well.

10. http://www.worldsciencefestival.com.

in stand-up comedy.[11] Fashionable online TED talks feature more scientists and engineers than any other professional groups; science festivals continue to blossom, not only in bigger cities but also in smaller, more rural communities; and the science cafe movement, which was pioneered in the UK by Duncan Dallas, building on an original French initiative of the early-1990s, has gone truly global.[12]

In these and hundreds of similar initiatives, the common theme is professional researchers (usually, but not always, working in research universities) in direct dialogue with non-scientists – members of the public who are eager to hear more about what is being said and done in the world of science. Speaking personally for a moment, as the Director of the MIT Museum in Cambridge, Massachusetts, I am under no illusion about the fact that the one indispensable asset available to me is the MIT community itself – the students and faculty who are doing science and engineering across the institute. Opportunities to engage directly with these people – whether in the museum itself or out in the wider community – are always the biggest draws. On the eve of our annual Cambridge Science Festival, for example, we offer something called *Big Ideas for Busy People:* ten short, sharp talks by Cambridge area researchers – 5 minutes per talk, plus 5 minutes for questions – which we advertise as 'a roller-coaster ride through some of the biggest, boldest ideas in science'. The result? We play to a packed house (or rather, to a packed First Church in Harvard Square) each year – in fact, in 2012 we had to turn people away at the door.[13]

The Ivory Tower was always an imperfect metaphor for the research university. Indeed, as Shapin (2012) has recently observed, the increasing use of this metaphor in connection with academic science in the postwar period was associated with a growing recognition of the important place that academic science now occupied in wider society. As a matter of fact, research universities have long recognized the reality of their cultural, social and political embeddedness; and, by the same token, it would be perfectly possible to analyse the multiple benefits to universities of supporting informal

11. For examples of each of these genres of informal science outreach, see the Secret Science Club at http://secretscienceclubg.blogspot.com; the Story Collider at http://storycollider.org; and Robin Ince at: http://robinince.com

12. http://www.cafescientifique.org.

13. http://www.youtube.com/playlist?list=PL56144796568C6900.

science outreach events such as those I have mentioned in this rapid review – of the positive effects that such events have in areas like student recruitment, student and faculty professional development, and even fundraising (not to speak of the obvious public relations benefits involved). At occasional times of crisis, when even universities' licences to operate may be in question, community outreach around current research can make a decisive difference.[14]

But though important in themselves, these and related benefits are, in the end, merely incidental. The real purpose of informal science outreach from research universities is not to help the universities but to help make science and technology integral parts of the wider culture. I take this latter purpose, in various forms, to have been the mantra of the science communication movement since its inception. Over more than a century, advocates of more and better science communication have bemoaned the sequestration of science from other areas of cultural endeavour. This was the common complaint of Thomas Huxley in the mid-19th century, of C.P. Snow in the post-war period, and of advocates for 'public understanding of science' in the 1980s and 1990s.[15] Today, there are one or two encouraging signs that our collective efforts in this direction over many years may actually be starting to work; that science may be in process of becoming better assimilated into at least some parts of the wider culture. Of one thing, at least, I am certain: the research universities are, and will remain, an indispensable resource in our ongoing work to ensure that this really does happen.

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14. I have discussed one such episode that took place at Harvard and MIT in the 1970s, when the city of Cambridge, Massachusetts set up a public inquiry to investigate whether these universities should be permitted to conduct research involving the use of 'recombinant DNA technology'. See Durant (2010).

15. See, for example, Huxley (1868), Snow (1959) and Bodmer (1985).

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Scientific temper and Indian democracy

Gauhar Raza

Abstract: Paradigm shifts in thought structures cause deep ramifications in every sphere of human activity. The secular and scientific ideas that crystallized in the furnace of French Revolution influenced the entire world. Nineteenth and twentieth century development in India did not remain untouched by what was happening in Europe. The freedom movement forged an inclusive 'Indian identity', for which the 'other' was British imperialism. This identity *per se* was secular and was based on 'scientific temper'. Jawaharlal Nehru, the first prime minister of India, introduced the phrase and accompanying notion into Indian discourse before India achieved its independence. It provided the ideological basis for shaping both science and science communication. Since then it has been repeatedly discussed, especially during the times of crisis, and has reinforced Indian democracy.

Keywords: scientific temper, Indian identity, freedom struggle, secular, science communication.

LET ME BEGIN by proposing that whenever the tectonic plates of ideas collide, the tremors shake the entire human world and beyond.[1]

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1. Although I have been working on issues of 'scientific temper' for the past 25 years and have observed some of the events and campaigns cited here quite closely, Prof. Bernard Schiele and Prof. Patrick Baranger's request gave me an opportunity to crystallize my ideas. I am thankful to them that they acceded to my request to deliver the lecture extempore. Based on memory and notes, the skeleton of the lecture is maintained here as it was delivered, but a lot of flesh was added later as I wrote it down.

The French Revolution was an event on the trajectory of human civilization when old, outmoded ideas collided fiercely with the newly emerging paradigm of thought.[2] The 'old world crumbled', and not just in France: the shockwaves were felt far and wide. *Liberté, égalité, fraternité* (liberty, equality and fraternity) epitomized a new vision, and the revolution in action, which was a transformation of theory into material force[3], gave other societies confidence that large-scale changes could be brought about in social structures.

The deeply religious, caste-ridden, feudal society of 19th and 20th century India did not remain untouched by the social, scientific and technological developments that were taking place in Europe. While tracing the history of rockets, Roddam Narashimnha shows that Tipu Sultan (1750–1799), a fairly important monarch of southern India, was aware of and curious 'about European inventions such as barometers and thermometers', and that he made 'vigorous efforts to promote manufacture of novel devices in various cities of his state'. He collaborated with the French to resist the expansion of British forces in India. This collaboration must have channelized information flow and discourse that was taking place in France and Europe, in spheres other than technological development.

By no stretch of imagination am I asserting here that opposition to institutionalized religion, the caste system, untouchability or feudal values began with the flow of ideas from the west. The tradition of scepticism and opposition to institutionalized inequality in India is as old as the conformist and divisive ideas that dominated the mainstream philosophies, which in turn shaped social, cultural and economic structures during the past few centuries. The Charvaka, Lokayata and Buddhist philosophies opposed the very notion of the existence of supernatural power and rituals in ancient India.[4] In the

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2. The plethora of fiction, songs, painting, short stories etc. that French Revolution produced shows that it had touched every section of society all over the world. In her recent novel, Jennifer Donnelly artfully expresses the radical change it brought about: 'Little by little, the old world crumbled, and not once did the king imagine that some of the pieces might fall on him' (Donnelly 2010: 171).

3. Marx (1884): 'theory also becomes a material force as soon as it has gripped the masses.'

4. Baniang (2011) gives an overview of how the idea of secularism has developed over the centuries. There were six theist (Astik) and six athiest (Nastik)

medieval period, Emperor Akbar (1542–1605 AD) was ‘opposed to all religious rituals’, child marriage and many other social beliefs based on dogmatic practices (Sen 2009: 38–39).

It should also be noted that the ideas popularized during the European Enlightenment took a few centuries to become part of the dominant social thought structure even in Europe. Propagation and absorption of new and radical ideas was a long-drawn sociocultural process, not a one-off event. Amartya Sen quotes many scholars, such as Ludwig Wittgenstein, Isaiah Berlin and Jonathan Glover, to point out that ‘It is, however, difficult to generalize about any overwhelming dominance of reason in the thinking prevalent in what is seen as the Enlightenment period’ (Sen 2009: 34). He also asserts that there were many different ‘counter-strands’ during the ‘age of Enlightenment’.

The intense debate that this ‘age’ generated lifted some already existing but dormant ideas, and many new ideas, to a higher plane of social consciousness. For example, notions of democracy, the equality of human beings, fraternity and freedom were not alien to humanity, but assumed new meanings during this period.[5] These ideas now transcended class, caste, race and geographical boundaries. Many ideas and actions were new to both the scientific community and to common citizens: the rejection of the geocentricity of universe, insights into the evolution of species, denunciations of the idea of ‘royal’ blood and subsequently the abolition of royalty, newly discovered causes of diseases on the basis of scientific evidence, and many more.

These ideas became the bedrock on which social, cultural, economic, scientific and technological structures were constructed in the emerging nation-states of Europe. Imperialism played a dual role. On the one hand, it propagated these secular ideas; on the other, it

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schools of philosophy in India. ‘The Indian school of materialism, Charvak, perhaps developed against the excesses of Brahmin priests and an exploitative society.’

5. ‘The lamp of assembly-based democracy was first lit in the ‘East’, in lands that geographically correspond to contemporary Syria, Iraq and Iran. The custom of popular self-government was later transported eastwards, towards the Indian subcontinent, where sometime after 1500 BCE, in the early Vedic period, republics governed by assemblies were common. The custom also travelled westwards, first to Phoenician cities like Byblos and Sidon, then to Athens …’ (Keane 2009: xi).

distorted them to suit imperialist political and economic interests. The ‘white man’s burden’ was one such notion.[6]

3.1 The Indian freedom movement

Historians are divided on when the notion of an Indian nationhood was born. Some argue that it existed before the British came to India. Others firmly believe that it grew in response to colonial oppression. Even if we concede the idea that a feeling of nationhood existed in this part of the world before colonization, it is apparent that the Indian identity was quite weak in the 19th century. Caste, ancestry, religious and regional identities were some of the markers which defined an Indian individual. Their abundant variety also indicated that nationhood was not a pre-colonial imperative.

Not once during the ancient period did a single emperor rule the entire landmass that today is known as the Indian subcontinent. Even during the medieval period large parts were ruled by kings, who were independent of the Delhi Empire (or Sultanate) or later Mughal state (see Chandra 2006). The Indian landmass can be divided into large regions, which have nothing in common – they were always geographically, culturally and socially diverse. Inhabitants of Punjab speak a language that for Tamil, Telegu or Malayalam speaking people is as alien as any other language in the world. More than 3000 dialects are spoken in India today. People differ in food habits, dress, habitat and much more. Numerous religions are practised in India. The list is long. There was really no ground for a common identity. However, the only common feature – the caste system[7], practised in various forms – did cut across all boundaries, even religious ones.

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6. Rudyard Kipling, in his famous poem ‘White Man’s Burden’ first published in 1899, articulated the prevalent consciousness that justified the aggressive exploitation of the entire human race by the imperialist powers. See http://historymatters.gmu.edu/d/5478/ (retrieved 17 November 2012).

7. See Ramesh Chandra (2005: 28), who has collected a number of definitions of caste; for example, ‘caste as a social group having two charecteristics: (1) membership is confined to those who are born of members and includes all persons so born; (2) the members are forbidden by an inexorable social law to marry outside the group.’

By the mid-19th century, the British had captured and ruled over almost the entire Indian population. It was a fragmented population, displaying many varied identities. However, for governance and administrative purposes the entire region had to be given a single name. Initially the British referred to this part of the world as 'the Indies' or 'the East Indies' after the 'West Indies' was discovered.[8]

'The Sepoy[9] Mutiny of 1857', as it was called by the British, or the 'First War of Independence', as it is remembered by Indians, was a major turning point in the history of India.[10]

The revolt continued for more than a year, but ultimately the British were able to crush it. Of course, it was not possible to quench this fire without the active help of large sections of natives. Substantial segments of the military (raised from other parts of India, like the Punjab and Madras) and many feudal lords remained loyal to their British overlords. It was a fragmented society that rose against a technologically modern force. While the rebels fought against the British, they did not fight for a common cause: the feudal classes had nothing in common with the peasantry or the sepoys. Visible seeds of democratic thought sown in the proclamations issued at the behest of the War Council constituted in Delhi, just after the mutiny, must have made the feudal lords quite uneasy.

The mutiny was crushed. What followed the defeat was sheer barbarism. It was the biggest revolt of the century and had to be dealt with using extreme brutality. A hundred thousand sepoys of the Bengal Native Infantry regiments had revolted and each one of them was killed. A million civilians were massacred.[11]

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8. See 'A new account of the East Indies being the observation and remarks of Captain Alexander Hamilton', which gives an interesting account of prevailing conditions and changes in India from 1688 to 1723. Retrieved 5 August 2011 from http://books.google.co.in/books/about/A_new_account_of_the_East_Indies.html? id=2YCoCwtJd1gC .

9. Sepoy: an 'infantry private' – the lowest rank in the Indian Army. The term came into use in 18th century in the British East India Company and is still used today.

10. Kaye (1880: 214) gives an interesting account of various Indian identities that mattered during the war, especially the religious and caste identities.

11. Taqui (2001: 264–267) describes scenes of horror and looting that took place in Lucknow, writing of one incident that '… there was no law and no justice. The innocent Indians were falsely convicted and put in the mouth of Howitzer and

Perry Anderson in his recent book points out:

> For a century after the seizure of Bengal, sepoys in the command of the East India Company outnumbered whites six to one. The mutiny of 1857 came as a severe shock [and] altered this mixture. Thereafter, the policy of the Raj was to hold the ratio at two to one, and make sure that native detachments developed no common identity. (Anderson 2012: 12)

The policy of 'divide and rule' was not confined to the configurations of the military. The social and religious crevices, wherever they existed, were actively enlarged to strengthen the Raj.

The leadership of the national freedom movement that subsequently emerged was divided right from the beginning. Some wanted to seek concessions from the British and played the 'game' by the British rules of justice and respect. There were also those who wanted to use force and organize people to overthrow the British Raj. It is important to note that all the political and reformist groups that emerged realized the importance of building an overarching national identity that would form a common thread and bind all Indians. This would be an identity that cut through all divisive identities, an identity based on a modern, secular and scientific value system.

All 'selves' are constructed against the 'other'. In order to commence a struggle against a colossal 'other', an equally robust and gigantic identity of 'the self' must be created. The seeds of this identity (that is, the Indian identity) were already present in the universal subjugation of the Indian masses, including the former ruling classes.

This Indian identity evolved during the freedom struggle, which continued for more than 90 years. The evolutionary process necessarily meant the propagation and inculcation of ideas that were not rooted in Indian culture and philosophy. Notions of universal suffrage, equality of genders, education for all, jobs for all, science and technology for nation building, secular value systems and scientific temperament were borrowed from the west.

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fired, even a smartly wound turban or a dashing military style moustache would be taken as proof that the owner was a sepoy and thus a mutineer. Thousands were hanged, shot, blown away from guns, etc. There was no record how many.'.The description of looting by the British fills pages – the looted palaces numbered 92 in the region spanning from Moosa Bagh to Bibiapur.

It is remarkable that Indian identity was not constructed against the image of the white oppressors. It was not a racial movement. The 'self' was built against imperialism. Nor was it an angry uni-directional crusade devoid of scholarship and self-critical analysis of feudal, irrational and unscientific social structures.

Jawaharlal Nehru, the most important leader of the freedom movement after Gandhi, wrote his celebrated book, *The discovery of India*, while imprisoned in Ahmednagar Fort. In his angst, he did not lose sight of what should be learned and what should be opposed by the leadership of the movement:

> Which of these two Englands came to India? The England of Shakespeare and Milton, of noble speech and writing and brave deed, of political revolution and the struggle for freedom, of science and technical progress, or the England of the savage penal code and brutal behaviour, of entrenched feudalism and reaction? (Nehru 1994: 284).

In the same book, while historically analysing the caste system, Nehru concluded that the system 'brought degradation in its train afterwards, and it is still a burden and a curse; but we can hardly judge it from subsequent standards or later developments' (1994: 84).

3.2 The scientific temper

In 1976, a constitutional amendment was introduced and, through an act of parliament, India became the first country to include spreading the 'scientific temper' as a fundamental duty of every citizen. However, the history of discourse is spread over a long period in pre- and post-independence India.

P.V.S. Kumar shows that the phrase 'scientific temper' first appears in the English language around the mid-19th century. In 1893, the phrase is used in an article in a journal, the *Andover Review* (Kumar 2011). He further suggests that the concept of 'scientific temper' in its initial form referred to a set of practices (praxis) prevalent among the community of scientists at that time. The frequency of its use gradually increased in the first three decades of 20th century.

In India, this was the period when the freedom movement was gaining momentum. Gandhi returned to India from South Africa in 1919 with a baggage of 'nonviolent resistance', yet to be perfected, and 'transformed Indian politics, leading the first mass movement to rock the British power since the Mutiny, and remaking the congress a popular political force' (Anderson 2012: 16–17). This mass movement was the most potent channel of secular ideas for the next many decades until India became free.

It is amazing that (barring a handful of communists, including Bhagat Singh, and a handful of those who were considered as left of the centre, such as Nehru and Ambedkar[12]) almost all important leaders of the Indian freedom movement were deeply religious, yet in order to build the Indian identity they had to accept and propagate secular ideas.[13] Their religious predisposition, belief systems and practices in personal life did not reconcile with notions of 'equality of human beings', 'equality of gender', 'education for all', 'equality of job opportunity for all', 'science and technology as the basis for future development of a nation' or 'rejection of miracles and intervention of divine powers'; however, each one of them actively propagated these ideas.

The construction of an inclusive Indian identity needed all these ingredients. The political leadership could not ignore the aspirations of any section of society. In this grand project, the contribution of all sections of intellectuals were also important. Anderson (2012: 15) calls this class of intellectuals the 'seedbed of Congress nationalism'. A galaxy of scientists, doctors, writers, science communicators and teachers had shaped the consciousness of this movement. For them, the creation of scientific temper among the people was a fairly important objective.

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12. Ambedkar later adopted Buddhism.

13. Gandhi relentlessly engaged with the issue of 'untouchability'. See Chandra (1989: 292): 'Gandhiji undertook two major fasts on 8 May and 16 August 1933, to convince his followers of the importance of the issue and seriousness of his efforts.'

3.3 Nehru's idea of the scientific temper

Nehru's *The discovery of India* has remained under the scanner since it was first published in 1946. According to him, the first draft was written over a period of five months and was given to other imprisoned leaders for reading and suggestions (Nehru 1994: 9). He finished the book during the next 'year and a quarter'. Within less than two years of its publication, he was elected the first prime minister of independent India, which clearly shows that by the time he had decided to write down his thoughts he had become the most important political personality, after Gandhi, to influence the people's mass consciousness.

Although *The discovery of India* is a commentary on a large number of issues, ranging from Nehru's personal life to contemporary international, national, social and political events, the book chronologically covers the history of India from ancient times to the 1940s. One small five and a half page subsection of Chapter 10 (pp. 509–515) carries the heading 'Religion, philosophy and science'. By just looking at the contents, one may ask a valid question: why so much fuss about a couple of pages in a book of 581 pages?

The reason is simple and twofold. First, the book was written by the most important leader of the freedom movement. Second, the writer was destined to become the first prime minister of India and was to shape the future science and technology of the nascent but largest democracy. Every statement in the book indicating future directions was of immense value and needed to be discussed by various sections of society. Therefore Nehru's views on science, technology and the scientific temper, reflected in the book, decided the direction of discourse – especially after independence.

The words 'science and technology' appear in the book 214 times in various forms. Throughout the book, Nehru appears to be in awe of scientific and technological developments that were taking place in the west. As a political thinker, he was concerned about the impact of science and technology on the 'economic, social, industrial, agricultural, communal' structures. He was convinced that the problems of Indian society were 'impossible of solutions' within the existing framework. He concluded that 'This approach of ours is partly due to tradition and old habit, but essentially it is caused by the steel-frame of the British Government which holds together the ramshackle structure' (Nehru 1994: 502). He believed that:

> When the British came to India, though technologically somewhat backward, she was still among the advanced commercial nations of the world. Technical changes would undoubtedly have come and changed India as they have changed some western countries. (Nehru 1994: 507)

Nehru uses the phrase 'scientific temper' at three places in the book. In the chapter on nationalism versus imperialism, he uses the phrase for the first time and emphasizes the fact that to develop the scientific temper 'some elementary scientific training in physics and chemistry, and especially biology, as also in the application of science, is essential' (Nehru 1994: 409). However, it is in Chapter 10 that he presents a novel definition of 'scientific temper', one that was very different from the notion that was prevalent in scholarly discourse at that time. He wrote:

> But something more than its application is necessary. It is the scientific approach, the adventurous and yet critical temper of science, the search for truth and new knowledge, the refusal to accept anything without testing and trial, the capacity to change previous conclusions in the face of new evidence, the reliance on observed fact and not on pre-conceived theory, the hard discipline of the mind – all this is necessary, not merely for the application of science but for life itself and the solution of its many problems. (p. 512)
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> The scientific temper points out the way along which man should travel. It is the temper of a free man. We live in a scientific age, so we are told, but there is little evidence of this temper in the people anywhere or even in their leaders. Science deals with the domain of positive knowledge but the temper which it should produce goes beyond that domain. (p. 513)

In order to remove any ambiguity from the above statement, he further explains that 'organised religion' in order to serve 'vested interests… encourages the temper which is the very opposite to that of science' (p. 513).

The last three pages of this subsection crystallized and articulated the notion of 'scientific temper' clearly, and gave a decisive boost to the current and future debate on the science – technology – society relationship.

3.4 The scientific temper and the past 60 years

The Indian identity was constructed with mortar that had secular values and the scientific outlook as its important ingredients. This does not mean that existing non-secular 'exclusive identities' based on religion, caste, region, language, region and so on were completely replaced by the secular Indian identity; neither did those identities wither away during the course of the freedom struggle (see Jaffrelot 1999). Since the Indian identity had to measure up to the 'other', which was British imperialism, it essentially had to be large enough, accommodative and inclusive. The other identities, compared to this newly built one, could be called 'pygmy identities'.

I have argued elsewhere that the nation-states that surround present India did not construct their national identities on a secular basis. For example, Pakistan's national identity was built on a religious basis, and that argument holds good for many countries such as Nepal, Afghanistan and Bangladesh. In those countries, no national-level debate on such matters as the scientific temper, the public understanding of science or science communication was ever carried out.

In 1976, India became the first country to include spreading the scientific temper as a fundamental duty of every citizen when the Indian parliament passed the Scientific Policy Resolution. This landmark constitutional change had a history in the debates about the 'assertion of secular identity', which were generated after the publication of *The discovery of India* and revived in 1958. The resolution states:

> Science has led to the growth and diffusion of culture to an extent never possible before. It has not only radically altered man's material environment, but, what is of still deeper significance, it has provided new tools of thought and has extended man's mental horizon. It has thus influenced even the basic values of life, and given to civilization a new vitality and a new dynamism.[14]

This was a reassertion of the scientific temper in unequivocal terms. This is the period when the economic model that had been followed in the 1950s and 1960s had started developing cracks. Stuart Corbrige (2009) observes that 'Ronald Inden exaggerates only

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14. The full text of the resolution is available from http://www.dst.gov.in/stsysindia/spr1958.htm (retrieved 15 November 2012).

a little when he says that in the Nehru – Mahalonobis universe planning came to substitute for religion as the new Godhead.' The crisis could not be wished away, and thus the debate on the scientific temper was kept alive.

However, after Nehru's death both the political and economic crises deepened. The Third Conference of Scientists, Technologists and Educationalists was held in November 1970. The stated objective of the conference was to review progress, suggest measures to remedy lacunae and, if necessary, issue a new science policy resolution. This once again revived the national debate on the scientific temper.

The 1971 Indo-Pakistan war invoked aggressive nationalism and diverted the Indian people's attention from all other issues. This variety of nationalism could not be sustained for long. The worst political crisis that independent India had ever faced brewed up, and a state of national emergency was declared in 1975. It was during the emergency that the constitution was amended, and 'to develop the scientific temper, humanism and the spirit of inquiry and reform' was proclaimed as a constitutional duty of Indian citizens.[15]

The five major landmark activities that brought the scientific temper debate onto the national agenda in the 1980s and 1990s were also synchronized with political and communal strife. The Scientific Temper Statement (1981), the Industrial Policy Statement (1983), Jan Vigyan Jatha (the People's Science Campaign) (1987), the National Literacy Campaign (1991) and the Public Awareness Campaign for Total Solar Eclipse in 1995 reasserted secular Indian identity. It would be difficult to establish a direct causal relationship between these events and the rise of the Sikh separatist movement, Hindu and Muslim fundamentalism and political instability that threatened the democratic structure of India. The nearness in time of these campaigns to near-flashpoint situations that undermined the robustness of Indian democracy shows that a section of the scientific, political and intellectual leadership, in order to save and reinforce democracy in times of crisis, brought the scientific temper debate back to the national agenda.

15. See http://lawmin.nic.in/olwing/coi/coi-english/Const.Pock % 202Pg. Rom8Fsss(8).pdf (retrieved 15 November 2012).

Most countries that came into being after World War II constructed their national identities on the basis of race, religion, ethnicity, language or a mixture of all of them (I call these 'pygmy' identities) and therefore could not build stable democracies. India has been able to balance the centrifugal forces of exclusive identities with a centripetal force – a secular Indian identity. The continuing debate on the scientific temper has played an important role in constructing and reinforcing democratic structures based on secular values.

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Part 3

Keynote addresses

4

What science stories do: Rethinking the multiple consequences of intensified science communication

Ulrike Felt and Maximilian Fochler

Abstract: In most industrialized countries, science communication activities are seen as essential for improving science – society relations. Telling stories about science and being a scientist has become a central activity for communicators, but increasingly also for researchers. In this paper, we ask: What do science stories and specific kinds of storytelling do? What repercussions do the widely produced and distributed public images, the multiple stories about science, doing science and being a scientist have? We trace the effects of dominant forms of storytelling about science, particularly on scientists and their ways of living and working in science, but also on society. In conclusion, we call for a 'storytelling ethics', which stresses that communicating science is also about choice, about what stories are being told and which ones are left out, and in that sense also about which kind of science we frame for which kind of society.[1]

Keywords: science communication, public image of science, economy of promise, ethics of storytelling, medialization of science, tacit governance, narratives about science.

1. This paper builds on a presentation by U. Felt delivered at the 2012 International Conference on Science Communication. For further reading on the impact of science communication on science, see also Felt & Fochler (2012).

4.1 More science communication

RECENT DECADES have seen an intensification of science communication activities in most industrialized countries, although to different extents that relate to different traditions and following different modalities of implementation and support. There is a flourishing business circulating communication models and best practice exercises. Despite all national and local differences, and whether they are labelled science communication, mediation, engagement, brokering or something else, these activities have one thing in common: they are all seen as essential for improving the relation of science and society, and thus remain largely unquestioned. For institutions of research and higher education, to take but one example, investing in telling stories about science and technology seems to have become a *must* when it comes to claiming their position in the public space. Research needs to be valorized through offering a web presence attractive to 'the public', press releases on the latest research results have to be sent out, and the doors must be opened for some outreach activities.

Forms and formats of communication have also been continuously redefined and diversified: science weeks and festivals, children's universities, public labs, science blogs, science slams – and the list could be continued. While these activities focus mainly on communication, we also encounter – even though to a lesser extent – formats fostering public participation and engagement in actively shaping the relation of science and society, such as citizen conferences.

4.2 Medialization of research

What we observe could be labelled a medialization of research – to use Peter Weingart's (1998) notion in a slightly extended manner. Our use of this term does not focus only on classical mass media, but embraces the whole spectrum of different forms of public communication and representation of science. Medialization thus on the one hand means an ever-increasing coverage of science in the media, as well as a multiplication of contexts in which scientists themselves present and re-present their work to different audiences. On the other hand, as we show in this paper, it also means that specific forms, formats and guiding values typical of classical media communication now become central in core areas of scientific practice, such as in funding processes, assessment exercises or self-presentations.

Medialization is fostered by policymakers, who not only financially support science communication efforts as stand-alone activities, but also formally define communication activities as among the aims and outputs of funded research projects. Also, researchers are increasingly asked to become active and participate in communication work, to become active storytellers of science. This can be seen in growing offers to train young researchers in communication skills in order to better represent 'their research' in the public arena, and placing them under an obligation to do so. This is expected to add some authenticity to the stories developed about science.

4.3 Driving forces and expectations

What is the motivation behind these activities, and why such an intensification? Different lines need to be distinguished here.

One major strand of efforts is devoted to making science appear more attractive, in particular to the younger generation. Staging contemporary societies as dependent on technoscientific developments, the concern is that not enough young people decide to make science and engineering their career choice, particularly in fields that are regarded as key for future developments. From the youngest age, children are to be attracted to science through colourful presentations and by having fun when they play 'doing science'. Second, these activities are also meant to counterbalance the alleged mistrust of 'the public' towards science and thus to ultimately lead to more enthusiastic support for new developments. But they are also geared to 'develop' or to educate the 'scientific citizen' (Irwin 2001), who can and is ready to participate and engage with research and research-related issues in a 'rational' manner, thus contributing to the creation of an innovation-friendly climate. Together, this is aimed at supporting a steady flow of innovations, which is expected to foster future societal development and welfare, at least in the currently dominant 'Innovation Union'[2] discourse on the European level.

To meet these aims, should we simply call for doing more and better science communication? Should we simply stress the need for more funds and more stable support, pretending that once these claims are fulfilled everything will be fine for science in contemporary societies?

In what follows, we argue that this would not only be a considerable oversimplification, but could prove counterproductive. We much more want to ask: What do science stories and specific kinds of storytelling do? What repercussions do the widely produced and distributed public images and sociotechnical imaginaries (Jasanoff & Kim 2009), the multiple stories about science, doing science and being a scientist have? We trace the effects of dominant forms of storytelling about science, particularly on scientists and their ways of living and working in science, but also on the public. The guiding question will thus be: How does this intensified and diversified storytelling about science tacitly govern (Felt & Fochler 2012) research and create a specific imaginary of science in broader societal arenas?

4.4 Storytelling

Looking into science communication as a storytelling activity builds on a longstanding tradition in the social sciences, in particular after the 'narrative turn'. We are interested in stories researchers narrate about the multiple relations of science and society and the kinds of ordering and positioning work that go into them (Czarniawska 2004). Interviews with researchers but also the many other kinds of formal and informal discussions we had with them are settings in which researchers are explicitly invited to engage as storytellers (Denzin 2001). Yet these are also moments when the dominantly circulating, quasi-institutionalized stories are assessed and counterstories of resistance narrated (de Certeau 1984). They are spaces where stories are 'produced (concocted, fabricated), sold (told, circulated), and consumed (listened to, read, interpreted) – often all in the same performance' (Czarniawska 2004: 45). Looking at researchers' narra-

2. http://ec.europa.eu/research/innovation-union/index_en.cfm.

tives through the lens of storytelling thus allows us to draw attention to a specific, culturally rooted way to organize information, to the rules that govern this kind of storytelling, to how stories unfold their emotional power, and how this is a means to perform the building of community. It means devoting attention to the way science and its relation to society gets narrated, and how different threads gain importance in this and form the fabric that science gets wrapped into.

The following reflections thus try to offer selective insights into what science stories do, drawing attention not only to how they are told, but to how specific ways of dominant storytelling act on researchers and their self-understanding. They build on more than 60 interviews as well as group discussions from two major research projects the authors have been involved in over the past six years, studying the way researchers live and work in contemporary science in Austria.[3]

4.5 Stories told about science

'If you think about your generation and earlier ones, what's the difference for you in terms of the skills one needs to be a scientist?' was a crucial question we asked young scientists in the Austrian life sciences. We also asked their senior colleagues an adapted form of the question. As answers, one could expect a range of arguments: the ability to master new methods and technologies, the literacy to deal with the enormous amount of published information available electronically, or the skill to navigate an increasingly internationalized science system. While all these issues did come up, there was another maybe less expected skill many of our interlocutors referred

3. The project 'Knowing – Knowledge, Institutions and Gender. An East – West Comparative Study' (FP6) compared the research cultures in molecular biology and sociology in five European countries. For this paper, we are referring to interviews and focus groups conducted with molecular biologists in Austria. The project 'Living Changes in the Life Sciences. Tracing the Ethical and Social within Scientific Practice and Work Culture' (BMWF; ELSA/GEN-AU) explored how life scientists narrate the relationships between biographical, epistemic, institutional and broader societal rationales. The authors would like to thank all colleagues who have contributed to the field work in both projects. See http://sciencestudies.univie.ac.at/en/research/completed-projects/.

to: to tell one's own research as a convincing story. Consider the following statement by a female PhD student:

> We are [perceived] a lot [through] what we published, we are also [perceived] a lot [through] the way we present ourselves … I know a lot of good professors with extremely good work, but who stand in front of an audience and start k-k-k – nothing comes out. And when that happens you lose … The fact that now we have … powerpoint presentations, movies and all these things makes communication easier, but it also is a challenge.

Our interviewees mentioned a range of different contexts for this kind of presentation work, from conference presentations to job interviews, blogs and interviews in classical mass media. Of course they would stress that different arenas call for different forms of stories to be told. However, the basic narrative form of these stories seems similar across contexts: stories need to be brief and speak to a particular audience in an entertaining manner, while simultaneously and convincingly conveying relevance. This is what is seen as making the difference in a dense economy of attention structuring science news or the blogosphere, and now increasingly also the scientific conference hall. Hence, it seems that elements of mass media communication logic have become quite pervasive in areas of intrascientific communication. That is why we call scientists' practice of talking about their research in these narrative conventions 'press-packaging science' (Felt & Fochler 2012).

It is important to note that these forms and conventions of telling stories about science are not imposed in direct media interaction. Rather, they are trained and rehearsed within science, particularly in the socialization of young researchers. Our interviewees would tell us about media training or science slams, where they learned to entertainingly sketch their work in three minutes for a general audience, and about pre-conference meetings in their groups in which presentations were rehearsed again and again until they were 'spot on'. In 1914, one of the sons of Charles Darwin, Sir Francis Darwin, wrote 'In science credit goes to the man who convinces the world, not to the man to whom the idea first occurs' (Darwin 1914: 9). Nearly a century later, one would hardly be surprised to find this quote in a training manual for science communication.

However, convincing the world today takes more than a 'spot on' presentation. This quickly becomes apparent in another domain in which both senior and junior scientists would describe press-packaging practices as central: science funding. Here, building linkages to grand societal narratives – as is the 'Innovation Europe' narrative at the time this article is written – is seen as equally crucial. Witness the following comment by a senior professor:

> Everybody writes, and so do I, as first sentence in the [grant application]: 'metabolic diseases are a major burden on humanity'. As if, with my grant, if I manage to get it through, I would solve that problem. [laughs] But of course it's actually not like that.

As this quote alludes to, it is not enough for a story about science to be brief and entertaining if its aim is to win research money or sustained public attention for the storyteller(s). It needs a more heroic plot, in which science contributes to shaping societal futures, to realizing societal values and to solving societal problems. In the light of the contemporary discourses around science and innovation, positioning the eternal quest for new knowledge and the insatiable curiosity of the scientist as selling arguments in the first paragraph of a grant proposal or in the press release announcing a new project no longer seemed an adequate narrative choice to many of our interlocutors. Rather, the take-home message should always be what this particular research effort will do for wider society. This ties the stories told into broader accounts about progress and innovation, about how more knowledge will necessarily lead to better lives.

In doing so, these promissory stories implicitly stage a particular relation between science and society. The ironic tone in which our interlocutor stages his experience directs our attention to this. He mockingly comments on the specific temporal causality inherent in his own narrative, and the linear relation that is established between proposed research and the solution of future societal problems. This linearity leaves little room for any uncertainties, complexities or alternative ways of problem solving – all of which this quite successful grant-story teller would see as mattering. Things are 'actually not like that', he would be keen to add.

Hence, the narrative form in which these stories about science are told both buys into and reproduces a grossly simplified picture of the way the sciences contribute to shaping societal futures. This is even more important to consider, as the logic of staging one's work as providing future solutions to contemporary societal problems is not confined to the genre of the research grant. The 'economy of promises' (Felt & Wynne 2007), in which the promise of future contributions to societal issues becomes a central medium for attaining reputation and resources within science, is equally observable in many other instances where stories about science are told.

4.6 Stories not told about science

What do the particular ways of telling stories about science sketched above do? How do they tacitly govern science, and how it relates to society? To grasp these issues, it is useful to look at which stories are not or can no longer be told in these narrative frameworks (Coyaud 2007).

In the context of the Austrian life sciences, it is not very hard to find researchers who are quite frustrated about the ubiquity and importance of the practices of storytelling we have described. This frustration is not linked to their lacking potential ability to tell of their research in a convincing or entertaining manner, but rather to a societal context in which not every form of new knowledge is seen as equally promising. For example, agricultural biotechnology has been deeply controversial in Austria over the past decades. In the 1990s, the first field experiments testing transgenic crops were protested against, and in 1997, in one of the most successful public petitions to parliament, more than 1.2 million Austrians signed slogans such as 'No food from the gene laboratory' or 'No field trials involving genetically modified organisms'. Now, 15 years later, public resistance against agricultural biotechnology has become a deeply rooted element of Austrian technopolitical culture and identity (Felt 2013), and has also spawned a quite restrictive legal and administrative regime for agricultural biotechnology.

In our field work, more senior researchers working in molecular plant biology, in particular, were quite concerned about how negative public opinion affected their work even in basic research. In this, the impossibility of telling stories that work in the current economy of promises in the Austrian context was of central importance, as the following statement by a senior group leader shows:

> I simply can't argue on the basis of the potential applications of these things, because there is no political support for these applications here. That means we can't do what the basic researchers in the medical field do, which is claim that they have a therapy for XY in five years time.

For her, as for others in related areas, this has quite direct consequences for her work. On the one hand, access to the most prestigious forms of research funding seems hardly possible because the right kind of story cannot be told, and hence cannot be converted into other forms of capital in the economy of promises. On the other hand, other important aspects of this scientific field are also affected, such as its re-production. Because of the lack of a positive storyline, students' interest in choosing this field for their PhDs and their future scientific careers is more limited than in neighbouring fields. Molecular plant biology in Austria is seen as a quite risky career choice.

As we can see from the case of agricultural biotechnology, the ability of a field to tell the right kind of stories has quite manifest governing effects. While this case is certainly the most extreme in the Austrian context, other sciences also face similar issues. The social sciences and humanities, for example, have been and are struggling hard to tie their work into these promissory forms of storytelling, with its emphasis on the direct usefulness of the knowledge produced for addressing societal problems.

4.7 Struggling with stories about being a scientist

Besides stories about science, stories about scientists and what living and working in research means are a second important type of narrative relevant to our argument in this paper. There are two contexts in which these stories are enacted. First, there is a growing range of communicative contexts in which scientists are asked to talk about who they are and what motivates them to do research. Among those contexts, communication directed at young people has become particularly central over recent years. Scientists go to schools to talk about themselves and their work, or they invite pupils to 'open labs' to show them what doing science is like. Second, particularly but not only in the mass media, iconic figures such as Craig Venter or other 'science celebrities', often circulating in more national and local circuits of communication, are staged as representing science in its most cutting-edge form, very often strongly relating to the promissory discourses we have described above.

In our own field work, it has been interesting to observe how many researchers in the life sciences struggle to make sense of the relation of their own experiences and biographies to these public stories about being a scientist. Not surprisingly, the public stories almost uniformly stage a particular kind of success. On the one hand, they do so in relation to the people portrayed, who are sketched as those who 'have made it', as elite scientists who deliver both scientific excellence and societal relevance. Failure is virtually only talked about in the context of reporting about fraud cases, where the scientists involved are staged as culprits and as a few black sheep violating the scientific ethos.

On the other hand, also in 'open labs' and other contexts where scientific practice is presented, epistemic failure or other exigencies of everyday scientific practice are hardly an issue. The experiments shown and conducted there are not experiments in the actual sense of a setting designed to find something new. Rather, they are demonstrations that doing science is fun and that results are always clear-cut. Time frames of experiments are reasonably short, and scientific work is portrayed as continuously exciting. In the daily lives of the researchers we talked to in our field work it often is not, as experimental practice is also full of routine work and setbacks and is connected to being notoriously behind schedule, and as moments of frustration are more common than the rare occasions of thrill and delight when things do work out. The scientists we talked to would repeatedly complain that these issues and experiences are mostly absent from public stories about science and scientists. To also show these aspects, one interviewee ironically suggested that a TV reality show reporting on science would be needed, because in his view 'only then we would have time for the stories which currently are not told.'

But why are researchers struggling with the fact that their lives and practices are portrayed more positively than they perceive them? After all, it does not seem such a bad thing to look good in the news or in any other presentation to the public. There are two sets of reasons why our interlocutors were often quite ambivalent about this.

The first is that representing scientific practice as continuously exciting and successful again implies a certain linearity in which science will be able to address and solve societal issues and problems. This creates societal expectations, which researchers see as based on a false representation of scientific practice, and hence as providing a skewed picture of the time frames in which research may contribute to meeting societal challenges. Simultaneously, as discussed above, researchers are using the linear arguments about science's future contribution to solving societal problems as argumentative resources in different contexts, and hence contributing to the (re)production of the very same genre of stories they criticize. This points to an essential tension scientists are currently facing, as under the conditions of an increased medialization of science they are both producers and subjects of stories about science.

Second, our interviewees were concerned about the picture of scientific practice and scientific careers conveyed to the young generation. For example, they would refer to the quite unrealistic picture of working in science they had as they started their careers, and say that they might have made different career choices if they had had a more realistic assessment. At this point, it again seems useful to ask which stories about being a scientist are not or only very rarely told in the public realm. In this, current developments around scientific careers are a particular case in point. In our interviews, young life scientists described their experience of pursuing a scientific career as structured by strongly temporalized and uncertain employment conditions on the one hand, and as guided by an intense competition for the few positions that offer a more long-term perspective on the other (Felt et al. 2012). Also, the normative lines along which academic careers develop are seen as rapidly changing, which means that the experiences and models of prior generations – often presented in media narratives – can give only very little orientation and guidance for young researchers today. A senior scientist reflected on the change of public images of scientists and the role models they offer for the young generation:

> Now there are glossy brochures in which scientists are portrayed. And they are portrayed in a completely different way, they are like pop

stars partially, so they have a completely different character than the role models I saw in my youth.

The stories about success in science told in these glossy brochures partly become role models for the younger generation, or maybe more precisely they become yardsticks against which one's own scientific biography gets measured. However, the stories about scientists portrayed in the media are first and foremost a set of quite narrow success stories, and they follow rather homogeneous patterns, also often omitting the contingencies and not so successful sides of the particular biographies. Hence, when compared to these stories, the individual lives of young scientists are deficient nearly by default. Some of the normative requirements of the 'excellence career' are always missing, be they research stays in prestigious institutions, too few high-level publications or media presence. This has considerable tacit governing effects on how young researchers think about themselves and plan their careers. The homogeneity they are confronted with reinforces young scientists' orientation on one particular career trajectory, which – as they are quite aware – will only be available for very few. At the same time, the lack of a repertoire of alternative stories curtails their thinking and creativity in developing alternative career models and in experimenting with different ways of living in research.

4.8 Concluding remarks

What can we learn from these examples and observations?

We want to start our concluding remarks by joining Nowotny, Scott and Gibbons (2001: 260) in stressing: *Mind the gap* – 'the gap between images of science and the actual practices', which runs the danger of 'becoming too wide'. 'In an age of intense contextualisation', an age where science and its representations have come to play a crucial cultural role in ordering modern societies, 'images of science need to have a strong "reality content", that is, be closer to actual practices and their rapid changes than the traditional and timeless images' (Nowotny et al. 2001: 259). In what we have shown above, we clearly see the consequences of the stories and work realities drifting apart.

From our perspective, it is essential to understand that telling stories about science in the public realm has an important impact on society, but also on science and in particular on the next generation of scientists. The medialization we have sketched also defines how researchers contextualize and value their own work and what kinds of promises will frame and possibly guide it. Finding a place and being successful in an economy of promise is not only to be understood as a game which is played outside science to assure support, authority and admiration. It also affects how researchers perceive their own role and their work in science. The stories we have analysed in this paper give shape to a specific temporal imagination of research, stress the idea of immediate innovation and direct usefulness as central values for making choices in science, and in the long run nourish the belief in a future that can be shaped and controlled. At the same time, they create a normative imaginary of the successful researcher and how s/he should be and act.

We thus argue that stories told about research and being a researcher have a tacit long-term impact on scientists' epistemic pursuits as well as on the skills and virtues expected from the scientist as a person. Nor do they leave society untouched: they are important parts of the broader societal imaginaries of research in contemporary societies.

The arguments we have made in this paper suggest that storytelling about science participates in the creation of a rather specific and often quite narrow imaginary of research, one of a fast and successful enterprise, where science is in control and provides solutions to clearly defined societal problems. Other possible storylines that would instead address the uncertainties and contingencies of current scientific practice and its relation to society are hardly present. In diagnosing this, we would like to refer back to de Certeau's (1984) writings, in which he reminds us that stories could be important spaces of resistance to dominant narratives of institutionalized power structures. Not giving place to alternative stories and rehearsing only specific narratives thus matters for the relation of science and society.

In conclusion, we thus do not want to simply buy into the logics of the frenzied business of selling science better and increasing its public presence at any price, but call for a 'storytelling ethics' in a world where science and technology have become so powerful.

Telling stories about science means much more than simply giving a correct account or an attractive presentation to convince members of the public. It is about choice, about what stories are being told and which ones are left out, and in that sense also about which kind of science we frame for which kind of society.

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5

Current issues and future challenges for science mediation and communication: What is the status of mediascience?

Michel Claessens

Abstract: Is science communication making a U-turn? In our society, scientists have some difficulties being heard. In several areas, researchers are failing to pass on scientific information as an input into public debates, despite numerous actions undertaken by all countries. Starting from a presentation of the current situation, I try to answer the question: should science communication evolve and adapt itself to tomorrow's challenges? In this paper, I also outline some communication challenges raised by the international ITER project, which involves 34 countries in the construction of the world's biggest fusion reactor in Cadarache, France.

Key words: communication, journalism, mediascience, PCST, models, ITER, fusion.

IN THIS PAPER, I refer to the concept of 'mediascience'. This is to recall this very basic fact: science never arrives on our plates as a crude product. Research fruits are always selected, washed, peeled, cut and prepared before being put on our tables. Science is cooked before being served. Talking about science, citizens mostly see and taste what I call *mediascience*, which means science (in)filtrated by media and served on a (TV) stage to the public. Media, and television in particular, are the premium source of scientific information for the European public. However, although popularization is as old as modern science, mediascience is a recent invention, resulting from the evolution of media and of the research community. Adapted to modern society and *packaged* according to media standards, mediascience is to science what the *news* is to subjects of a general interest.

As it has been well shown by Paul Ricoeur (1983), a narrative is a fundamental vehicle which allows the transfer of experience in the language and knowledge. Indeed, the journalist and the science communicator are not in a position to simply reproduce reality as it is. And which reality are we talking about here? The journalist rarely attends a live scientific experiment, and the communicator most often produces a narrative on narratives. Our questions on any specific experiment therefore concern the witness to that experiment or the author of the narrative which has been brought to our attention. These narratives are types of *reflections* of the experiment or the scientific discovery, of which they aim to be reconstructions. Journalists and communicators are therefore far more than just information relayers or amplifiers; they reconstruct the reality to understand it. Following an active and personal investigation, the narrative they are constructing is not necessarily in opposition with the notion of objectivity, which can be well integrated in the production criteria. However, this narrative cannot pretend to reveal the complete truth. It is the task of science journalists and science communicators to construct, as a hermeneutic approach, narratives which will contribute to the dissemination of scientific knowledge. Those narratives constitute what I call mediascience.

Having been reassured that mediascience does not interfere, or only marginally interferes, with the scientific method, there is no doubt that mediascience contributes effectively to knowledge dissemination and hence to the public production of this knowledge. There is indeed a genuine ‘journalistic method’, which participates in knowledge development. The journalistic approach of the real world represents an epistemic framework which, although still relatively simple and undoubtedly perfectible, must be acknowledged as such. As a result, this abolishes any question about the legitimacy of science communication practices while raising, in parallel, the need for communicators to consider their own expertise, of which many examples have shown the limits.

In any case, the conditions for good quality (science) journalism can be defined, even if they are not completely formalized. They involve, in particular, cross-checking the sources, carrying out investigation work (which is a precursor to any science journalism work), introducing the main research being carried out in this field, and a quest for a 'certain truth'. Science journalism is, very much like science, sanctioned by the real world.

Current practices therefore support the fact that, in parallel to the scientific method, there is a genuine although still embryonic 'journalistic method'. Taking into account the conditions mentioned above, journalism can be considered effectively as a specific way to access the world we live in. Taking these conditions into account, the existence and the specificity of mediascience should be acknowledged, which leads us to explain errors published in the media not just by a lack of culture or scientific literacy on the side of communicators, but also by the fact that scientists do not seriously take into consideration these journalistic standards. Fulfilling all these conditions also requires, in parallel, that science journalists respect a strict deontology.

5.1 Hitting the news

Science communication or, more precisely, the public communication of science and technology (PCST), very often hits the headlines. This was particularly the case with the Fukushima – Daiichi accident, which illustrated the difficulty in informing the public on scientific and technological subjects during a crisis. The accident also revealed information restrictions and manipulations at the source. On a more anecdotal mode, on 6 April 2012 a well-known news agency republished a report from one year before which announced the fusion of the nuclear core of a reactor in Fukushima …

Indeed, before being a nuclear accident, Fukushima was a communication incident that brought into the spotlight the incompetence of the main actors involved. In this entire story, the media did not play their role of being a counter-power: between *images choc* and *chiffres chic*, very few media delivered high-quality information. It is even a case study for students in communication.

Although I have some scientific background, I needed to consult and confront lots of different sources after the incident to understand what was going on and to evaluate whether the accidents involving the Fukushima – Daiichi reactors were 'very serious' or just 'serious'. So I could easily figure out how difficult it was for the layperson (which we all are!) to find their way in the flows of becquerels, admissible doses, time averages, millisieverts and natural radioactivity. The media often presented results without any point of reference, without suitable units and with confusing absolute and relative values. How can the public, who do not have my level of education, make their own judgements on scientific and technological issues? The mass of data which we receive every day often opens the door to approximation and manipulation. And words sometimes increase the confusion: for example, it was said on television that there was no 'abnormal increase' in radioactivity. However, in Fukushima there was an increase, and that increase was indeed 'abnormal'.

In France, there has recently been a public dispute between, on one side, two TV producers and bestselling authors, the twins Igor and Grichka Bogdanov, and, on the other side, the scientific community. The dispute was about the twins' PhD theses, described by some physicists as having a very poor scientific content. The case threw light on some aspects of science communication. While the Bogdanov twins are recognized as excellent science popularizers, their research does not receive unanimous credit from the scientific community. Some have even found similarities with the Sokal hoax. The polemic has shown the determination of the twins to keep their scientific references. The truth is that, to talk about science and to have public credibility, it is better to be seen as a genuine scientist. 'We belong to the same family as Einstein,' they said in a recent interview.[1]

We can also mention the recent story about neutrinos, suspected for some time of going faster than the speed of light. This case exemplified the difference between scientific and journalistic timescales.

Another recent breaking news story was the discovery of the Higgs boson, which has given science communicators some hard work: How do we explain the role and the existence of these elementary particles? How do we explain to laypeople the 'standard model' which is used to describe the fundamental interactions? Some communicators and even some scientists made references to the 'God particle'. As far as I am concerned, I find this formula very odd and counterproductive.

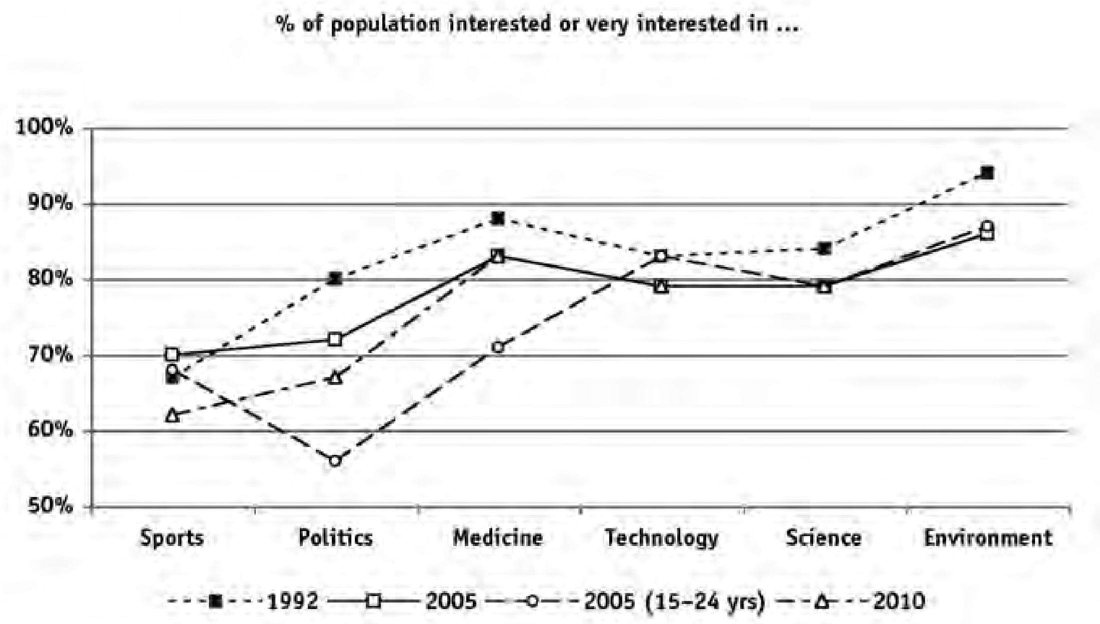
PCST is therefore a subject on its own. It may also be becoming a scientific discipline on its own, as there are increasing numbers

1. *Le Point*, 25 June 2012.

of research works, peer-reviewed journals and scientific conferences on this subject (Gascoigne et al. 2010).

However, with regard to PCST, scientists do not always have a scientific attitude! Many scientists believe that the public, and especially young people, are no longer interested in science. The Eurobarometers carried out by the European Commission in 1992, 2005 and 2010 do not support that view (Figure 5.1)

Figure 5.1 Eurobarometer: Is anyone interested in science? (1992, 2005 and 2010)



Some scientists are used to provide cliches, prejudices and personal opinions. It is astonishing to see that some PCST models and principles, although very basic and even naive, are still used and promoted by the scientific community. This is the case with the deficit model, which is about organizing, in an almost caricatured way, a transfer of knowledge from the world of 'savants' to the mass of 'ignorants' – the transfer from brains full of knowledge into empty boxes. The same applies to the gradient model, which postulates that citizens having a good scientific literacy and scientists trained in public science communication will be able to talk to each other on the same level. The same applies also to models and practices glorifying 'science communication', which is, at best, an oxymoron. Indeed, everyone could agree with the fact that science is, in a strict sense, *incommunicable*. A scientific theory or equation is not subject to an exchange between promoters and opponents. It is true – or not. More exactly, it is either verified – or not – by experiments. What we call public science communication is actually a communication on the applications and the issues arising from science (and more rarely, which is regrettable, on its limits).

Recently, Matthew Nisbet and Dietram Scheufele organized a conference on the 'science of science communication' in May 2012 in Washington. They have published an article which identifies five 'intuitive failures' that many scientists help to promote about the public and communication (Nisbet & Scheufele 2012). The five can be summarized as follows:

- People no longer trust scientists.
- Science journalism is dead.
- Entertainment media promote a culture of anti-science.
- The problem is the public, not scientists or policymakers.
- Political views don't influence the judgements of scientists.

Scientists are also inclined to think that the public, and especially young people, are no longer interested in science (see Figure 5.1).

We should therefore reconsider the 'linear' models which still determine many initiatives in this field (that is, the assumption that there are consecutive steps leading to public support: Research → Knowledge → Culture → Support to S&T).

All countries worldwide take actions to produce and disseminate mediascientific content in order to share the knowledge, improve public trust and strengthen the links between science, technology and society. What can we say about the results so far? I would say that there are mixed feelings about both the actors and the actions.

Let us first talk about the actors. There is today a genuine and dynamic community of innovating science communicators. But, on the other side, the scientific community still shows some scepticism. While expressing a growing interest in public communication, many scientists still disseminate primary and simplistic ideas about it, as well as some concrete expectations. This is a good example of a linear model: many researchers believe that promoting PCST activities will result in improved science literacy among the public, who will therefore become more supportive of increasing government research budgets. Along the same lines, a majority of industrialists and research managers think, albeit a bit naively, that knowledge automatically stimulates development.

We also observe some scepticism about PCST actions. There is a very large diversity of initiatives, practices and experiments covering a continuum of objectives, publics, etc. (see Figure 5.2). Some scientists, however, do not depart from the idea that PCST activities are close to 'mission impossible'. Why popularize, inform and communicate scientific concepts? We can all see the limited impact of these activities: close to one European out of four still believes that the Sun rotates around the Earth, and that proportion is almost unchanged after 30 years, despite 'astronomic'[2] efforts devoted to popularizing our solar system. This message has been taken up by the scientific community, who see in it one of the causes of Europe's problems: EU citizens have a low science literacy and, for that reason, are less positive and even sometimes reluctant about scientific and technological advancements – contrary to Americans' attitudes, in particular.

Figure 5.2 PCST encompasses a continuum of actors, objectives, targets and means

A continuum				
Researchers	◁—▷	**Actors**	◁—▷	Communicators
Culture	◁—▷	**Objectives**	◁—▷	Information
'Laymen'	◁—▷	**Targets**	◁—▷	Socioprofessional categories
Centralized	◁—▷	**Means**	◁—▷	Decentralized

On many subjects that raise public and media interest, researchers have some difficulty being listened to, or even being heard. On controversial topics – such as the impact of genetically modified organisms, mobile phones and radio antennas on the environment and human health – the current scientific data shows that there is no proven risk to human health. This message, however, does not reach the media, and hence the public. The visibility given to opponents of these technologies seems to be, to a large extent, exaggerated and unbalanced. Books and talk shows provide a lot of speaking

2. There are more than two thousand planetariums on Earth!

opportunities to creationism, intelligent design, crystal-gazing, etc. How can science compete with the *show?*

So, we must address the following question, which will immediately raise a profound paradox: Is it still possible, in our techno-scientific societies, to communicate about science and educate the public in this field? Despite what I have said here, I am convinced: yes, we can! We all know recent successful initiatives in the area of science communication. Those initiatives often result from a major change which happened some 10 years ago, but science communication underwent a deep mutation and is no longer restricted to books, conferences and museums.

This does not always bring advantages. Disturbed by this wealth of initiatives, scientists have expressed a genuine scepticism and a deep misunderstanding. While they recognize the need to do something, they are lost and doubtful about the means which should be devoted to science communication. Because of the lack of concrete results achieved – which is quite misleading – some have been tempted to see ‘scientific’ evidence for the status quo. In order not to be seen as inefficient, let’s be inactive!

5.2 A malaise

In my opinion, the current situation reflects a quite deep malaise in the scientific community. Let us look at public science communication and examine the opinions of scientists on this subject. We should mention here the study carried out by the Royal Society, involving 1500 British scientists and published in June 2006, which showed that a quarter of them considered popularization and communication with the public as activities having a negative impact on their professional careers[3] and often being carried out by those who were not eligible for an ‘academic career’ (Royal Society 2006).

I also refer here to some results from a PhD thesis defended in November 2012 by a Spanish student, Claudia Loaiza. She interviewed some 200 researchers about their involvement in science

3. This was rather surprising, as the United Kingdom is probably one of the countries with a long tradition and a genuine culture of science communication.

communication (Loaiza 2012). Very few referred to the grand objectives of PCST, such as economic, utilitarian, democratic, cultural and social purposes. Loaiza collected the messages most frequently given by researchers in the discussions she had with them:

- 'We need to attract politicians to get funds but we don't like to do this.'
- 'I have been participating at the open days because it is obligatory for us.'
- 'The French scientific community is under extreme pressure.'
- 'This is a waste of time because it is not part of the promotion system.'
- 'I am under high pressure at the moment.'
- 'There are myths spreading about science in order to get more funds. It is portrayed as making miracles and this is exaggerated; we need to explain the limits.'
- 'If the public is informed, they will support science policies.'

One can perceive a genuine malaise in these statements. I believe that the numerous calls for improving public science communication are yet another symptom of this malaise. But which malaise are we talking about here?

Today, the international scientific community is facing several difficulties, which are more or less acute depending on the countries involved. These difficulties are due, in particular, to a lack of funding, support and professional recognition. Other factors play a role here, such as expectations about career promotions, prejudices (for example, about the public's goals), the growing privatization of research, the fact that scientists are not very visible on the public and mediatic scenes, and finally the whole issue of competences, which I summarize by the word *mécompétence* ('miscompetence'). It is probably excessive to say that we are facing a 'scientific crisis'; nevertheless, one should acknowledge the fact that the scientific community is today facing major problems. There are epistemological bottlenecks, and key questions remain unanswered. Despite the discovery (with a probability of 99.9999 %) of the BEH (Brout – Englert – Higgs) boson, we still have no clue about the 'dark matter' that is supposed to make up 85 % of the universe's mass.

This century has seen much substantial advancement in all the fields of scientific and technological knowledge. At the same time, we have become almost blind to some global issues, which are fundamental and complex, and this blindness has generated many errors and illusions, in particular on the part of scientists, technicians and experts.

Hyperspecializing is an obstacle preventing us seeing the global, which is fragmented into parcels. What is essential then becomes diluted in secondary considerations. However, essential issues are never fragmented and global issues are more and more binding.

What should be the place and role of scientists in a society confronted by major and multifaceted problems? How to integrate and act on these problems, which require multidisciplinary approaches? I use in this context the concept of 'miscompetence'. Just as misunderstanding describes poor understanding, miscompetence means a lack of competence. A priori, scientists are not incompetent. But the competence required to address the main questions of this time is obviously multiple and distributed. Miscompetence is, for each of us, altogether a reality, a weakness and a strength.

Our current conception of skills and competence is basically 'disciplinear' and related to a specific field of science or a technology. Competences are used in a linear way (or 'top down'). This must be replaced by a new governance which takes into account the fact that, in a complex and interconnecting world, competences are distributed and decisions that are likely to affect the whole society must involve, in one way or another, all the stakeholders concerned. The success of the Intergovernmental Panel on Climate Change (IPCC) is an interesting example of this new necessary governance. Because the IPCC is unanimous on at least one point, supporters and opponents of anthropic climate change agree to recognize that, thanks to having scientists, economists and politicians working together, this UN organization has created a powerful strike force. If, as an old saying goes, one's success can be measured by the number of one's enemies, there is no doubt that the IPCC is today a major achievement. Despite numerous attempts to discredit the quality of IPCC work, the international group of experts is now widely recognized as a model for technoscientific governance, thanks in particular to associating scientific and political competences in a decision-making perspective. It is therefore no surprise that its political impact goes well beyond the climatic framework. This shows that the relation between knowledge and competence is now more tenuous and, to say the least, less obvious.

Our times call for a new technoscientific governance. Recent developments show that citizens want to take part in scientific and technological decisions which are likely to affect society, even if their real commitment in this field is not always very active – despite some violent demonstrations which have been extensively reported in the media.

At this stage, my conclusion is that the global and current interest in PCST reflects as much a need to inform the public as a need to improve communication between scientists and the whole society.

5.3 The iter project

Now I would like to emphasize, through the ITER project, some current aspects and trends in PCST.

The project is currently under construction in Cadarache, 40 kilometres from Aix-en-Provence in the south of France (Figure 5.3). The first experiments are scheduled for November 2020. From 2027 onwards, ITER will operate with deuterium/tritium (D/T) plasmas to enhance energy production.

ITER is already a fantastic observatory of science – society interactions and, particularly, science communication and journalism.

Figure 5.3 An artist's view of ITER (which means the 'way' in Latin)

An initiative by China, the European Union, India, Japan, Korea, Russia and the United States, ITER should show that hydrogen (H, the lightest and most common atom and one of the two atomic components of water) heated up to 150 million degrees can produce a net balance of energy thanks to the fusion of the hydrogen nuclei – a reaction which occurs inside the Sun and other stars. With the ultimate objective of demonstrating the scientific and technological feasibility of fusion energy, ITER has a crucial role in the current discussions about energy supply policies.

ITER will be a ‘tokamak’ reactor. Tokamak is a Russian acronym for a toroidal magnetic chamber.

Today, ITER is essentially a huge platform of 42 hectares lost somewhere in Provence. Nevertheless, ITER is already very visible in the media worldwide.

A major scientific and technological challenge, ITER is also a communication challenge! Difficulties relate essentially to four characteristics of the project:

- ITER is a research project (both fundamental and applied).
- It has been conceived by politicians (US President Reagan and USSR General Secretary Gorbachev in 1985).
- It is a long-term project, and therefore not very interesting for politicians.
- ITER is also controversial, and criticized by some scientists.

The main criticisms concern the project cost, the use of tritium (a radioactive isotope of hydrogen) and several uncertainties related to fusion and tokamak technology, such as the nature of the material which will be used for the walls of future commercial reactors. Also, we do not yet know whether a fusion reactor will be able to work 24 hours a day. For these reasons, some scientists believe that the decision to build ITER was premature. They could be right.

Our communication work at ITER basically consists of providing high-quality scientific information (we work closely with the fusion and ITER scientists). We also aim to achieve openness, which starts with grassroots objectives such as having some visibility on the local roads (‘scientific tourism’, road signage) and obviously on the electronic grid (the web). Openness also means openings, for example through ‘Open doors’ days, which are very popular in the region (they have attracted over a thousand visitors on a single Saturday).

I am convinced that the mediascientific discourse must be credible and transparent. This is the price we pay to build complex scientific projects. I see this happening at ITER where, thanks to a shift in our public communication, we have observed a qualitative and quantitative improvement in media reports.

In fact, supporters and opponents of a given technology are sometimes closer to each other than could be deduced at first sight from external appearances. Thus, for example, well-known and established scientists have used their own reputations to support the tobacco industry, homeopathy or climate scepticism. Most of the anti-nuclear associations count scientific researchers among their membership. On both sides, the semantics is essentially the same and the expertise is often of a very high level. Let us remember the Sokal case[4], which has shown that high-level and renowned experts can be bluffed by a pseudo-scientific discourse – in reality, a false one. It is therefore not surprising that the public adheres to extreme and even opposite positions. Technological supporters and opponents are the two faces of the same ideological reality, which illustrates different political or societal choices that are, from this point of view, inseparable.

As my colleagues and I often participate in discussions and debates about ITER, we are often accused of incompetence. This is for me a 'red light' which signals that we are leaving the area of science and entering ideological territory. This means that my interlocutors, at this precise time, are no longer interested in information and objectivity. Scientific and *rational* arguments are then useless. You just need to protect yourself and preserve your personal integrity. In a quite paradoxical way, high technology and incompetence are getting on quite well …

Before closing this paper, I would like to invite you to read the Nancy Declaration.[5] We are all convinced that science communication is useful and even necessary, but it is also necessary to remind our colleagues, managers and decision makers that science communication is an integral part of scientists' work. Hence, it deserves to be fully acknowledged and rewarded during their professional careers. This means also supporting, with adequate means, the structures involved in science and technology mediation and communication, which include universities and research organizations obviously, but also media, social networks, science centres and museums.

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4. In 1996, physicist Alan Sokal succeeded in having an article, which prooved to be a hoax, published in the cultural studies journal *Social Text*.

5. http://www.jhc2012.eu/images/declaration.pdf.

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6

Reconfiguring the public of science

Bernadette Bensaude-Vincent

Abstract: This paper reconsiders recent changes in science – public relations in France in the light of earlier ideas about the role of the lay public. A broad historical perspective shows that the categories used to describe communications between knowledge producers and society have been reconfigured again and again (Secord 2004). Notions such as such as 'savants' and 'amateurs', 'popular science' and 'science mediation' are historical constructions heavily dependent on the institutional conditions of scientific research and on its technological applications (Topham 2009ab). This paper first emphasizes the epistemic and social conditions of the construction of the notion of the public as 'those who do not know' in the 20th century. It then tries to understand when and how the notions of 'citizen science' and 'participatory science' emerged. Finally, through a brief survey of various modes of participation developed over the past decade, it questions the notion of a radical change or paradigm shift.

Keywords: deficit model, participatory model, citizen science, public engagement in science.

6.1 The construction of the deficient public

OVER THE PAST CENTURY, science and society issues have been framed around the evidence of a divide between scientists and the lay public. There were two entities: the small scientific elite – the '*savants*' – on the one hand, and the mass of those who do not know – the '*ignorants*' – on the other.[1] All efforts at popularizing

1. See, for instance, Raichvarg & Jacques (1991).

science were aimed at bridging an increasing gulf between scientists and the public. The popularization enterprise was thus considered as a necessary consequence of the progress of science.

Since the late 20th century, new catchwords such as ‘citizen science’ and ‘public engagement in science’ have spread around Europe. Suddenly the public seems to be allowed to have a say about scientific and technological topics. So striking is the change that historians and social scientists describe this episode as a paradigm shift: from a *deficit model* – in which the public was defined negatively as ‘those who do not know’ – to the *participatory model* – in which the public is invited to take part in the scientific enterprise (Broks 2006, Schiele 2008).

How are we to understand this changing image of the public of science?

In the 20th century, it was tacitly assumed that the progress of science has a cost: most people – 99 % of the population – are left behind. And the challenge was to bridge the gap through campaigns of popularization. In 1939 the author of the article ‘La vulgarisation scientifique’ in the *Encyclopédie française* insisted on the increasing difficulty of the task of science popularization:

> Jadis le problème (de la vulgarisation) aurait été facile car la science était peu avancée, les savants étaient des amateurs et il y avait peu d’écart de culture entre eux et les gens du monde. En outre la langue qu’ils parlaient était la même. Aujourd’hui l’abîme s’est creusé entre les créateurs de la science et l’homme moyen. Etroitement cantonnés, les savants sont d’autant moins compris qu’ils ont un vocabulaire et des tours d’expression particuliers. Le nombre des faits et de principes qu’il faut connaître pour suivre l’évolution d’une science est considérable et l’apprentissage est rebutant. Tout concourt à rendre la vulgarisation difficile. (Sudre 1939)[2]

In surveying the changing relations between science and the public over time, Sudre distinguished three periods. In the dawn of modern science, the scientist and the layman differed only in their style of argumentation, and Descartes’ or Newton’s cosmologies were popularized in the salons. Later on, according to Sudre, the increased formalization and mathematization of science in the

2. See also Bensaude-Vincent (2001a).

19th century created a difference of language: translation was needed, from the scientific language into ordinary language. Popularization thus developed as a process of translation. It was still possible to bridge the gap.

The 19th century was admittedly the golden age of popular science. Science magazines, science museums and popular science publications were booming in France and many industrialized countries (Bensaude-Vincent & Rasmussen 1997, Bensaude-Vincent 2009). This mass consumption of science was enabled by material conditions, such as new techniques of printing, cheap presses, railways, and greater literacy among the population. Yet it also presupposed that the distance between the scientific elite and the public could be overcome. The continuity between science and common sense was the basic assumption, underlying and even inspiring most 19th century popular enterprises.[3] The gap between scientists and the public was viewed as accidental rather than essential and did not disqualify the public's knowledge. Laypeople had to catch up, to follow the progress of science and technology, which was assimilated with the progress of civilization itself.

In the early 20th century, after the development of relativity theory and quantum mechanics, Sudre continued, translations from scientific language into vernacular language were no longer possible because the notions introduced by physicists had no equivalent in the common intuition of space and time. Scientists and ordinary people lived in two different worlds. An ontological gulf came into being: no common reference allowed the process of translation. This radical break between science and the public threatened the popularization agenda: to put 'science in every one's reach'.

In the interwar period, the 'new physics' – relativity theory and quantum mechanics – became favourite topics of science popularization despite the assumption of an ontological gap. In fact, as the 'science = progress of civilization' equation became less and less obvious in the aftermath of World War I, popularizers had to promote the notion of pure and disinterested science. Star scientists were celebrated as geniuses concerned with the pursuit of

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3. This credo has been clearly formulated by Auguste Comte. Positive science, in contrast to metaphysics, emerged out of common sense. See Bensaude-Vincent (1991).

truth, living in a spiritual world, ignoring economic interests and national boundaries. Science was beyond good and evil, beyond moral judgements. Theoretical physics became the model science, and the distance between science and common sense became a cliché. Gaston Bachelard's epistemology of rupture was largely inspired by this campaign. With non-Euclidian geometries, relativity theory and quantum mechanics, the 'new scientific spirit' required a radical break with common-sense views.[4] So distorted were the non-scientists' views that they had better keep silent and never express their opinion. Immanuel Kant's famous injunction '*Sapere aude*' ('Dare to know!' (Kant 1784) – never rely on others' opinions but cultivate your own faculty of judgement – no longer made sense. Laypeople would necessarily have to rely on experts. Ironically, a direct impact of the advancement of scientific rationality was the collapse of the Enlightenment motto 'Have the courage to use your own understanding.'

How to understand this paradox? The notion of laypeople as deprived of science is a social construction linked to a specific practice of science. Whereas science in the 18th century was a social activity open to amateurs, in the 20th century lay practices of science, popular and indigenous knowledge have been disqualified as pseudo-sciences. Legitimate science is the specific practice of academic communities working in public or private research laboratories, and ruled by their own systems of values and evaluation (the peer review system). As a result, non-scientists could never challenge the authority of professional scientists.

Could that authority be challenged by science mediators – those who occupied the allegedly increasing gap between science and the public? Science writers and journalists became professionals in charge of spreading an image of science among the public, rather than enlightening the public (LaFollette 1990). In the aftermath of World War II, they very efficiently spread a positive image of nuclear physics as a source of clean and cheap power rather than as a military weapon.

4. In 1938, Bachelard presented opinion as the major obstacle to the 'formation of scientific spirit'. He even deprived laypeople of their capacities for thinking and judging ('l'opinion pense mal, elle ne pense pas') (Bachelard 1972: 14).

However, dazzling images meant to reinforce the public acceptance and acclamation of scientific research did nothing to bridge the gulf between scientists and the public. In the 1980s, alarming surveys of the public understanding of science in industrialized countries raised a political concern to increase 'scientific' literacy. The mission of science mediators was to augment public knowledge of scientific topics – to spread scientific rationality within society. The mission was never to open the scientists' minds to other forms of rationality and other styles of thinking. It was a one-way flow from the source of knowledge production to the mass of knowledge users and consumers.

6.2 The erosion of the 'gulf' between science and the public

Some protests emerged from within the scientific community in the 1970s. For instance, the 'scientific culture' movement denounced the increasing isolation of science from culture and society, while the 'science for the people' movement in the United Kingdom and 'Impa-science' in France debunked claims of neutrality (Debailly 2010). In the 1980s, the prestige and the authority of science started to come under attack from the public.

On one shore of the alleged 'gulf', the monopoly of expertise was questioned as a result of a number of public scandals, which brought to centre stage the collusion of interests between the scientific establishment and public or private interests. In France, during the Chernobyl disaster in 1986, the public authorities systematically denied that radioactivity on French territory had increased. They assumed that the radioactive cloud had stopped at the German and Italian borders and took no steps to prohibit the consumption of milk and vegetables. This attempt, against all factual evidence, to assuage the public's fears only generated public mistrust of both scientists and politicians.

That mistrust has since been deepened by revelations about deliberate attempts to conceal or dismiss certain data for economic reasons. For instance, the tobacco industry concealed or denied epidemiological data about the danger involved in smoking (Proctor

& Schiebinger 2008). The attitude of Monsanto in the controversy surrounding genetically modified crops and, more recently, the disclosure of the risks associated with Bisphenol A have reinforced the public's conviction that commercial interests permeate and distort all scientific data (Robin 2008).

More widely spread is the growing scepticism about climate change. Despite a growing consensus among experts about climate change and its anthropic origin, doubts are widely publicized in order to prevent governments taking effective countermeasures (Oreskes & Conway 2010).

As a result of so many controversial affairs, science could hardly be considered as a value-free, neutral activity transcending power and ideologies. Instead, there is wide support in public opinion for a view of science as a domain dominated by economic interests and political orientations. For many people, all expertise is biased and the selection of experts is a political decision. The age of experts as those who 'speak truth to power' seems to be over (Jasanoff 2003).

On the other shore of the 'gulf', the view of the public as a mass of passive receivers of innovation has been eroded by a number of spectacular actions. In Germany, the anti-nuclear movement opposed the construction of nuclear plants, stopped trains shipping nuclear waste, and organized protest sit-ins. In France, massive public protests against genetically modified organisms and the destruction of genetically modified trial crops have led to a temporary moratorium on the planting of Monsanto MON810 genetically modified corn. In 2006, the opening of Minatec, a big research centre in Grenoble dedicated to nanotechnology and neuroscience, spurred intense protests from a local organization named 'Pièce et main d'oeuvre'. This small group of determined, anonymous activists, using more or less humorous denunciations of the local lobby, drew public attention to the non-democratic nature of decisions and investments in nanotechnology. The group's purpose is to systematically debunk all research initiatives in nanotechnology and related technologies.

More constructive actions demonstrated that laypeople can produce legitimate knowledge. An early example of co-production of knowledge was in AIDS research. Patients contributed to experimental investigations – even conducting clinical trials on a specific drug after scientists had refused to do so (Epstein 1995, 1996). In France, a civil association was created in the aftermath of Chernobyl to challenge radiation measurements delivered by official institutions. Twenty-five years later, CRIIRAD (the Commission of Independent Research and Information on Radioactivity) is a legitimate non-profit organization in charge of risk surveillance and public information, equipped with permanent laboratories run by a dozen permanent employees supported by thousands of volunteers (Topçu 2008). Another civil counterexpertise organization based on that model – CRIIGEN (the Commission of Independent Research and Information on Genetic Engineering) – was founded in 1999. However, it is more like a group of experts-acting-as-citizens who develop an alternative approach to the risks and benefits of genetic engineering. Its results are periodically under attack and its members are denounced as impostors or charlatans because they directly question the independence of academic research.

As a result of scandals and controversies about nuclear power, genetic engineering, nanotechnology and climate change, the clear-cut boundary between science and opinion collapsed in a few decades. The polarized landscape, with a small scientific elite holding a monopoly of truth language on the one hand, and a passive public submitting to the authority of experts on the other, has been deeply questioned. Science is now increasingly viewed as an archipelago of scattered islands populated by experts, as scientific controversies between experts on issues such as genetically modified crops and climate change have become more and more commonplace. Experts do not speak with a single voice and cannot reach a consensus. Although the English language has no plural for the abstract noun 'expertise', the plurality of expert opinions has been recognized (Bucchi & Neresini 2004, Bucchi & Trench 2008). And the public itself is no longer seen as an abstract entity, a mass of anonymous laypeople. They are individuals defending their interests and capable of producing knowledge. They are citizens aware of their rights. The erosion of the image of the gulf is so pronounced that the issue 'science and the public' has been reformulated in terms of 'citizen science' (Irwin 1995).

6.3 The collapse of the ivory tower

The divide between scientists and the public could be maintained as long as science was perceived as a separate world, independent of the context in which it was practised. Scientific research, confined in closed laboratories, was supposed to be ruled exclusively by epistemic values such as truth, objectivity, and so on. However, the recent controversies (genetically modified organisms, climate change, personalized medicine, etc.) have revealed the social and political dimensions of scientific issues. Over the past two decades, social scientists have described science as highly context-sensitive and permeated by non-epistemic values such as 'competitiveness' or 'sustainable development' (Longino 1990, Gibbons et al. 1994).

Whether this is or is not a 'new regime of knowledge production' is a matter of debate, but what really matters is that officially science is no longer pursued as a disinterested and value-free activity. The dominant view in science policy is that scientific research is not an end in itself – it is oriented towards society and the economy. Science is no longer 'the endless frontier', as it was in Vannevar Bush's famous 1945 programme, which gave considerable autonomy to scientists. '*Society* is the endless frontier' is the European vision of research and innovation for the 21st century (Caracostas & Muldur 1997). Over the past two decades, technosciences such as information technology, biotechnology and nanotechnology have developed in parallel with the urge to refocus science on social concerns. Suddenly, the ivory tower of academic research opened to the world. Science policy became a major actor, and a crowd of industrial people, venture capitalists, users' groups, consumer associations, environmental activists, trade unions and NGOs came to the front of the stage and talked about science.

Along with the reorientation of scientific research towards societal or economic demands, the practice of science broke the walls within the ivory tower. Multidisciplinary research networks working for a few years on a specific research project tend to dissolve the strong disciplinary identities of academic scientists. They have to raise funds and make alliances with other laboratories, industrial companies and banks. They have to behave as entrepreneurs rather than comply with the traditional scientific ethos defined by the four pillars (universalism, disinterestedness, communalism, organized scepticism) (Merton

1973). In addition, the increasing role of computers, computer-based modelling and simulation is changing the epistemic culture deeply. In research fields such as genomics, investigations are aimed at the collection of innumerable data rather than the search for universal laws of nature. And computer sciences in their historical development have been much more open than conventional disciplines to amateur practices. Not only have hackers, free software and open source movements demonstrated that sound knowledge can be produced outside academic circles, but academic circles are occasionally inviting amateurs to participate in their research, as exemplified by Stanford University's *Folding@home* project, which was launched to solve a problem related to protein folding. New epistemic cultures, such as distributed computational research or crowdsourcing for enrolling young talent in the exploration of new research areas, are emerging, blurring the traditional boundaries between academics and amateurs.

Does this mean that the age of experts and technocrats is over and that science is now more in the hands of citizens and under democratic control?

6.4 Towards a participatory model?

Science policymakers, NGOs and scientific communities seem to agree that more control of science is needed. They are increasingly concerned with frauds and conflicts of interests and call for more transparency. The concept of accountability, introduced in the 18th century to make the apparatus of government answerable to the public, has resurfaced as a major requirement for scientists in the late 20th century. Public investments in scientific research have to be legitimated, and scientific activities have to be scrutinized by public authorities. Social scientists have been engaged in a number of national research initiatives on nanotechnology or biotechnology. 'Responsible innovation' has become a catchphrase both in industrial research and in the public domain. Society, it seems, has to be present from the outset, upstream, on the laboratory floor.

In stark contrast to the former one-way science communication model, an impressive number of *dispositifs* have been developed to initiate a two-way traffic between citizens and scientists. Science cafes, public debates, consensus conferences, citizen conferences or juries, scenario workshops and hybrid forums are routinely organized in many European countries. The *cafés des sciences* recreate the public space where the notion of 'the public' emerged in the Enlightenment. In the standard process of a citizen conference, a panel of citizens is asked to formulate its opinion about a scientific or technological topic after hearing a number of experts and their opinions; its recommendations are publicized and can influence the decision-makers. When invited to participate upstream in the R&D phase, rather than downstream when innovations enter the market, assessors may prompt decisions in science policy and the imposition of new regulations.

Upstream technology assessment is not the only role that citizens can play. In hybrid forums, citizens are invited to cooperate in the construction of knowledge; they become legitimate co-producers of knowledge (Callon 1999, Callon et al. 2001). They are mobilized not only as individuals who volunteer to improve technology or to augment knowledge, but also on the basis of political activism. A number of NGOs, environmentalist movements, patient groups and consumer associations have set up their own laboratories and research facilities to produce their own expertise on specific issues such as medical research, radioactive contamination and genetic adulteration. They thus renew the tradition of 19th century advocates of popular science as an alternative science, such as Auguste Comte, François Raspail and Victor Meunier (Bensaude-Vincent 1988). Their mission is not exactly the social control of science that 19th century science popularizers envisaged, but is something like a surveillance of experts. Their frequent claims of 'independent expertise' suggest that the knowledge produced by scientists is not independent, loaded as it is with public or private interests. However, that phrase is misleading because the knowledge produced by active citizens is neither value-free nor disinterested. It is through the confrontation of various experts that one can expect to approximate the truth.

It is too early to evaluate the impacts of such *dispositifs* on science and society. To be sure, science and technology have entered the public arena and are discussed in the agora, but it would be naive to think that a couple of hybrid forums and citizen panels alone have the ability to put science and opinion on an equal footing. Public participation remains confined to a very limited set of technoscientific issues. Citizens' interventions in the process of decision-making have so far been extremely limited, and the citizen panels are by no means representative of the public opinion because activists are systematically discarded. Often the motivations for engaging the public upstream are to prevent the public rejection of new technologies, to avoid controversy and to foster public acceptance of innovations. Is it social engineering or participatory democracy?

More precisely, the governance of science by bringing together the 'stakeholders' at a round table is inspired by a management technique initially developed in industrial companies. In this model, the norms of management – success, efficiency – replace the normativity of law as well as the normativity of science (Bruno 2008: 75–76). The same managerial inspiration prevails in the role assigned to the social scientists engaged upstream in research programmes. They have to anticipate the potential impacts of new technologies on ethics, the economy, society and law. They have to identify key issues and potential risks, to balance costs and benefits, and so on. In other words, they have to adopt the instrumental rationality that prevails in science and technology. This appears to be a technocratic control of society as much as a democratic control of science and technology.

In conclusion, the relations between science and opinion have been continuously reconfigured since the dawn of western science in Greece. However, it would be simplistic to conclude that we have shifted from a deficit model of the public as those who do not know to a democratic model of active citizens participating in the advancement of science.

The emerging participatory model has not yet prevailed over the deficit model. Many scientists and citizens are still convinced that there is an increasing gulf between science and the public, and that laypeople cannot have an opinion about scientific choices. The deficit model that prevailed in the 20th century did not eradicate the earlier model of the enlightened public. There have been no paradigm shifts, although novel characterizations of the public emerge continuously. New roles for the public may prevail, but they never overthrow the earlier roles and concepts.

Many rival images of science and the public are competing in today's society. Through this perpetual struggle, science and the public are mutually shaped and reshaped. Their interactions or isolation determine the role of science in society and the public attitude towards science.

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7

Scandinavian engagement in science

Jan Riise

Abstract: The three Scandinavian countries, Norway, Denmark and Sweden, invest relatively heavily in research and development, and are quick to implement new environmentally friendly technology or methods. The Scandinavian people trust other people and researchers somewhat more than people in other countries. Nevertheless, interest in science and technology among young people is decreasing, and their performance is below the average of OECD countries, China, Korea and Japan. On the other hand, they have a long tradition of engaging in science, so it is no wonder that outreach activities in the Nordic countries have had a focus on direct meetings between scientists and the public. 'Borrow a researcher', science parliaments, shopping mall presentations and debates as well as other events in unusual venues have attracted hundreds of thousands of visitors to science weeks and festivals.

This paper focuses on some of the formats for science communication that have been tested in Scandinavia and the outcomes so far, with a particular emphasis on public participation and dialogue events. It is written from a practitioner's point of view, so there are some statements that are more personal observations than evidence-based facts. Engagement activities in Scandinavia and elsewhere have yet to be evaluated and studied scientifically.

Keywords: public, engagement in science, dialogue, outreach, science parliaments.

7.1 The landscape

7.1.1 Scandinavians: rich, healthy and happy

THE SCANDINAVIAN countries – Sweden, Denmark and Norway – together cover about 820,000 square kilometres, or less than a tenth of the area of the United States. Almost 20 million people inhabit Scandinavia: 5.5 million in Denmark, 4.7 million in Norway and 9.1 million in Sweden (CIA 2012)

Sweden, Norway and Denmark are in many respects similar, with a common history, and basically all Scandinavians understand the three national languages, although some will claim that it is with considerable difficulty.

The three countries can be found among the top 20 in almost any ranking of GDP (gross domestic product) or purchasing power parity. In GDP per capita in 2001, the World Bank ranks Norway third, after Luxembourg and Qatar, Denmark ninth and Sweden tenth (World Bank 2012). The rankings are based on estimates and should be used carefully. They do not necessarily reflect standards of living in a country, as GDP is not a measure of personal income. However, with some caution, it seems fair to say that the three Scandinavian countries are among the richest in the world.

The three are also among the leaders when it comes to implementing environmental protection initiatives.

The World Happiness Report ranks Denmark, Norway and Sweden as number 1, 4 and 5 globally for 'average happiness (with life as a whole)', with neighbouring Finland in second place and the Swiss in third place (Helliwell et al. 2012: 41).

7.1.2 Researchers, explorers, educators

During the first days of October every year, for one week from Monday to Friday, the scientific world looks to Stockholm and the presentations of the Nobel Prizes in medicine or physiology, physics, chemistry, literature, and finally the Peace Prize.

The Nobel Prize has been awarded for achievements in these areas since 1901. In 1969, the first laureates in Economic Sciences received a prize, established by Sveriges Riksbank (the Bank of Sweden) in memory of Alfred Nobel, thus celebrating the bank's 300th anniversary.

It was in 1895 that Alfred Nobel wrote in his will that the interest of a fund should be distributed in five equal parts to those who have 'conferred the greatest benefit to mankind'. The Nobel Prize is probably one of the most well-known prizes in the world, and it has undoubtedly meant a lot to the image of Sweden as a nation of science.

Earlier in the 19th century, the first *folkeskole* was established in Denmark in 1814; Sweden followed in 1842. In Norway, the school system was reshaped in the 1880s to provide seven years of school for all children.

In Denmark, Nikolaj Frederik Severin Grundtvig established the *folkehøjskole* (folk high schools) in 1844. Grundtvig advocated the inclusion of history, poetry and practical skills as important parts of the teaching.

Norwegian history is characterized by some courageous and curious explorers, such as Thor Heyerdahl, Roald Amundsen and Fridtjof Nansen. In 1947, Heyerdahl sailed across the Pacific from South America on a raft, trying to prove that ancient people could have made the same voyage and created contacts between cultures. His unorthodox methods were never really acknowledged by the scientific community, but he received several awards and honorary doctorates. In April 1997, he opened the first International Science Festival in Gothenburg, Sweden, at the age of 83, exactly 50 years after he set sail from Peru on the *Kon-Tiki*.

This culture of education has resulted in a generally high level of education. Roughly 35 % of people 25–64 years old in the Nordic countries have gained a tertiary level education. This is more than in the European Union and OECD countries, but below the United States, Korea and Japan (Nordic Council of Ministers 2012).

At least in Sweden, the high level of education is connected to a confidence in science and technology. Although there have been some indications of a decrease, the general level of trust in science and technology is high in Scandinavia. It has been said that Swedes have the highest level of trust compared to other countries.

7.1.3 Investing in research and development

Sweden has one of the world's highest R&D budgets. In 2010, total Swedish R&D spending amounted to 3.4 % of gross domestic product. About two-thirds is industry related and one-third is publicly funded. Only a few countries, such as Korea, Finland and Israel, reach the 3.5 % level of public and private funding. Another handful of other countries spend more than 1 % of their public budgets on R&D, including Sweden's Scandinavian neighbours, Denmark and Norway (OECD 2012).

7.1.4 Trust in science and scientists

Swedes and their neighbours in Denmark and Norway generally have a high degree of interest in science and scientists. The Eurobarometer asks people in the European countries about their interest in new scientific discoveries and technological developments. In 2010, 43 % of Swedish citizens described themselves as 'very interested', compared to 35 % of Norwegians and 32 % of Danes (EC 2010). One in ten Swedes, one in ten Norwegians and almost one in four Danes (23 %) say they are not at all interested.

The European Union average for 'very interested' citizens is 30 %, compared to 40 % in the US and 30 % in India (Vetenskap & Allmänhet 2012).

Swedes also have a high level of confidence in scientists in general: 77 % trust university researchers, although the figure for researchers in companies is considerably lower, at only 51 %.

Between 58 % and 65 % of Scandinavians agree with the statement 'We can no longer trust scientists to tell the truth … because they depend more and more on money from industry.' The European Union average (27 countries) was 58 % (EC 2010).

The Scandinavian countries are secular countries, with approximately one in five citizens claiming that they believe in 'neither a spirit, god, or life force' (EC 2005). This is a little above the European average of 18 % measured in the same poll. Sweden is sometimes described as one of the most atheist countries in the world, and according to the Eurobarometer poll is the third least religious country in Europe, with 23 % not believing in a spirit, god or life force.

The three Scandinavian countries are all strong performers when it comes to investments and results in the environmental field. In the Environmental Performance Index 2012, published by the Yale Center for Environmental Law and Policy at Yale University and the Center for International Earth Science Information Network at Columbia University, Norway was ranked third, Sweden ninth and Denmark twenty-first (Yale 2012).

So, overall, Scandinavians seem to live rather pleasant lives. They are happy, healthy, rich and environmentally conscious and have high educational levels.

However, there are worrying signs – not least in schools. As in many other western countries, students' performance is less than expected and even below the average for OECD countries. Only Finnish schools seem to manage to keep quality on top: their results are comparable to those of schools in Korea, Singapore and Japan.

Of course this is problematic, and political representatives are searching for explanations. Meanwhile, the situation creates the backdrop for many science outreach activities that take place outside school, such as science festivals, and several initiatives have been launched to support, for example, science teachers through continuous education and other activities.

7.2 The engagement

7.2.1 35 years of collaboration

The Swedish universities are governed under a law that includes a paragraph concerning the universities' 'Third Task', in addition to research and education. A Swedish university is expected to 'collaborate with society and inform about its activities'. Furthermore, when the university employs staff, communicative skills should be part of the evaluation.

This was first implemented in the 1977 law, and has since been updated twice. The most recent update, in 2009, also includes innovation and states that the results attained at the universities should be useful to society.

In 1977, this was quite a step to take. Before that, universities were basically isolated from the rest of society, and collaboration with industry was almost unheard of. At the same time, university education was free – it still is – and, at least in Sweden, everyone who wanted to study was allowed to.

At that time, Swedish universities opened ‘contact secretariats’ to assist in the dialogue with society and in particular the industry. University colleges were established in a number of smaller cities, with the explicit objective of supporting regional development.

7.2.2 Outreach and direct meetings

Science communication events, such as science festivals, were established in the Scandinavian countries in the 1990s and the first years of this century. In 1995, the idea of a science festival in Gothenburg was first discussed with representatives of the universities of the city, the city itself and some of the major companies, using the science festival in Edinburgh as a role model and template. Besides the objective of raising awareness of science and technology, another important aim was to contribute to the image of Gothenburg as a ‘city of knowledge’, rather than as an industrial city with serious environmental problems – an image that had been dominant during the 1980s.

Similar discussions were going on in the other Scandinavian countries at the same time. In Denmark a national science festival was established, with the objective of strengthening the links between schools and universities: activities such as ‘Borrow a researcher’ became popular with teachers and classes all over the country. And in Norway, the Research Council created ‘Research Days’, a national event with a particular focus on the relations between universities and industry.

This development took place in a number of other European countries as well. It has been described in the ‘White Book’ (Eusea 2005), where science communication events were analysed and compared.

The science festivals in Sweden, Denmark and Norway are all characterized by the use of unusual places – venues that are not directly connected to the universities or particular research institutions or labs. This also involves face-to-face meetings between members of the public and scientists. The Science Festival in Gothenburg and its sister organizations in Denmark and Norway have developed and tried a number of formats for presentations that might be useful as inspirations for others.

Science roulette

Science roulette uses the Gothenburg Wheel, a 60-metre Ferris wheel with 42 glazed capsules, each accommodating eight people. During the opening day of the two most recent festivals, a researcher from one of the festival's university partners has occupied each capsule. Then, as the attraction opens to the public, each visitor gets a five-minute presentation on a random subject – depending on which capsule the visitor gets into – while the wheel completes its normal rotation. As the capacity of the wheel is more than 1,000 people per hour, the event is actually open to quite a big audience.

The shopping mall

From the very first year, the major shopping mall in the Gothenburg area, 'Nordstan', has been an important arena for Science Festival activities. The mall is where people just passing by can spend a few minutes or considerably longer, taking part in short talks, typically 15 minutes, or other forms of interactive presentation. An exhibition area in the middle of the mall is turned into festival space, with a stage, exhibits and places to talk or try out experiments. A specific programme is put together, indicating times for presentations or discussions from the stage, but a large proportion of the visitors take part in a more unplanned way.

The experimental workshop

At the time the Science Festival was established, there was no science centre in the Gothenburg area. It was decided to open a temporary centre, or rather an experimental workshop, and invite teachers in the region to spend half a day with their classes there during the festival period. This has been extremely popular, and the activity is fully booked months in advance. The workshop is rebuilt every year, despite the fact that there is now a very popular science centre in Gothenburg, the Universeum, which will host the

Ecsite Annual Conference in 2013. From 2011, the workshop has also been open to preschool classes, giving children 5–6 years old a chance to meet researchers first-hand and try some experiments.

Science parliaments

During 2WAYS, a ‘science in society’ project funded by the European Union, science parliaments were organized in Sweden and Denmark. The parliaments involved some 60 students, aged 18 or 19, in each of the four cities of Copenhagen, Lund, Gothenburg and Stockholm.

The students participating in the local science parliaments discussed four specific issues concerning life science research, such as access to genetic information and the use of embryonic stem cells. They produced resolutions on all issues and handed them over to a local or national policymaker representative. In addition, two students were elected to take part in the first Young Europeans Science Parliament, which took place at the European Parliament in Brussels during three days in late 2010.

Conclusions so far: it works

Science events and science centres and museums, not only in the Scandinavian countries, all report the same story. It works. People come to see, listen and participate in activities, presentations, festivals, temporary exhibitions, discussions and debates.

Researchers also have many anecdotes about the value, for them, of participating in events and activities.

However, evaluations and research concerning formats, impacts and long-term effects are to a large extent still missing. According to one study, evaluations are certainly made, but on rather low budgets and in the local language, making it hard or even impossible to compare initiatives. With limited resources for the activities, it is no wonder that evaluations have to be downsized, even though sponsors and partners are most interested in the outcome of their support.

7.3 Developing the dialogue

Science is not the authority it used to be. This seems to be a fact in many countries, including the Scandinavian countries, even though general trust and confidence in science and researchers is relatively in high in Scandinavia compared to other regions.

Discussions about sustainability, particularly in its social dimension, have made it clear that public participation and engagement in society's decision-making are valuable and necessary.

Research on the actual impact of early dialogue (such as in urban planning) is yet to be carried out and published, but there seems to be a general trend calling for 'socially robust decisions', for example by including the voices of other actors, such as NGOs, community-based organizations, professionals and individual members of the public.

Thus, 'public engagement in science' has also become a key expression in Scandinavian countries. Engaging people in science and society is a basis for empowerment and improved governance.

There is also a general trend towards an increased emphasis on innovation and the usefulness of science, expressed in the change from 'DG Research' to 'DG Research and Innovation' at the European Commission's Directorate General for Science and Research. A reasonable conclusion would be that this trend also calls for closer communication between research and innovation, policymakers and the public, in order to develop the connection between 'the market' and research, development, innovation and commercialization.

7.3.1 Creating places for dialogue

Dialogue uses a wide range of formats and methods to make all voices heard, to reach mutual understanding and to avoid conflicts. They have been created to meet societal challenges and to contribute to better decisions and decision-making. They were not necessarily developed with particular scientific issues in mind, but rather to support urban and societal development on a wider scale. Some formats may be closer to market research than to dialogue, while others have genuine deliberative moments built into the process.

The consensus conferences, as developed by the Danish Board of Technology, are a model of communication in which deliberation and to some extent negotiation form the dialogue (Horst 2008). A group of laypeople – a panel of citizens without any specific scientific or other professional knowledge in a field – is invited to deliberate on a specific subject to arrive at a consensus statement, shared by all participants. Expert knowledge, such as from scientists, is available throughout the consensus conference, which typically lasts for two or three weekends.

Other formats for deliberative dialogue include the citizen conference, joint fact-finding and youth parliaments such as the science parliament described above. There are also formats like charettes, the South African 'deep democracy' and 21st century town hall meetings, which are based on quite well-defined guidelines. Formats that come closer to the traditional 'diffusion' model of science communication include science cafes, which have become very popular all over the world. A science cafe may well include significant dialogue, but no formal channels for communication to policymakers or others concerned about a specific issue.

These formats are certainly familiar to dialogue organizers in the Scandinavian countries, but were not invented and developed there.

Evaluation studies and research on the actual effects of dialogue activities and events are scarce. The Young Europeans Science Parliament and the local youth parliaments that preceded the European event were evaluated as part of the 2WAYS project. The participating students perceived the parliament as meaningful and motivational, they felt encouraged to take part and ask questions, and they were more interested in the subject discussed after the event than before (Salmi 2010).

A comprehensive German study of a range of participatory events, including citizen and consensus conferences, found that the most important factor for success is the 'mandate' (ZIRN & W-i-D 2011). Participation and the development of views and opinions were more significant where policymakers expressed interest in the outcome of the process.

Science cafes and similar events, where formal links to policymakers are weaker or lacking, and where there is no mandate to participate in a capacity-building process, have consequently not been investigated to determine their influence on policies. However, the potential importance of participating for one's own personal development has been discussed. Activities such as science cafes may be seen as opportunities for empowerment, and the learning process that might occur as part of a dialogue should not be underestimated (Davies et al. 2009).

In a similar way, little is known about benefits to presenters and scientists from their participation as experts or guests on such occasions. Anecdotes and personal observations indicate a surprisingly positive attitude, at least in some cases. The learning effects are not well known, but could be considerable.

7.3.2 Facilitating the process

The use of unusual places for science events, such as science festivals in the Scandinavian countries, seems to play a significant role in the public perception of those events. Evaluations of the Gothenburg International Science Festival showed that the visitors' profiles were significantly different in the different arenas of the festival. The shopping mall and, at that time, a large tent in one of the central parks, had considerably more young visitors and visitors from neighbourhoods and parts of the city that were considered 'less academic'. Of course, comparisons are difficult because the programmes offered at different venues were not at all the same (Pousette 2005).

The use of 'neutral' places gets some support from the discussion about the 'third place' initiated by Ray Oldenburg in 1999 when *The great good place* was published. Oldenburg claims that these great good places, or 'third' places (not at home, not at work), play vital roles for communities by providing a neutral and informal setting where people go to enjoy the company of others. Modern public administration buildings are not often built for participation, so politicians and policymakers need the 'third places'. That could also be part of an explanation for the success and rapid spread of the science cafe format.

The science centres are one type of place that could make excellent 'third places' for the further development of public engagement in science. In many cases there are already a context for engagement based on informal education in science and technology, as well as entertaining, making them attractive destinations for a day out for families or adults on their own.

There also seems to be a trend towards holding more events at science centres, such as festivals or science days on particular topics, especially during weekends. One example is the 'Portal to the public' at the Pacific Science Center in Seattle in the United States. On the Scandinavian and European context, this development is encouraged and supported, not least through the 'PLACES' for Cities of Scientific Culture project funded by the European Union.[1] The project involves more than 60 European cities with science centres and science festivals, and explores the criteria for 'science cities'.

Finally, the conclusions from an evaluation of different dialogue formats, published by a German team in 2011 (ZIRN & W-i-D 2011) and emphasizing the importance of a mandate for asking people to spend time on engaging in science, could also be counted as a factor in favour of science centres and science events. Such initiatives are most often supported by local and regional authorities, agencies and governments, thus providing a direct link to policymakers. With the public in general as their major target group, the centres and events occupy a particularly interesting interface where both groups might meet – not at home, not at work.

The Scandinavian countries, with their long tradition of education, political stability, open access to information and negotiation (rather than conflict), and their interest in strengthening their positions as healthy, rich, creative and environmentally concerned, might well be the pilots in this development.

One extraordinary opportunity would be to use the world-leading research infrastructure that is being built in Lund, Sweden, as the context and the 'place' for creating arenas and meeting-places for informal education, dialogue, innovation and collaboration between science and society.

That and other initiatives would include opportunities to study the impact and long-term effects of science communication efforts in more detail. The monitoring and evaluation of such initiatives, whether temporary or more permanent, are necessary to create confidence about the results.

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1. http://www.openplaces.eu.

Finally, just one word: *facilitation*. It could be that 'engagement' and 'participation' do not just happen by themselves. It could be that the trick is not only to provide the place. It might just be even better if there is also some kind of value-adding input, facilitating the process, such as an event, an exhibition, and a cool and interesting environment.

The research on dialogue, public participation and engagement is still in its initial phase, it seems. More studies, from different disciplines, multidisciplinary and transdisciplinary, would be most welcome.

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8

Consensus in context: The development of the Danish model of science communication

Maja Horst

Abstract: Using Denmark as a case, the paper argues that cultures of science communication have to be understood in relation to national and political cultures in general. Building on a particular political culture of anti-elitism and consensus-seeking, Denmark has pioneered a tradition of democratic science communication. Best known is the format of participatory consensus conferences developed by the Danish Board of Technology. The format aims to integrate laypeople's views into science policy and is characterized by a distribution of roles, which can only be understood if viewed in the context of the Danish consensus culture. The paper also argues that, although ill-advised, the recent cut of government funding for the Danish Board of Technology does not mean that the culture upon which it is built will cease to exist.

Keywords: consensus conferences, deliberation, Denmark, political culture, anti-elitism.

THE PURPOSE of this paper is to contribute to the discussion about cultures of science communication and how they relate to national and political culture in general (see also Horst 2008, 2012; Horst & Irwin 2010). I use the Danish model of science communication as an example. This model has been influential outside the borders of Denmark and, because of its specificity is a good starting point for the discussion of culture.

When, for instance, the British House of Lords Select Committee on Science and Technology was writing its report, *Science and society* (SCST 2000), it decided to do a field trip to Denmark to study the Danish organization of science communication and public engagement with science. In its report, it concluded that:

> Denmark … has evolved institutions to give effect to a society whose political philosophy is to seek consensus rather than confrontation … Denmark's bodies such as the Danish Board of Technology, the Danish Council of Ethics, and the Central Scientific and Ethical Committee offer reassurance and, to some extent, involvement to a public which tends to be suspicious of both government and experts, including scientists. (SCST 2000: 82)

It is my belief that the House of Lords committee thereby gave a very precise description of the cultural core of the Danish model of public engagement with science. In order to grasp the function of these institutions, however, we need to recognize how they are deeply ingrained in the Danish political culture. We cannot appreciate these institutions without understanding the wider culture in which they were developed. This is what I focus on in this paper.

The three Danish institutions mentioned by the House of Lords committee were established in the 1980s on the basis of widespread discussion and controversy about the development of bio- and information technology. In the present context, I focus solely on the Danish Board of Technology, as it is the one best known internationally.[1] The board was founded in 1986 and was not intended to be an expert panel. Instead, it was designed to create and stimulate different processes of technology assessment, including what is referred to in Denmark as 'broad public debate'. The board employs a variety of methods, but is best known internationally for its participatory forms – and especially for participatory consensus conferences (Horst 2012, Mejlgaard 2009).

Internationally, consensus conferences have attracted substantial scholarly attention as a key example of deliberative democracy in the governance of science and technology (Joss & Durant 1995, Horst 2008). They have also gained influence as a practical format for doing technology assessment.

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1. See http://www.tekno.dk.

The US-based LOKA Institute website lists 20 countries as having engaged in ‘Danish-style, citizen-based deliberative “consensus conferences” on science and technology policy worldwide’. But the consensus conferences have also been more widely praised for their deliberative potential and their promise of democratization. In his 2007 book, *Over to you, Mr Brown*, Lord Giddens made this positive evaluation:

> in the ‘consensus conferences’ held in Denmark, findings are incorporated into parliamentary discussion as a matter of routine … they have directly influenced parliamentary decisions. (Giddens 2007: 193)

Unfortunately, there is not much direct evidence to support this expectation. The results of the consensus conferences have never been implemented directly in parliamentary decisions. In fact, quite the contrary – it is difficult to point to specific regulations that have come out of these conferences. However, this does not mean that Giddens is wrong about the overall positive evaluation of the consensus conferences. As a Danish person with an interest in these issues, I have participated in many consensus conferences, and I have had many roles as citizen, expert and organizer. I believe that the consensus conferences are an instantiation of an extremely important aspect of the Danish political culture, and that they have helped materialize that aspect in a very important way.

In order to sustain this argument, I will give a short introduction to what a consensus conference is. I then demonstrate how the format is deeply interlinked with Danish political culture. Subsequently, I discuss recent developments that paint a slightly more gloomy picture for the future of the Danish model.

8.1 Consensus conferences

A participatory consensus conference, as developed by the Danish Board of Technology, is a meeting between experts and citizens to discuss and evaluate a particular, potentially controversial, technology (Andersen & Jæger 1999, Jensen 2005, Blok 2007). 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 in order to create a consensus statement (Grundahl 1995, Klüwer 1995). The consensus statement is subsequently presented to policymakers, experts and the general public in order to enrich and broaden technological debate.[2]

The topic of a consensus conference has to be carefully chosen with regard to timeliness, controversy and focus:

> According to DBT 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 & Jæger 1999: 334)

A planning/steering group is in charge of organizing the conference, including the fair selection of members of the citizen panel and the experts. The citizen panel, with approximately 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 particular personal or professional vested interest. The panel receives written information about the subject and meets for two preparatory weekends prior to the conference to prepare its members for the discussion of the subject. Experts are found by the organizers according to the questions prepared by the lay panel.

The conference itself runs over four days, of which the first 1½ days are used for expert statements and cross-examination of the experts by the citizen panel. This part of the conference is open to the public and the media. After this, the citizen panel and its moderator withdraw to write the consensus statement. On the last day, the consensus statement is read out to the public. Experts can suggest corrections to factual mistakes, but otherwise the consensus 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.

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2. See also http://www.tekno.dk/subpage.php3?article=468&toppic=kategori12&language=uk (retrieved 19 October 2007.

The most important thing in this format is that laypeople are allowed and expected to ask questions of the experts, and to evaluate the answers they are given on their own terms. In this way there is a very important equality in the role distribution. The experts are expected to give the most factual answers they can, but they have no say in how the citizens evaluate that information. The experts do not have any authority over the consensus report; rather, that authority lies firmly with the citizens – the lay panel members. They are trusted to be capable of evaluating the scientific expertise and to formulate a consensus statement on this basis. In this way, the format is a challenge to the traditional distribution of roles, in which an expert is usually expected to know more, and therefore to make more credible evaluations of knowledge, than people without any expertise.

To people outside Denmark, this distribution of roles has often been puzzling. I will dive into the history of Danish political culture to describe why it makes good sense in a Danish setting.

8.2 A consensus-seeking culture

To understand the Danish propensity to let citizens evaluate knowledge and to speak on behalf of the collective, we have to understand some deeply held cultural values in Denmark and make a short detour to the teachings of one of the most influential cultural figures in Denmark, the priest, poet and politician N.F.S. Grundtvig (1783–1872) (see also Horst & Irwin 2010).

Grundtvig was an active proponent of the creation of a nation-state in which the Danish people would be united in a common history and a common mother tongue (Korsgaard 2004). For this purpose, he devised a special institution, the 'folk high schools', whose task was education in knowledge about practical human life. The folk high schools were intended to transform young people into citizens and members of a Danish people with a shared culture and a common destiny. Grundtvig envisaged these schools as much more important for society than the universities, which he perceived as teaching 'dead' knowledge to individual scholars (Knudsen 2001: 99–105). He was fiercely opposed to one-way teaching and envisaged folk high schools as open and anti-authoritarian institutions dedicated to the achievement of educational dialogue. His ideal of dialogue was founded on a belief that ‘the living word’ would transform both teacher and student and unite them in a sense of shared culture (Korsgaard 2004: 225–7).

Grundtvig had an explicitly anti-elitist perception and regarded the ordinary people as far more knowledgeable about the common life of man than any of the authorities in society (Knudsen 2001: 104). Knowledge, in his perception, came from experience of an ordinary life, shared culture and a common destiny as members of the nation-state community. In one of his songs, an often-cited line reads: ‘And the sun rises with the farmer, not at all with the learned’[3] (Grundtvig 1839). Ordinary folk were seen as better connected with the knowledge of practical life than so-called experts in universities. They should therefore not listen to authorities and think that elites know better than them. Rather, they should find their own standpoints through deliberation among themselves.

The folk high schools became an integrated, although informal, part of the Danish educational system, as it became common for young people to spend a year at a folk high school before they settled into more adult life. Following industrialization and the development of new urbanized lifestyles, the educational content in the folk high schools progressed, but the core objective has continued to be the development of the democratic skills and identities of the students (Korsgaard 2004), and there is still a large network of these schools in operation. Mejlgaard summarizes the influence of folk high schools in these terms:

> As such, the people’s high schools have been influential beyond providing training in S&T skills by promoting a wider discourse of ‘active humanism’ …, by institutionalizing a principle of ‘life-long learning’, which has become very important in Denmark, and by stimulating an environment of active appropriation of science and technology in a Danish context. (Mejlgaard 2009: 488)

The teachings of Grundtvig and the backdrop of the folk high schools were important factors in the anti-authoritarian, left-wing critique of science and technology that developed in the aftermath of the student revolts in the late 1960s in Denmark: ‘A large part of

3. All quotes from Danish sources have been translated by the author.

these oppositional arguments drew upon a challenge to modernity, industrialisation, capitalist exploitation and – not least – hierarchical antagonism' (Horst & Irwin 2010: 114). Grundtvig was evoked as a founding father of a culture in which experts were envisaged as no more competent than so-called laypeople in making decisions about the life to be led in common. Technical experts were often described as having a particular interest in the development of a technology, and they were therefore less able to speak for the common good than were citizens with no specific, or vested, interest in the issues. In this way, Grundtvig's anti-elitism and his distinction between the dead knowledge of universities and the shared knowledge about common life developed through dialogue was explicitly invoked as a foundation for the discussion of public engagement with science and technology.

It was on the basis of these developments that a more deliberative turn in Danish science governance occurred in the 1980s. General expectations of major future change brought about by emerging information technology and biotechnology led to demands for a more institutionalized way of dealing with new technology and its effects on society, organizations and individuals (Lassen 2004). In 1985, this led to the formation of the first version of the Danish Board of Technology. Its objectives were to 'follow and initiate comprehensive assessments of the possibilities and consequences of technological development for society and citizens [and to] support and encourage a public debate on technology' (Klüwer 1995: 41).

The board was intended to be an inclusive force and to encourage interactions between a number of different stakeholders in society. During its years of operation, it has developed a number of specific formats for technology assessment, including expert reports, but the specific format of the participatory consensus conference is most widely known (Einsiedel et al. 2001, Seifert 2006, Horst 2008).

It should now be clear how this format is explicitly based on the cultural tradition of which Grundtvig was a very notable proponent: in the participatory consensus conference, the citizens take centre stage. It is their task to listen to the testimony of the experts and then decide which aspects of that testimony are relevant for a shared understanding of the technology and for a consensus agreement on its future development.

8.3 The de-institutionalization of the Danish model

We now turn to more recent developments in Denmark, where the story becomes less positive. During the past decade, the Danish Board of Technology has had to struggle for survival and it has been almost impossible to find funding for new consensus conferences. In 2002, the board was threatened with closure after a new conservative and neoliberal coalition came into power in the autumn of 2001. For the first time in decades, a parliamentary majority did not need to be found across the middle of Danish politics, and the neoliberal prime minister, Anders Fogh Rasmussen declared that the government was going to change the values of Danish society. A few months later, he gave his first New Year's speech and called for a 'confrontation [or showdown] with the arbiters of taste'. He announced that the new government intended to close a number of expert committees:

> Many of them have evolved into state authorised arbiters of taste, who decide what is good and right in different areas. There are tendencies towards a tyranny of experts, which threatens to oppress the free public debate. The public should not have to submit to raised fingers from so-called experts who think they know best. (Rasmussen 2002)

The interesting thing about this quotation is that the prime minister used the anti-elitist part of the Danish culture to argue for a closure of, among other things, the Danish Board of Technology, which is in no way an elitist body. However, the irony was lost in the smoke of the battle. What was clear was that the government wanted to get rid of a particular group of advisory bodies, which it connected to a left-wing or environmentalist discourse.

Although The Board of Technology managed to survive in 2002, it faced hard times. It had been struggling for funding since the end of the 1990s (Lassen 2004), and media attention and support for its activities had also diminished during that period (Lund & Horst 1999). Finally, in 2011, a political decision was taken to end government funding of the board. At the time of that decision, it actually came as a surprise to all – even the board itself – but viewed in a longer perspective the decision might have been anticipated. And, in contrast to the 2002 decision, it was not possible to revoke the 2011 decision to stop public funding.

Consequently, the Danish Board of Technology ceased to exist as a government-funded body in 2012. It now manages to survive as a private foundation, but in future its survival will depend on its ability to attract independent funding and consultancy projects. The Danish Board of Technology is no longer a public institution with the obligation to assist with participatory technology assessment. It has no formal connection to Danish politics, and in so far as it establishes consensus conferences they will be independently funded enterprises.

Viewed in a broad perspective, the Danish story seems to run against the engagement currents in other countries. The positive take-up of, for instance, the format of participatory consensus conferences has corresponded with a decline in the board's influence in Denmark. As a Dane, I find it both sad foolish that Danish policymakers are not more proud of this export of a fruitful technique. However, I believe that there is more to say about this story than merely to complain about the poor timing and judgement of Danish politicians.

The closure of the Board of Technology as a publicly funded body can be explained in a variety of ways, such as that the 'innovation' agenda won and the 'participatory' agenda lost in Danish science policy. Due to an increasing focus on the commercialization and dissemination of research results, Danish governance of science and technology has left diminishing room for issues of democracy, engagement and public participation.

But this is not the full story. Although it is very sad to see the end of the public funding of the Board of Technology, the more deeply rooted culture on which the board was built is not simply ending with the funding. Danish public debate is still formatted around publics asking critical questions of experts of all sorts, just as expertise is often not taken at face value. Danish experts still have to be very ready to argue their cases. The authority of Danish academics does not lie in their roles as university employees or their titles as professors. Rather, their authority and status as experts are shaped in specific processes of argumentation, where they, as well as all other citizens, have to give good reasons for their statements. Furthermore, critical public debate, which has been epitomized by the participatory consensus conferences, is still very much alive in Denmark, although it might be harder to summarize its conclusions now that the Board of Technology is no longer a public body.

In short, my conclusion is therefore that the political culture, which bred the Board of Technology and the participatory consensus conferences, is still very much alive, but that in the future the democratic discussion of science and technology will take place in other forums.

On a more general note, this story illustrates the relationship between the culture of science communication and wider national political cultures. The Danish Board of Technology has been an instantiation of the ideal of deliberation, but it was not created out of thin air.

At the same time, a culture of deliberation is clearly no guarantee that a deliberative agency like the board will always exist and receive funding. On the contrary, it demonstrates that the development of these formats and bodies is not a unidirectional evolution. We should, perhaps, also realize that the idea of deliberation in order to identify the common good can be seen as deeply oppressive in political cultures built on antagonism more than on consensus.

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9

The knowledge society favours science communication, but puts science journalism into a clinch

Martin W. Bauer

Abstract: The knowledge society creates favourable conditions for science communication, while science journalists come under pressure. Journalists working on the 'science beat' are key actors in the chain of communication that keeps the great conversation of science-in-society alive, often through controversy, but their professional situation is becoming precarious. Recent studies bring together systematic observations on the working conditions, the professional ethos and the future of science reportage in the mass media. Those studies allow us to gauge trends and to put into perspective a 'sense of crisis' in the profession. This paper reports some results and interprets them in the light of larger trends in the relationship between science and society and the need for a functioning public sphere of science.

Keywords: knowledge society, science communication, science journalism, sense of crisis, comparative research, decline of public sphere, public relations.

9.1 A new context of science communication

MANY PEOPLE live in high expectations, maybe not in great expectations, of a 'knowledge society'. For the movers and shakers of the European project, this was a key notion of the Lisbon Agenda 2000, and it merges into the current Agenda 2020. The term denotes a historical transition from an old to a new modus operandi of society, anticipating a society where the productive forces are tied to newly created knowledge (that is, where the productive sector depends on developments at the frontiers of science). Nations with ambitions based on the knowledge society seek to increase their R&D spending, which is currently somewhere between 1 % and 4 % of gross domestic product in OECD countries but comes increasingly from the private sector. The knowledge society will revive the private patronage of science, but from global business interests, not from churches, kings and queens.

The knowledge economy will restructure employment. Jobs will move to the knowledge sector, and investment will flow into intangibles such as patents, education and communication rather than into machinery, buildings and real estate. This was modelled by Rohrbach (2007), who reclassified some national statistics. According to those calculations, the knowledge sector of 10 major OECD countries increased by 58 % in employment and by 34 % in value added from 1970 to 1999.

The knowledge sector comprises four domains of employment, some of which have grown considerably faster than the sector overall:

- *Knowledge creation:* research and development (employment in 1999: 191 / added value in 1999: 132, from 1970 baselines of 100)
- *Knowledge infrastructure:* paper products; manufacture of computing, radio, TV and other equipment; computing; post and telecommunications (82 / 221)
- *Knowledge management:* legal, accounting, auditing services; tax consultancy; market and public opinion research; advertising; business consultancy (592 / 208)
- *Knowledge mediation:* education; publishing; printing and reproduction; distribution through newspaper, radio, internet, library and archival services; culture industry (133 / 80).

We note that the knowledge management and knowledge mediation domains have grown faster than expected, and will probably continue to do so. We can reasonably locate science communication in these two sectors: research into public understanding of science (knowledge management) and the professional design of science communication (knowledge mediation).

In the knowledge society, science communication will support technoscience in its ‘expeditions into the unknown’. Those expeditions have many names and rallying calls, such as the ‘war on cancer’; the ‘decade of the brain’ for neuroscience; biotechnology and genomics; nanotechnology; synthetic and systemic biology; nuclear power and renewable energy; and many more to come. ‘Technoscience’ refers to large-scale research in which science and engineering are indistinguishable. Arguably, public communication is integral to these efforts to mobilize support, to secure resources and to make knowledge creation possible in a context that is nationally and internationally competitive.

Much can be learned from looking at these efforts using an analogy – how social movements mobilize resources and frame issues for political and societal impact (see Zald & McCarthy 1987, Tarrow 1994: 135ff, Bauer & Jensen 2011). Let us consider attention seeking, actor coalitions, action repertoires and risk management.

9.1.1 Attention seeking

One of the key functions of public communication is to seek the attention of stakeholders. Gaining that attention is not an easy task in a postmodern public sphere that is brimming with fragmented conversations of all kinds: important, entertaining, futile and ephemeral. The public sphere is constituted by a multitude of arenas and channels – old ones such as meetings, conferences, newsprint and broadcasting, but also new ones such as the internet, Facebook, blogging and Twitter. The fragmentation of societal conversations into small niches of common outlook makes it harder to capture the attention of sizeable parts of the public at any moment in time. Achieving issue framing with lasting resonance is thus more important and more difficult than ever.

The communication function of technoscience seeks public attention for the following reasons (there may be others, as well):

- to attract sponsors and move as yet undecided bystanders
- to mobilize insiders and believers in the project, and to give them public status
- to determine the leadership of the research sector, which is very competitive
- to demobilize opponents
- to absorb epistemic uncertainty.

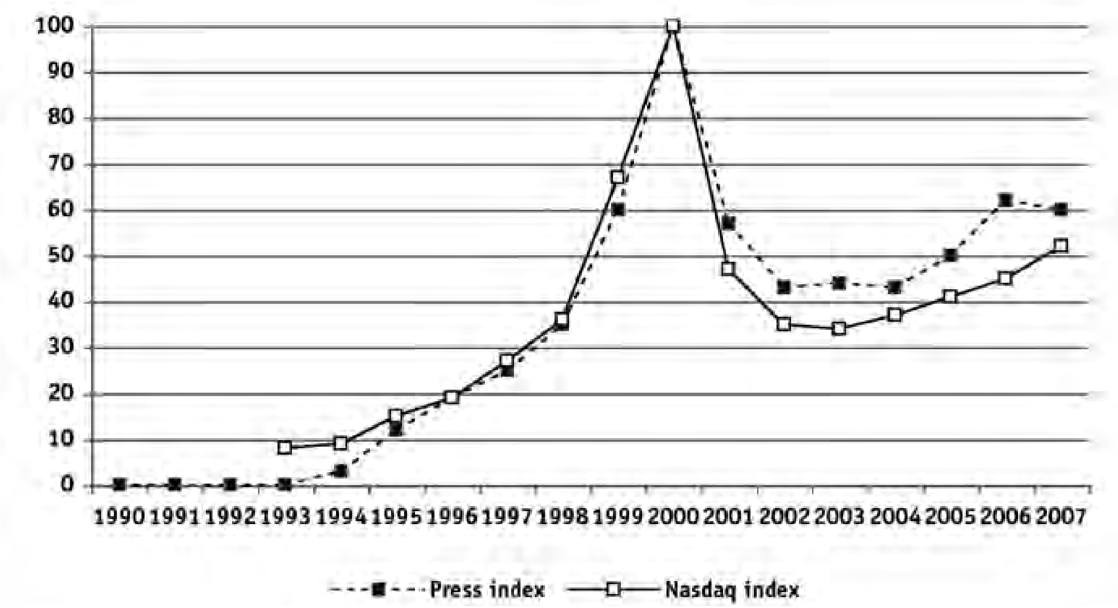
The researcher at the coalface (the laboratory bench) is rarely sure of what (s)he does and finds; uncertainty rules the day. However, uncertainty is not very convincing to outsiders, who are often under pressure to act. In response, science communication often presents knowledge as more certain than it is, as more concrete than it is conceived, and visualizes the unfamiliar in iconic images. All this is suitable for managing public attention, and makes for public appeal and for more comfort among scientists.[1] Communication of science outside the core-set is thus integral to the conduct of modern science, and not an optional add-on to established facts (see Fleck 1979, Jurdant 1994). But scientists and researchers happily leave the communication to the professionals, while keeping their focus on their lab bench. They are happy to savour the good news on their research, and they easily dismiss controversies about that research as the result of journalistic simplification. The notion of ‘popularization’ is open to self-serving interpretive flexibility (Hilgartner 1990).

Hence, much attention seeking for technoscience is professionalized according to the age-old logic of product marketing. We are familiar with the idea that clothes, cars and creams need a ‘unique selling proposition’. We have found a genetic test for breast cancer, or several tests, and they might differ only a little in robustness, modes of application and the reputations of the providers. So, what is their unique selling proposition? Public relations comes into play to create brands and brand value, once necessary for Corona, Kaiser or Carling Black Label, but now also for research groups and laboratories. Not only do we brand research projects and universities as locations for research, but regions (Regio Basiliea, Silicon Valley) or entire countries (‘Iceland, the gene lab’). Apparently, most embassies are now showcasing their national sciences rather than their military affairs. And, finally, public affairs management is at hand to secure a favourable policy environment and pre-empt laws and regulations that could unduly interfere at the national and international levels, not only for tra-

1. Note that science communication also increasingly involves the unmasking of ‘certainty’ in claims made in public. The pandering of overstated certainties creates an opening to pander for uncertainty in public controversies. Consider, in this context, controversies in the fields of vaccination and global warming.

ditional clients like the armaments industry, but for the innovative sector more generally.

Figure 9.1 Annual movement of the NASDAQ index for stock of high-tech companies (1993 to 2007) and references to the 'internet' in the British press (1990 to 2007)



Note: Indexed on 2000 (= 100).
Source: *Guardian* archive.

Professional communication relies on the mass media to attract an audience. Communicators know the operational ins and outs of mass and social media, and adapt to their *eigenlogik* – their characteristic modes of operation. This logic includes the particular news values of science (see Hansen 1994), exogenous and endogenous issue cycles (see Bauer 2012a), and framing that resonates with the context (see Neidhardt 1993, Gamson & Modigliani 1989). One implication of this new context for communication might be illustrated in Figure 9.1, which shows the media references to the keyword 'internet'. Newspapers follow each other in such cycles ('journalistic herding'), so taking one paper as proxy for all others is quite valid when measuring news intensity. The UK press coverage of computer news and the NASDAQ stock index are highly, if not perfectly, correlated (r = 0.97). This is consistent with the supposition that science and technology news is seeking the attention of capital as much as anybody else. On the other hand, success in the high-tech stock market feeds more internet news.

9.1.2 Actor coalitions

A large number of actors are seeking to spread the word about new scientific knowledge. There are actors close to the core-set of the lab bench, such as universities and research laboratories, hospitals and clinical research units, and industry with an R&D function. Then there are particular interests, such as patient groups, scholarly societies, funding agencies, philanthropic foundations, stock markets and venture capitalists. Then there are the old and new outreach actors, such as the American Association for the Advancement of Science, the British Science Association and their European (European Science Open Forum), Chinese (China Association for Science and Technology) and other equivalents. And then there are the science museums and their younger cousins, the science centres. There are scientific journals and publishers, and a swarm of entrepreneurs who participate in science communication as advisers and consultants whose services can be hired. Finally, there are controversial countervoices who also refer to technoscience with strong public resonance, such as the anti-nuclear movement; the environmental movement; creationist and anti-science activists; animal liberation activists; and Flat Earthers and so on.

In this concert of public references to science, it is increasingly difficult to say who mobilizes whom. For some developments, one can identify a coordinating actor, such as HUGO (the Human Genome Organisation), which sought to globally coordinate research and communication on human gene mapping during the 1990s. More often than not, we face an uncoordinated network of actors in mutual stimulation and competition. Many actors are ‘issue entrepreneurs’ who seek revenue to sustain their own mission of communicating science, seeking issue attention and brand value at the same time.

9.1.3 Action repertoires: old and new

Equally varied are the action repertoires available to science communicators. Action repertoires have gone through a cycle of considerable innovation over the past century. Traditional school education, public lecturing, exhibitions, information campaigns, public meetings and press conferences continue unabated. Even Hollywood is in the act (see Kirby 2011). However, new formats of event making have emerged, such as roundtables, websites, Twitter, blogs, science cafes, science festivals, science weeks, consensus conferences, focus group discussions, public opinion polling and NGO stunts. Many innovations respond to public unease about lectures 'from on high' to move towards more dialogical formats, known as 'technologies of humility' (Einsiedel et al. 2001, Jasanoff 2003, Gregory 2011).

How to classify and evaluate this repertoire of actions? It remains open to debate and analysis whether any of these events counts as extension, education, advocacy, persuasion, deliberation, dialogue, community-building or community-empowering, or as a rhetorical trope of ethos, logos and pathos (see Bucchi 2008). To my knowledge, a comprehensive treatment of the actors and the action repertoire of modern science communication remains an open task in the research literature.

9.1.4 Communication risk management

Many statements on the public understanding of science and public engagement with science are statements that motivate and justify why we should communicate science, and do it more often and better. Recently, a 'reflexive turn' and empirical research have raised questions about undue idealism and the spectre of dysfunctional outcomes (see Weingart 1998). For example, the 'medialisation of science' thesis points to repercussions of the media orientation of science. The strategic adaptation to the logic of attention seeking might derail research from its ethos of certifying robust knowledge and of speaking truth to power (see Roedder et al. 2012). If scientific leadership is decided on public prominence rather than scientific reputation, the ethos of science could be jeopardized.

There are other risks. The technoscientific project can fail; this is the ultimate risk of any mobilization effort. Accidents and errors can happen on the way. Whether due to human error or systemic failure, such events 'stigmatize' a development, as in the case of nuclear power, which it is difficult to think positively about after Three Mile Island, Chernobyl and Fukushima. Hyperbole about new developments can create great expectations, and frustrations follow when things do not materialize as expected. Many claims to save humanity from cancer have this characteristic.

The build-up of professional communication in research institutions can lead to an overwhelming preponderance of PR activities. A recent estimate in the UK speaks of an imbalance of six PR officers for every science journalist.[2]

Modern public opinion is also simply too complex to be predictable. An old metaphor of public opinion as the 'Holy Spirit' of modernity holds that it evades efforts to control it.

A final risk of mobilization lies in the rigidity of the effort in the face of friction – overcommitment to a cause creates immunity to public sentiment and blindness to feedback. The grand question hovering above all social mobilization remains: is public opinion a source of trouble or a valuable resource and potential ally?

9.2 Science journalism in a clinch

In the remainder of this paper, I focus on one particular actor: the professional science journalist. In the knowledge society, the science journalist faces a particular paradox: just when their services are most needed, the economic basis of their work is eroding fast. How come?

On the one hand, the internet and social media undermine the traditional business model of newspapers and print media, which

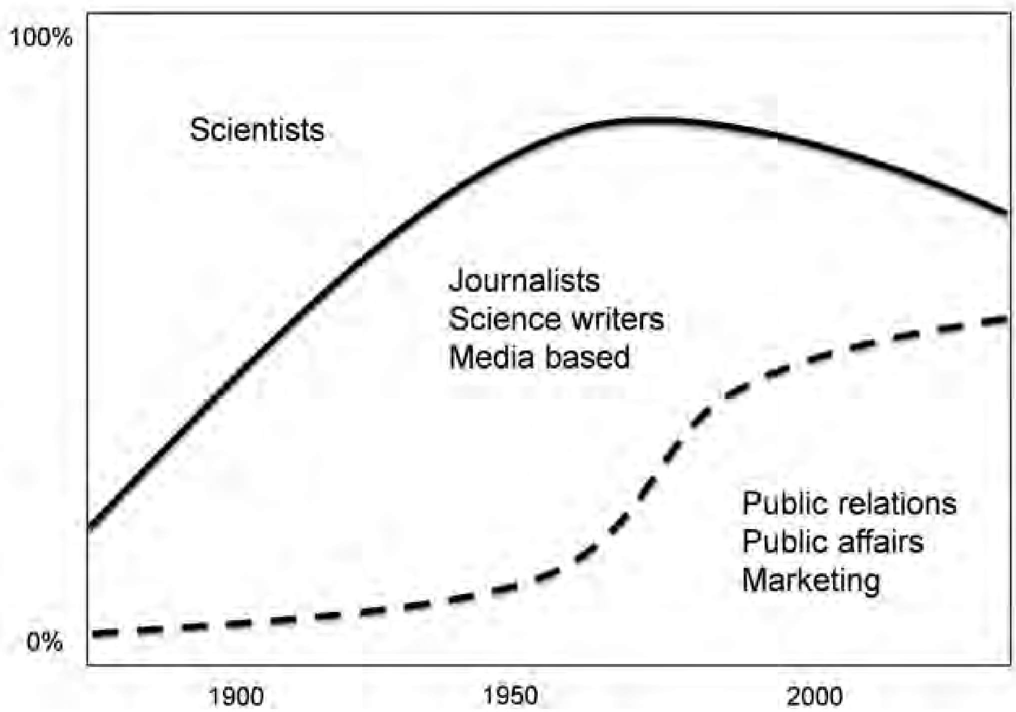
2. The ratio of 6: 1 (PR: journalists) was mentioned at the recent biannual conference of the Association of British Science Writers at the Royal Society on 25 June 2012. Participants complained that science writing spends too much effort on 'exhibition' and not enough on 'exposure'.

is selling the attention of readers to advertisers. Newspapers are losing readers. The young no longer buy newspapers or even read them – they surf the internet and expect information to be free. Advertising follows the readers, and the income stream from newsprint implodes. Newspapers experience a secular decline, concentrate forces and reduce the staff of full-time journalists. The internet has not yet generated an alternative business model, and the economic basis of science journalism in print and broadcast media is eroding. Specialist beats are often the first to go when newspapers cut staff (OECD 2010, Manning 2009).

On the other hand, private patronage changes the typical scientific career and alters the public image of science (Shapin 2008). It also brings the professional communication function into science. Some years ago, we called this a trend towards 'PUS Inc.' (Gregory & Bauer 2003), elaborating the earlier idea of 'selling science' (Nelkin 1987). A secular trend might be illustrated in Figure 9.2. If we look at three time slices, we can say that in about 1900 most science communication was done by scientists themselves. Scientists lectured in public, some wrote in newspapers and magazines, and some later worked with radio. By about 1960, this had changed radically. By then, most science communication was done by professional mediators – the science journalists who formed professional organizations in the postwar period. In the new millennium, we see a return of scientists to the scene. Many scientists are now active again in blogging, Facebook or Twitter. And on the other end of the spectrum we witness the massive expansion of PR for science. The middle ground of traditional science journalism is in a clinch between scientists and PR.

I have explored some of the consequences of this changing structure for a critical public of science in another paper (Bauer 2012b). What is ultimately at stake is the proper functioning of a public sphere to which science contributes. The notion of a public sphere (see Taylor 2007: 185ff; Habermas 1989 [1962]) builds an account of a historical achievement of modern societies that is at risk of decline. The public sphere is a space where citizens debate matters of common concern under circumstances that free them from exclusive considerations of kinship (it matters who you are), of the powers that be (might makes right), and of money (he who pays the piper calls the tune).

Figure 9.2 The changing structure of science communication – hypothetical trajectories of stakes of three different actors



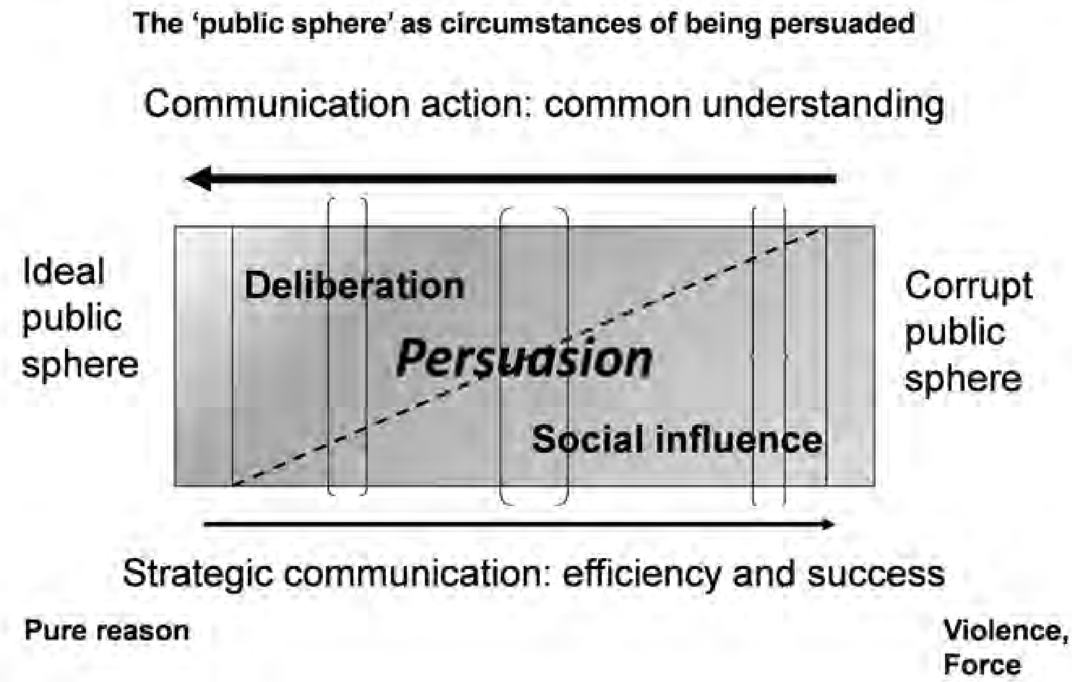
Note: The total for each period is 100 %. This scheme is hypothetical, and not based on actual data. It reflects the historical imagination and 'trend spotting' by the author.

A functioning public sphere is constituted by four ideal features of public reasoning:

- transparency and the inclusion of all voices
- equality among participants; all hierarchies are bracketed
- the absence of force, violence and coercion
- neither deception nor self-delusions.

These points of common orientation guarantee the power of the better argument (see Aristotle's *On rhetoric*); they liberate the 'illocutionary force' of speech by demanding that all claims be validated on truth, morality and truthfulness (Habermas 2008: 49ff). Reasonable decisions have three constraints: evidence, tradition and preferences. Figure 9.3 illustrates the positioning of any existing public sphere somewhere between the poles of 'ideal' and 'corruption'. Persuasion towards the 'ideal' side is dominated by deliberative formats, while persuasion towards the 'corrupt' side is given to symbolic and physical violence, or a monologue of either science, tradition or preferences. In extremis, the barrel of the gun makes decisions on arbitrary preferences. Somewhere in between the extremes, most public spheres operate with a mixture of deliberation and uninvited social influence (Sammut & Bauer 2011).

Figure 9.3 Shifts in methods of persuasion between the ideal and the corrupt



Note: Any particular public sphere is represented by a vertical slice (brackets) and the particular balance of deliberation and social influence that it entails.

What seems at stake in the knowledge society, with a system of science communication in which corporate communication dominates over independent journalistic reportage, is a functioning public sphere. Empirical trends in the communication of science shift the existing public sphere towards the more 'corrupting' end of the schema (as shown in Figure 9.3). Circumstances in which persuasion is dominated by uninvited and hidden influences, bordering on coercion, will be open to risks of unreason. The public will no longer be well informed, debates will be rigged, and decisions will be made not for a common good but for the benefit of interests of power, money or kinship. One of the factors that increase the risks of unreason in knowledge societies is the structural weakness of science journalism, in the clinch between scientists and corporate communication (see Göpfert 2007).

9.3 The working conditions of science journalism: a sense of global crisis?

The current crisis in the newspaper business model has generated a number of studies that investigate the situation of science journalists in this uncertain climate. It is useful to contrast current worries about science journalism with the results of a French study 40 years ago (Maldidier & Boltanski 1969). At the time, there was no sense of crisis, but a vigorous ethos of torch-bearing for science in society. Science journalists were more defenders of science than were scientists themselves.

In the new millennium, the evidence is different: a critical engagement with science, but professional stagnation or even crisis. Williams and Clifford (2010) investigated the science beat in Britain. They found that since 1989 the elite press had stable and well-staffed science beats, while the popular press and broadcasters were expanding their science base. However, that expansion stalled in 2005.

Williams and Clifford interviewed the core set of 50 British science journalists in the national press and broadcast media. Most of them agreed that the sector is in a steady state, but some saw a decline: workloads have increased and the quality of copy is threatened by time pressures and ‘churnalism’ (cutting and pasting convenient PR material). Science journalists recognize increasing PR penetration, but mostly deny using PR material. All in all, the prospects of quality reportage are declining.

A feature in *Nature* reported on a survey of 491 science writers, biased towards its North American and European readers (Brumfield 2009). Most were in full-time positions, had been in the profession for more than 10 years, and were working mainly in print, web content and blogging. Thirty per cent were aware of recent cuts in staffing, and one-third were pessimistic (they were more or less certain that they would not be working in the profession in five years’ time). An even higher proportion would not recommend a science journalism career to a young student. *Nature* expects a paradigm shift in science writing.

But is this predicament of science journalism universal? My colleagues and I recently asked close to 1000 science journalists across the globe about their working conditions and views of the profession (Bauer et al. 2012a). We balanced our sample to correct for the North Atlantic bias in *Nature*. The survey was rolled out between June 2009 and April 2012, mostly online in English, French, Spanish, Portuguese and Arabic. We collected 953 responses from North, Middle and South America, Europe, South and East Asia, North Africa, and the Middle East.

We can report that across the globe most science journalists are young and highly educated, typically male, between 20 and 45 years old, and less than five years in the profession. However, in the Americas, females are more typical in the profession. Most professionals hold a university degree, and 10 % have PhDs. Only 10 % learned the trade in the old style, on the job.

9.3.1 Working practices

Print remains the most likely output medium for all science journalists (only about 5 % report never working in print). Second are stories on the web (only around 10 % report never writing for the web). About two-thirds of science journalists are blogging, and blogging is particularly likely across Africa. About half report working also for radio or TV, at least occasionally.

The intensity of work varies across different regions of the world, but the intensification of work is global. The average workload is about 9 items over a two-week period. Most science journalists work on between 5 and 11 items, but those working in Africa and Asia are slightly busier than others. Women and men have similar workloads, except in North Africa, where men report more items over two weeks, and in Asia where women report more work. Two-thirds or more of respondents report increasing workloads over the past five years.

Precarious working conditions are more the rule than the exception – only about half of science journalists work in full-time positions. In Asia and in Latin America, professionals are more likely to work in full-time positions than elsewhere, while across Africa a full-time position is very uncommon. This situation is more likely to have worsened over the past five years than to have improved, except in Asia and Latin America, where the outlook seems brighter.

9.3.2 Professional ethos and job satisfaction

The ethos of science journalism varies across the globe. The good science journalist is typically seen to be 'well trained and reporting the facts independently, neutrally and in an original manner', but many lament the disappearance of a critical edge in the profession. Too much 'exposition' and not enough 'exposure' is how the 2012 meeting of the British Association of Science Writers saw it. For many professionals, 'formal science training, understanding of statistics and a passion for science' are important; for others, the journalistic skills of 'knowing how to deal with new media, visualization and dealing with facts and their investigation' are more important.

Despite difficult and deteriorating working conditions, most professional science journalists are happy and like their job; only 10 % are clearly disappointed and dissatisfied. We distinguished satisfaction with the operational specifics of the job (such as physical safety, freedom of expression, and access to information and scientists) from general job satisfaction. European, US and Canadian science journalists are more likely to be happy about the specifics of their work than with the general conditions; in other regions of the world, this is reversed. Across Africa the specifics of the job are lacking, while overall the professionals are happy. In Asia and Latin America, the two dimensions are in balance.

Asked directly whether they agreed that 'science journalism is in crisis', most respondents in North America, the Middle East and North Africa agreed, while most in Latin America and sub-Saharan Africa disagreed. Opinions were more balanced in Europe and Asia. Asked 'will you be working in the field in five years' time?', between 10 % and 20 % of respondents in North America and Europe thought that they would probably or certainly not be working. In all other regions, the future seems much brighter. Finally, asked 'would you recommend a career as science journalist?', 20 %–30 % of professionals in North America and Europe would not do so; in all other regions, science journalists see much less reason for pessimism.

Globally, work pressures are increasing, conditions deteriorating, and daily practices are moving from print to online platforms. Nevertheless, there is much more pessimism in the profession in

North America and Europe than elsewhere. We asked: Is there a sense of crisis in the profession? Answer: It depends where you work!

9.3.3 What can be done?

Many analysts concerned with the state of the public sphere advocate philanthropo-journalism, in which charitable organizations support the production of quality materials to news outlets.[3] This involves not only political news but also science news. SciDev.Net, which is based in London, has for some time taken on such a subsidiary role and a global mission.

These support actions might also include the enabling of new types of science journalism, such as:

- *Doing less with less.* This means, first and foremost, searching for the really good story, rather than churning out mass stories based on PR (apparently, this is the new agenda at the *Guardian* in the UK, and also how the weekly *Economist* works)
- *The investigator on the scientific paper.* Peer review is not able to pick up all possible flaws in modern research. Publications such as the *British Medical Journal* have an investigative journalist on their staff who will do background checking on research which is about to be published. They seek to expose incomplete data reporting and hidden funding that might bias the results.
- *A consumer beat for knowledge.* A new role is emerging for journalists who investigate knowledge claims made in public (including claims by fellow journalists who fall prey to PR spin) or who directly expose the claims-producing industry. British journalist Ben Goldacre has created a brand ('bad science') for this sort of debunking in the UK and beyond.

3. See a critical discussion in 'Philantro-journalism: Reporters without borders', *The Economist*, 9 June 2012, p. 59.

9.4 Future challenges and the role of research on the public understanding of science

I have argued that the emerging knowledge society creates a new context for science communication that bears a considerable risk of a deterioration in the functioning of the public sphere. The question is: Can a public sphere that is dominated by strategic communication guarantee the authority of science? Turning this question into one that is answerable using empirical data, we have to ask: Is the authority of science intact, for how long is that likely to last, and is this authority stable or changing across all social strata or contexts (see Bauer et al. 2012b)?

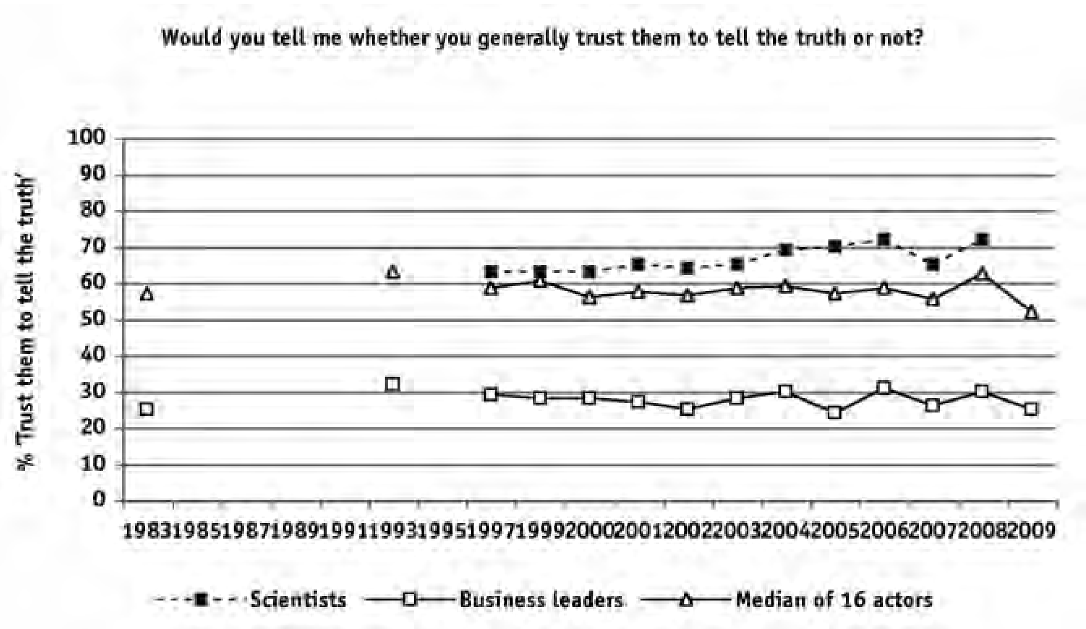
Data in the US has shown that the authority of science has declined among 'conservative' Republican voters since 1974, while it remains intact among 'liberal' Democratic voters. Overall, confidence is declining, and one finds the population split and an increasing gap between the political milieus, known as the 'politicisation of the public sphere of science' (Gauchat 2012).

However, it is unlikely that this scenario repeats itself elsewhere around the globe. In most other countries, conditions are very different from those in the US. For example, Figure 9.4 shows the relative stability of trust vested in major social actors over the past 30 years and the growing advantage of science over other actors in the UK. Public confidence in science is rising in the new millennium, from 65 % to over 70 % of respondents.

To monitor and investigate the cultural authority of science in different contexts is clearly a key topic for public understanding of science research in the coming years. Although old topics will persist, the old Mertonian question of the authority of science is now being raised again.

However, in all the coming and going of research questions in the public communication of science, we need to keep in focus the perennial one: the unintended consequences of good intentions. All strategic action creates friction and collateral effects. Evaluation research that is fixated on preset targets and objectives often degenerates into exercises of creative data handling to tell a success story. It is much more important to keep a methodical eye on collateral effects that jeopardize the sustainability of projects. Since the research on the human genome in the early 1990s, many people refer to a 3 %–5 % proportion of funding that should be invested in 'ELSE' themes (the ethical, legal, social and economic consequences of new developments). This has been boldly implemented in Portugal nationally under the Ciencia Viva programme as public engagement with science. The former science minister, Mariano Gago, has advocated this model more widely in Europe.

Figure 9.4 General trust invested in various professions in the United Kingdom since 1983



Note: The three lines compare scientists against 'business leaders' and the median of 16 other public actors.
Source: Various reports available at the website of Ipsos MORI (http://www.ipsos-mori.com).

I go a small step further, and argue that the 3 %–5 % proportion for public engagement must be complemented by a '3 %–5 % of 3 %–5 %' proportion to evaluate these expanding efforts of public attention seeking for science, as characterized in this paper, with a serious research agenda. In the context of the knowledge society, and considering the mathematical product of two percentage figures, 0.9‰–2.5‰ of research investment must be allocated to methodical evaluations of the collateral effects of public engagement with science. Research in this field has to go beyond the development and implementation of a toolbox and action repertoire. It is unlikely that growing activism is always and everywhere for the better, and the known and unknown risks of this expanding field of activism need to be recognized, monitored and managed on an evidential basis to avoid to dual pitfalls of complacency and misplaced anxieties.

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10

Scientists and the public: An international comparison in the context of changing academic professions

Fabienne Crettaz von Roten

Abstract: To widen the analysis of the factors affecting scientists' willingness to engage with society, we propose to test the classic factors related to science communication studies (age, status, discipline, gender) in an international study and to explore new factors derived from higher education studies (related to changes in the academic professions). Our findings relativize the frequency of scientists' public engagement, show the influence of changes in the academic professions and suggest cultural differences among scientists from various countries.

Keywords: popularization of science, science communication, scientists' engagement activities, social responsibility of scientists, academic profession, cultural differences.

IN THE PAST two decades, the rhetoric pervading much of recent discourses and their underlying objectives – be they political or academic – has involved public participation in the governance of science and scientists' engagement with society to cope with the dazzling development of science, its growing influence over society, and the consequences of memorable crises such as Chernobyl, mad cow disease and genetically modified crops and foods. However, are statements sufficient to change scientists' perceptions and behaviours? What are the factors that affect those practices? Are there cultural differences among scientists from various countries? Attempts to answer these questions have led to the emergence of empirical studies of scientists' public engagement activities.

An informed reader will object that such studies emerged before the late 1990s, for example by reference to the studies by Boltanski and Maldidier (1970), Goodell (1977) or Dunwoody and Ryan (1985). Actually, those studies are not really similar because they basically define the relationship between scientists and the public as a one-way, top-down communication from a scientist to a scientifically illiterate and passive public, in what was called the 'deficit' model. By contrast, more recent studies encompass different science communication models – such as deficit, dialogue and participation (Bucchi 2008). Because no model has supplanted the others, a scientist can move from one model to the other, depending on the circumstances.

Although empirical studies of the past 15 years have yielded interesting results[1], they have only rarely addressed the influence of recent changes in the academic professions. As the popularization of science is often criticized for bearing on facts and not on science in the making, one could also find that the studies on scientists' engagement focus on engagement activities without encompassing science in the making, as well as laboratory life or institution life. Indeed, some studies consider engagement as a kind of 'enchanted parenthesis' because they do not take into account the influence of scientists' everyday, practical concerns.

To broaden our understanding of scientists' engagement[2], we will rely on an international study, first to test the influence of classic factors (status, age, discipline, gender) and then to explore new factors related to changes in the academic professions, which will be briefly presented at the beginning of the second part.

10.1 Classic factors explaining engagement

The study by Luc Boltanski and Pascale Maldidier (1970) noted that about a third of scientists studied in France take part in the

1. See, for, example special issue 20(1) of *Public Understanding of Science*.
2. In the rest of this paper, we mean by 'engagement' all activities of information, dialogue and participation intended for a wide audience.

popularization of science and that they display characteristics highlighting social structure phenomena. Indeed, those who have reached the highest level of university education and those who are higher in the academic hierarchy popularize more; correspondingly, these practices are more common among older scientists. The authors showed how the scientific community controls and restrains the manifestation of an interest in popularization on the part of a scientist deemed to be too young and not recognized: 'Everything happens as if the pressure that each group of scientists bears upon all others, operated as a system of cross-checks whose function is to protect the autonomy of the academic world' (1970: 118).[3] As for her, Goodell (1977) emphasized the low share of 'visible' scientists in the media, highlighting feedback loops[4] of media attention, and identified many similarities in personality traits and values among visible scientists. In the United States, Dunwoody and Ryan (1985) stated that only 37 % of scientists studied had no contact with the media in the previous year, and then examined their perceptions of scientific institutional constraints on popularization, revealing a significant effect of discipline and institutional affiliation, but not of status or age.

More recent studies have confirmed the influence of age, status and discipline on various engagement activities[5] in different countries: the United Kingdom (Wellcome Trust 2000, Royal Society 2006), Norway (Kyvik 2005), France (Jensen & Croissant 2007), Switzerland (Crettaz von Roten 2011), the United States (Andrews et al. 2005), etc.

Although the study by Boltanski and Maldidier (1970) and that of Dunwoody and Ryan (1985) focused on scientists undifferentiated by gender, recent studies have incorporated this dimension. Their results indicate that female scientists are involved in significantly less engagement activities than their male counterparts in the United Kingdom (Wellcome Trust 2000), the United States (Andrews et al. 2005), Switzerland (Crettaz von Roten 2011). These gender differences are partly explained by the role the media plays, as they are

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3. 'tout se passe comme si la pression que chacun des groupes de scientifiques faisait peser sur tous les autres, opérait comme un système de contrôles croisés dont la fonction serait de protéger l'autonomie du monde savant' (translation by the author).

4. Previous media coverage makes a scientist more visible and thus influences the current level of attention by the media.

5. For example, visits to schools, participation in an institutional open day or science cafe, or collaboration with associations or non-government organizations.

more likely to contact male than female scientists (Kitzinger et al. 2008; Crettaz von Roten, in press).

Unfortunately, the picture of factors influencing public engagement offered by these studies is unsatisfactory because the studies are not comparable. They do not include the same population of scientists (depending on discipline, type of institution, etc.); measure the same engagement activities (based on various models of science communication); or introduce the same explanatory variables. It is therefore not possible to develop a synthetic vision of the factors affecting scientists' engagement. To that end, we propose a secondary analysis of an international study on the academic professions in 12 European countries.

The EUROAC research, financed by the European Science Foundation, allows one to understand how scientists perceived, interpreted and coped with recent changes in the academic profession in 2010.[6] The survey measured scientists' public engagement[7] by the number of articles written in newspapers and magazines in the previous three years.

Analysis of the data reveals a discrepancy between the rhetoric of public engagement and reality[8] public engagement activities are realized by roughly a third of scientists, but with wide national differences (Table 10.1). Some countries stood out as very active: the Netherlands (49 %), Switzerland (37 %) and Norway (35 %) – countries where citizen participation in political decisions related to science is part of a long tradition (MASIS 2012), which has certainly encouraged scientists to engage towards society. Other countries have far fewer engaged scientists, although those scientists are more productive, such as in Italy (which reaches an average of 1.9 popular articles for only 28 % of engaged scientists).

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6. The research consisted of a questionnaire survey, complemented by interviews, sent to scientists working for at least 50 % of their time in higher education institutions; 16,400 people completed the survey. See Höhe and Teichler (2013) for information on the project.

7. In the media, as in the public sphere, scientists may take three roles: popularization, metadiscourses about science or the science – society relationship, and expertise (Peters 2008). Unfortunately, the survey does not make this distinction.

8. The interviews also relativize the level of engagement: when describing the expectations of society towards them, scientists rarely mention engagement (only research and education) and, when they do, it is mainly to deplore the lack of recognition by the institution.

Table 10.1 Percentage of scientists with at least one popular article in the past three years and average number of articles per scientist, by country

Country	% of engaged scientists	Mean (standard deviation)
Austria	29	1.16 (3.60)
Croatia	31	1.32 (3.30)
Finland	33	1.14 (3.02)
Germany	29	1.34 (4.90)
Ireland	30	1.09 (3.06)
Italy	28	1.87 (7.58)
Netherlands	49	1.82 (5.22)
Norway	35	1.36 (5.46)
Poland	19	0.80 (2.70)
Portugal	33	1.07 (3.43)
Switzerland	37	1.22 (2.69)
United Kingdom	27	0.74 (2.96)

To determine whether engaged scientists differ from non-engaged ones, a logistic regression was performed with the classic explanatory factors (gender, status, age, discipline[9]) for each country separately. The factors are not significant simultaneously in all countries (Table 10.2). This analysis distinguishes, first, countries with many significant factors (Switzerland and Finland) and countries with few (Croatia, Norway and the United Kingdom). Judging by the analytical grid of Boltanski and Maldidier (1970), it seems that the Swiss and Finnish scientific communities resort to many criteria to define who can represent them before the public and therefore strongly control their members on this point. On the other hand, the Croatian, Norwegian and British science communities control engagement much less, hoping for a very large majority of scientists to be involved.

9. Following the literature, 'status' distinguishes junior and senior researchers. Age was recoded into three categories: up to 30 years, 31 to 40 years and older than 41 years (reference category). 'Discipline' differentiates medical sciences, social sciences, humanities, technology and natural sciences (reference category).

The scientist's discipline is the most important among the classic factors because it influences the odds of engagement in all countries except Germany and Croatia. However, we observed differences of effect among disciplines. In all countries except the United Kingdom and Ireland, scholars from social sciences and humanities departments are significantly more likely to engage than those in the natural sciences. Taking the analytical grid of Dunwoody and Ryan (1985), it seems that institutional norms are more vague in the social sciences and therefore allow more engagement. In Austria, Italy, Poland, Portugal and Switzerland, scientists from medical sciences tend to engage more than those from the natural sciences. Finally, in Italy, Portugal, Switzerland and the United Kingdom, scientists from technological fields are also more likely to engage than those from the natural sciences.

Table 10.2 Binary logistic regression for factors affecting the odds of having at least one popular article, by country, plus quality of model

Country	Gender	Status	Age	Discipline	R2 Nagelkerke
Austria	ns	ns	s	s	0.09
Croatia	ns	ns	s	ns	0.09
Finland	ns	s	s	s	0.12
Germany	ns	s	s	ns	0.05
Ireland	ns	s	ns	s	0.04
Italy	s	ns	ns	s	0.06
Netherlands	s	ns	ns	s	0.08
Norway	ns	ns	ns	s	0.08
Poland	ns	ns	s	s	0.03
Portugal	ns	ns	s	s	0.08
Switzerland	s	s	s	s	0.21
United Kingdom	ns	ns	ns	s	0.05

s = significant at the 5 % level; ns = non-significant.

Age is the second most often significant factor in seven of the 12 countries. Its influence translates in different manners, indicating national differences in the way engagement comes into play at various stages of a scientific career. In Austria, Croatia and Portugal, the chances of engaging at younger than 30 years of age are lower than for scholars aged 40 and over, suggesting that the scientific community excludes scientists from engagement at early stages of their careers. In Poland, the chances of engagement between 30 and 40 years of age are lower than for those over 40, as the scientific community dissuades from such endeavours in the intermediate phase of careers. Finally, in Finland, Germany and Switzerland, the first two age groups engage significantly less than the older one, which indicates a long phase of control over young scientists by the scientific community.

What is more, there are separate effects of age and status in the latter three countries, which means that, at the same age, researchers with higher status are more likely to engage, and also that, with similar status, older scientists are more likely to engage. This can be explained by different mechanisms: either media contacts remain institutionalized (that is, governed by scientific and organizational norms, which tend to favour higher status) or senior scientists free themselves from the scientific community's norms because they are more likely to have secured permanent positions. In addition to these three countries, status is significant in Ireland, where senior scientists are significantly more likely to engage than junior ones.

Gender is significant only in Italy, the Netherlands and Switzerland, where male scientists are more likely to be engaged than female ones, even when one controls for age, status and discipline.

Finally, these models explain a small part of the variation in the data. It is therefore important to broaden the explanatory factors by questioning engagement differently.

10.2 A new approach to explain engagement

10.2.1 Major changes in the academic professions

Many scholars have studied the evolution of knowledge production and of academic professions. Gibbons et al. (1994) defined the new production of knowledge – 'science mode 2' – as mostly interdisciplinary and conducted in the context of applications within a network with actors outside academia, such as industry or the users of knowledge. Ziman (1996) described changes in the scientific ethos in 'post-academic' science. As the university became 'entrepreneurial' (Clark 2005), scientists became entrepreneurs, responsible for finding funds for research, for innovating, for increasing their visibility among peers and for valorizing their results to a wide audience. Pestre (2003) traced the hold of the industrial world over science, which generates a reorganization of research via managerialism and a privatization of knowledge production that affects the public image of science.

Onto this reconfiguration of knowledge production came to be grafted neoliberal ideas and a new public management policy, which engendered efficiency injunctions and increased controls on scientific institutions. Emphasis was put on the evaluation of research results and of scientific productivity (the ranking of institutions but also impact factors of scientists), which placed scientists under the burden of 'publish or perish'. Enders and de Weert (2009), in this context, also stressed the professionalization and the process of internationalization and globalization of higher education institutions.

This evolution was also characterized by the contextualization of knowledge in a new public space, called the agora, and the emergence of socially distributed expertise (Nowotny et al. 2001). Scientists were asked to show greater social responsibility. The new governance of science required dialogue, debate and the participation of society to include its demands and values in the production of knowledge (Bensaude-Vincent 2010). Universities saw their missions of teaching and research increased by a third mission that includes engagement with society (Laredo 2007).

Finding out whether these changes are real or merely self-fulfilling prophecies is not the question in this paper: what interests us is to see whether the internalization of these changes by scientists influences their engagement practices. Lacking longitudinal studies on the level of engagement of scientists, we cannot determine whether changes in the academic professions explain the evolution of the level of engagement. But we can look at the individual level, to try to determine whether conformity with the current characteristics of scientific production is related to the practice of engagement.

10.2.2 The influence of change in the academic professions on engagement

The injunction of scientific productivity

Scientists, as they are urged to increase their scientific productivity (books, book chapters, scientific articles, patents, etc.), may have to make choices, and one strategy could be to focus on activities that can guarantee career promotion. The relative lack of recognition for engagement activities, which is universally noted, may well lead to a focus on activities targeting one's peers – to the detriment of public engagement activities.

However, the analysis of the relationship between the number of activities for peers[10] and those for society shows a significantly positive correlation in all countries (Table 10.3): this means that more activities for peers are linked with more engagement activities, and vice versa. This result confirms the observation of Boltanski and Maldidier (1970) that agencies of popularization ensure the collaboration of recognized scientists (that is, those who are endowed with the authority and legitimacy granted by their academic status and their activities for peers).

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10. To account for time differences required for each type of activity, we calculated for each scientist a weighted average of number of articles in journals or books (1 point per item), of books edited (2 points) and of books authored (5 points). This recoding has been used in Bentley & Kyvik (2011).

More contextualization

Scientists are increasingly invited to consider that any production of knowledge is contextualized and to include the demands and concerns of society in their production of knowledge, so it is interesting to ask whether the fact of sharing such a vision actually underpins scientists' engagement.

Table 10.3 Average number of activities for peers and correlation between activities for peers and activities for society, by country

Country	Mean (standard deviation)	Correlation between activities for peers – society
Austria	7.90 (15.21)	0.13 s
Croatia	8.64 (8.97)	0.20 s
Finland	7.04 (9.74)	0.23 s
Germany	8.35 (11.52)	0.19 s
Ireland	7.86 (11)	0.17 s
Italy	14.98 (14.05)	0.18 s
Netherlands	8.39 (11.13)	0.16 s
Norway	7.44 (9.82)	0.32 s
Poland	4.86 (8.06)	0.29 s
Portugal	7.80 (12.94)	0.17 s
Switzerland	7.47 (10.26)	0.31 s
United Kingdom	7.35 (9.30)	0.08 s

s = significant at 5 % level.

In all countries except Croatia and Finland, a belief that one's discipline implies the application of knowledge to the problems of society is significantly related to engagement: those who feel such an obligation are more likely to be engaged, and vice versa (Table 10.4).

By repeating the analysis in Table 10.2 with these two additional factors (activities for peers and obligation to apply knowledge to societal problems), the quality of the models is greatly improved, and the new factors are significant for the most part. Indeed, the level of activities for peers is the most significant factor in all countries except Portugal. The obligation towards society is the third most significant factor (behind peers and discipline) and influences engagement in all countries except Austria, Croatia, Finland and Norway.

Other changes in the academic professions

Knowledge production has long had an international dimension, but the internationalization and globalization of higher education institutions has increased. Some difficulties arise: the tension between national and supranational logic, the predominance of English, the widening of the circle of competition and so on. These difficulties, and the distance that internationalization[11] may generate in the relationship with society, can influence engagement activities. This factor is significant in all countries except the Netherlands, Poland, Portugal and the United Kingdom (Table 10.4). Contrary to preconceived ideas, the fact of collaborating on the international level increases the chances of engagement activities, and vice versa.

11. Internationalization can be measured in different ways. In this study, we chose to define it as collaboration with international colleagues.

Table 10.4 Correlation between engagement and five new factors, by country

Country	Obligation to apply to societal problems	Internationalization	Interdisci-plinarity	Importance of the missions	Good com-munication
Austria	0.12	0.11	0.16	0.06	0.07
Croatia	ns	0.15	ns	0.11	ns
Finland	ns	0.08	0.10	0.11	– −0.07
Germany	0.15	0.13	0.11	0.09	ns
Ireland	0.12	0.12	ns	0.08	ns
Italy	0.11	0.09	0.09	ns	ns
Netherlands	0.10	ns	ns	ns	ns
Norway	0.08	0.11	0.13	ns	ns
Poland	0.10	ns	ns	ns	ns
Portugal	0.08	ns	ns	ns	ns
Switzerland	0.17	0.08	0.11	ns	0.06
United Kingdom	0.14	ns	0.09	ns	0.08

ns = non-significant at 5 % level.

Knowledge production occurs more and more often in an inter- or multidisciplinary context. If hyperspecialization can be a barrier to engagement, will interdisciplinarity foster engagement? This factor is significant in nearly half the countries studied (Table 10.4): the fact of working in an interdisciplinary context increases the likelihood of engagement activities in Austria, Finland, Germany, Italy, Norway, Switzerland and the United Kingdom. It should be noted that the study did not make it clear whether the 'integration' was with one of humanities and social sciences or with other disciplines.

Governance in a more entrepreneurial style involves, among other things, paying particular attention to the missions of the institution. However, in many countries, the third mission of engagement has been defined as mandatory at the national level (Denmark, Norway, etc.) or at the institutional level (Switzerland). We can therefore expect that the importance of the missions is related to the engagement of scientists. In fact, this factor is only significant in Austria, Croatia, Finland, Germany and Ireland, where perceiving the importance of missions in the governance of institutions is related to increased public engagement.

Given the increased role of administrative staff in the institutions, communication between the administration and the administered has become a very important factor in describing the climate within an institution. This factor is significant in four countries, but the effect varies among them: in Austria, Switzerland and the United Kingdom, good communication between the administration and scientists increases public engagement activities, while in Finland, bad communication is related to more engaged scientists. The Finnish result suggests that internal problems can lead to scientists turning more outward.

10.3 Some conclusions on scientists' engagement

The results of our study indicate that engagement activities are carried out by a minority of scientists, but with significant differences among countries. These results contribute to the relativization of the current picture, often idealized, of public engagement. On the one hand, it is not enough to announce a new mission for scientists to fulfil; on the other hand, it is not enough to offer an activity for the public to be interested and willing to participate in it.

Analysis of engaged scientists shows a pyramidal distribution: a small group of scientists, differentiated by status, age, gender and discipline, performs most activities of engagement. This result corroborates the work of Bucchi (2002) establishing a similarity between the distribution of the visibility of science in the public space and the distribution of resources and rewards in the scientific community.

The fact that young scientists continue to engage less, although they have always been bound by the third mission, may indicate their inability to cope with changes in the academic professions, which affect them more than senior scientists who have already 'made their careers'. This is all the more worrisome because the reduced visibility of young researchers, but also of women researchers, in the public space provides fewer role models to encourage scientific vocations.

This secondary analysis of data reveals the tension between singularity and transversality of results from different European countries and provides, in a new way, multiple declensions of factors affecting scientists' engagement in those countries. While this approach has clear advantages, its limits should be stated. First, the engagement activities were measured solely by the number of 'popular articles', so it is unclear whether the same factors had been significant for other engagement activities.[12] In the future, one must try to confirm these results with a study incorporating a wider range of engagement activities. Second, the comparison of different countries involves recoding some variables in the lowest common denominator, and the only possible common recoding of status among the different countries studied differentiates only junior and senior status. However, this recoding certainly diminishes the influence of the status variable: for example, the same analysis using the British coding of academic professions[13] gives status and discipline as significant factors in the United Kingdom.

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12. With this engagement activity, the effect of gender in Switzerland is not surprising, given the low visibility of women in the media. It is not clear whether the effect would persist in other activities of engagement.

13. The five categories are professor; senior lecturer / researcher / reader; lecturer; researcher; other.

More generally, this exploratory study of the influence of changes in the academic professions on scientists' engagement is promising, given the numerous explanatory factors revealed. It is interesting because, among other things, it leaves behind society's postulated crisis of confidence in science in order to root scientists' choices about carrying out engagement activities in their daily lives. This study needs to be continued by integrating the evolution of scientific and academic policies, as well as the evolution of the relationship between science and society in each country.

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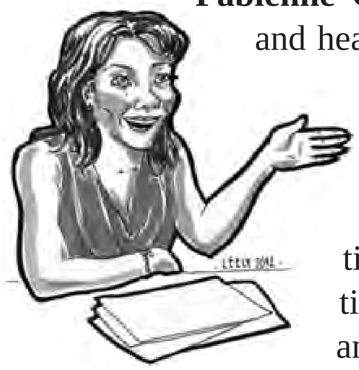

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11

Science communication: Fault lines between scientific and indigenous knowledge

Hester du Plessis

Abstract: Local or traditional knowledge is developed over centuries in communities inhabiting specific environments and often exhibiting a variety of cultural attributes. Within such domains, sustained efforts of knowledge production are revealed by the merging of practical know-how (in relation to local needs and practices) with specific belief systems, as well as local technological innovation. At more or less the same time, for somewhat different reasons, the global knowledge growth of the natural sciences graduated into distinct disciplines, each with its own methodological and theoretical framework.

The focus of discussions among science communicators about scientific knowledge and local (indigenous) knowledge is usually from either a sociological or an epistemological point of view. In the sociological field, pseudoscience and the social aspects thereof are often conspicuously in the foreground, while the epistemologists are inclined to rate the degree of order and planning higher in so-called 'modern science' than in local traditional knowledge systems.

The tension between these 'sciences' not only characterizes the science communication process that takes place, but also illustrates the dilemma faced by policymakers in their efforts to ensure the fair and democratic take-up and dissemination of scientific findings.

Keywords: indigenous knowledge systems, fault lines, rock art, rhinoceros poaching, modern science, transdisciplinarity.

11.1 Introduction

> … let me say this: the pursuit of science – the cultivation of rational or theoretical knowledge of the natural world – seems to presuppose an intense desire, at least initially, for knowledge for its own sake, not for the sake of some immediate practical results. It appears that our cultures had very little, if any, conception of knowledge for its own sake. They had a conception of knowledge that was practically orientated. Such an epistemic conception seems to have had a parallel in the African conception of art … this practical or functional conception of art, which dwarfed a conception of art for art's sake, must have infected the African conception of knowledge, including scientific knowledge, for its own sake. (Eze 1997: 31)

ALTHOUGH WE ARE all familiar with the geological term 'fault line' (indicating abnormalities and tensions in the Earth's crust), there are additional applications of the expression. 'Fault lines' is also used by the social sciences and humanities in reference to societal fractures, displacement and discontinuity of cultural practices and community worldviews. The meeting ground for these fault lines is within and between communities – often in relation to tensions between political ideologies or socioeconomic and cultural differences.

Fault lines occur when changes in social systems become prominent. In order to stabilize and ensure progressive development, all individuals, and ultimately all communities, need to make sense of the complex realities of events that affect their lives. As a result, individual members of a society often seek collective solutions and concrete answers to what could be perceived as harmful and often puzzling events and situations that might transform the cultural traditions of their specific community. For example, communities often reject the introduction of new products, systems and even knowledge if they find them superfluous to their specific needs. At the same time, new technologies, predominantly motivated by global economic (capitalist) development, quite often do not facilitate or accredit the societal, political and cultural structures embedded within communities.

According to Vassilis Fouskas (Fouskas & Gokay 2012), the philosophically based essential of 'being free only when we act in accordance with our reason' is embedded in the ability to choose between what is necessary and what is harmful to us and the community we live in. While acknowledging our freedom to choose, we collectively develop a post-Hegelian notion of *global fault lines* that:

> …does not separate/break the totality into instances (economic, ecological, political, ideological, cultural, ideational), while, at the same time placing class (Marxist) analysis as a core analytical tool of that totality. Thus, class and social struggle cut across social formations and historical epochs and develop the elements of totality unevenly causing great disruptions, discontinuities and breaks. (Fouskas & Gokay 2012)

To further explain this notion of a global fault line, we can argue that class and social struggle became the rallying cry for imperialism and colonialism in Africa by dividing society according to race and class. Accordingly, race and class developed their own inherent fault lines dictated by the creation of a difference in understanding of the realities faced by the colonized and colonizer (the colonizer's experience of reality will of necessity differ sharply from that of the colonized). These fault lines indicated the existence of different notions and perceptions regarding the origins of reality.

In order to understand the different origins of the 'realisms' these colonized societies faced, communities generally followed either or both of two routes: by pursuing a teleological conception of reality and by looking at reality in terms of mechanical causation (Teffo 2002: 161). A teleological perception will be driven by the belief that events happen because of some (often obscure) external (often intangible) aim, while those considering a mechanical causation look at a 'scientific' or 'rational' explanation. Note that this way of dealing with reality happens continuously and not necessarily only when (for instance) some new technology is introduced into a community.

Therefore, when attention shifts to countries on the African continent, the notion of a fault line emerges somewhat differently (and more problematically) than is the case in most modern 'European-harmonized' countries. In the first instance, the epistemological role and function of what constitutes a community takes on a different appearance. Here different races and different tribes often share space within what was accepted as constituting a 'community'. These communities were socially fragmented, displaced and subjugated to a colonial system and thereby felt a loss of identity acutely. The now popular notion of modern science communicators 'speaking to the public(s)' attests to the complexity encountered when doing research within specific communities. References to the 'public(s)' recognize a society comprising groups of people with a multiple and specific identity. However, little is understood about communities that were colonized and suffered a loss of identity.

It has been well argued that the notion of an 'identity that constitutes a community' has constantly been shifting and changing. The topology of 'community' has popularly been considered subject to the prevalent modes of economic production and to sociopolitical choices and responses, and driven within a specific cultural context. According to D.A. Masolo (2002: 558):

> … the social science understanding of community has, until recently, tended to regard it as a typical specific (one of a kind) social unit or entity endowed with stable and recognizable features which, like those of its type, are regulated by laws which simultaneously account for their differences and similarities.

Masolo further argues that 'in both their synchronic structures and diachronic mutations and regenerations, communities were viewed as subject to some natural laws which regulate social phenomena'.

Sociologists also attempted to separate communities as units different from each other but, in essence, consider the units as homogeneous social units. Pierre Felix Bourdieu's (1990: 14) 'action-response model', for example, places cultural knowledge, such as knowledge of ritual, central to the creation of social units of specific modes of rationality, legitimation, power and social action. The function of all such social units is to maintain a single set of values that is shared and recognized by all concerned.

However, the Bourdieuan system, as critiqued by Masolo (2002: 568):

> loses sight of the open-endedness of communities and produces an image of communities as collectable, exhibitable and manageable social units, juxtaposed but unconnected one to the other.

To further stress this point, Masolo (2002) poses the following:

> … according to sociologists, the characteristics of community include commonly shared geographic place, a consciousness of kind, a

totality of attitudes, a common lifestyle, a possession of common ends, and local self-sufficiency among others.

For practical purposes, this perception of community enables researchers to separate and characterize groups of people according to simplified classifications based on race and class. Community can also be considered as 'collective which is a repository of knowledge that has been generated through the process of distillation of abstract ideas extracted from experiential episodes' (Raza & du Plessis 2002: 59).

For the colonizer, in the historically colonized Africa, the perception of what a community should look like served as a politically motivated framework to fragment society. It provided a useful tool for colonial subjugation and separation between (to start with) white, black and Asian populations through the creation of administrative boundaries and the separate 'preservation' of traditions. The white and Asian populations maintained their respective western and Asian citizenships and worldviews. The indigenous black population became secondary citizens with 'inferior' identities. Studies of the indigenous populations were typified by the writings of early anthropologists, such as Lévy-Bruhl's *How natives think* (1910) and Lévi-Strauss's *The savage mind* (1966). Isidore Okpewho (1992: 17) mentions past studies on literature, such as British anthropologist Captain R.S. Rattray's *Ashanti proverbs: The primitive ethics of a savage people* (1916), as examples of the racial arrogance that characterized the attitude of colonial administrators and field researchers in their quest to understand African cultures. These attitudes created damaging and lasting negative perceptions, as noted in the damning 2001 United Nations *Durban declaration of the world conference against racism, racial discrimination, xenophobia and related intolerance:* '… Africans and peoples of African descent, and people of Asian descent and indigenous peoples were victims of colonialism and continue to be victims of its consequences'.

The notion of community in Africa therefore exists within a framework of what Masolo (2002) refers to as 'dialogically' rather than 'ontologically' constituted communities. African communities, however, are never static: according to Kwame Appiah (1992), African communities evolved through a long and persistent process of cultural hybridization and continue to do so. Ivan Karp (1992: 3–4) further refers to society groupings as the 'institutions of society' and says that their identity as community is 'experienced as encounters in which cultures, identities and skills are acquired and used'.

When researchers in the field of the public understanding of science consider their relation with the 'public(s)', the task might not be as simple as recognizing the distinction between different and differentiated groups within the society.

Furthermore, it is evident that communities display a remarkable ability in engaging with different levels of reality in their daily lives in order to ensure and sustain sociopolitical and economic stability against a (most often subconscious) fear of societal (civilizational) collapse. In this regard, Basarab Nicolescu warns that:

> The process of the decline of civilisations is one of enormous complexity and its roots lie deeply buried in the most profound obscurity. Of course one can find multiple after the fact explanations and rationalisations without ever successfully dispelling the feeling that there is an irrational element at work in the very heart of the process. From the great masses to the great decision makers, the actors in a very well-defined civilisation, even if they become more or less aware of the processes of decline, appear powerless to stop the fall of their civilization. One thing is certain: a great unbalance between the mentalities of the actors and the inner needs of the development of a particular type of society always accompanies the fall of a civilization. Although a civilization never stops proliferating new knowledge, it is as if that knowledge can never be integrated within the interior being of those who belong to this civilization. And, after all, it is the human being who must be placed in the centre of any civilization worthy of the name. (Nicolescu 2005: 5)[1]

11.2 The role of science communication

It is generally agreed that science communicators assist in activities related to the implementation and take-up of science and technology findings and that researchers into the public understanding of science are mostly concerned with the assessment of that take-up. We readily acknowledge that current science communication activi-

1. Also found in the *Manifesto of transdisciplinarity* by Nicolescu (2002).

ties are embedded in the promotion of modernity and that they are premised upon a western foundational perception of science. However, whatever science communication route society follows, we need to understand that people are always influenced by their own conceptual schemes, histories, social circumstances, languages, indigenous belief systems and personal emotions. We therefore need to revisit the inherent complexities of a society that is made up by multiple communities with mixed identities and realities, and measure societal change against history.

We can examine a good example of the complexities we face at the fault lines between modern society and ancient traditions by revisiting depictions of ancient rock art and the current mass slaughter of the rhinoceros in Africa. This is an apt illustration of the tension between the sometimes supportive (and often conflicting) application of a teleological viewpoint and/or following the route of science.

In South Africa, we are currently witnessing the mass slaughter, through poaching, of the rhino population.[2] Rhino horn is much sought after in some parts of the world, sometimes for ornamental purposes (dagger handles in Yemen) but mostly as a natural medicinal potion in South-east Asia. However, the popular line, followed by large numbers of the South African public(s) (and this includes, paradoxically enough, many scientists and conservationists), is that 'The sustained erroneous belief that rhino horn has aphrodisiac properties continues to hinder efforts to stop the illegal trade in rhino products' (Skinner & Chimimba 2005: 527).

The rhinoceros[3] has been the topic of myths and legends for centuries. In southern Africa, evidence of this is found in the rock

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2. At the start of August 2012, the number of rhinos lost to poaching for the previous eight months in South Africa alone was 281. In 2011, a total of 448 South African rhino were taken by poachers ('Nearly 300 rhino poached this year', *news24*, 17 July 2012, retrieved 1 August 2012 from http://www.news24.com/SouthAfrica/News/Nearly-300-rhino-poached-this-year-20120717).

3. Family Rhinocerotidae, of which two species inhabit southern Africa. The white rhinoceros (*Ceratotherium simum*) feeds exclusively on grass and has two recognized sub-species. The black rhinoceros (*Diceros bicornis*) is a browser with four recognized sub-species (Skinner & Chimimba 2005: 527).

According to the International Rhino Foundation (IRF 2012), the population of southern white rhino is now estimated to be around 14,500, 93 % of which are in South Africa. The northern white rhino survives in only captivity.

art[4] of the nomadic San people who were the original inhabitants of the southern regions of Africa. Looking at San depictions of rhinos, it is not possible to ignore the detailed knowledge displayed by these artists. More often than not, the image of the rhino is in almost perfect correlation with its living double, and it is clear that the San possessed a very intimate (scientific) local knowledge of the biology and ecology of these animals. But many symbolic and non-realistic depictions of rhino and other animals (in which, for instance, exaggerated horns or other body parts are added) point to a widespread spiritual and metaphorical function of the art.

Often, through visual depictions (and oral tradition), the power and the sexual link of the rhino and the human hunter came to the fore. David Lewis-Williams 2002: 176) indicates that, in the art of the San, arousal and penile erections ‘ are associated with altered states of consciousness and sleep’ and notes that in southern African rock art ‘a great many figures are ithyphallic.’ In this regard, Patricia Vinnicombe (2001: xviii) refers to the valuable connection between the rock art and mythology and records the words of one of the pioneers of the documentation of this unique art form, Dr Wilhelm Bleek, who wrote some one hundred years ago:

> … it gives at once to Bushman art a higher character, and teaches us to look upon its products not as the mere daubing of figures for idle pastime, but as an attempt, however imperfect, at a truly artistic conception of the ideas which most deeply moved the Bushman mind and filled it with religious feeling.

Similar intriguing works of art (engravings and paintings) were made in northern Africa. Jean-Loïc Le Quellec (2004) studied the

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Until 1900, the black rhino was the most numerous rhino in Africa, with numbers ranging into the hundred of thousands. Hunting and illegal poaching subsequently reduced their numbers to fewer than 4500 by 2010. The western African subspecies of the black rhino was declared extinct in 2011 by the International Union for the Conservation of Nature (IUCN 2012).

4. These legendary rock paintings and petroglyphs (engravings) date back to a period before the written word. The depictions are normally referred to as ‘San rock art’, and the artefacts that the artists left behind in caves housing the artworks are classified as generally dating from the (African) ‘Middle Stone Age’ (Vinnicombe 2001: 9).

rock art originating from the northern Sahara region, 'first discovered' on 5 July 1850 by Heinrich Barth. Barth was travelling through the Wadi Tellizzaghen in the Libyan Messak on his way to visit Tumbuktu with a caravan of Tin-Alkum Tuaregs. According to Le Quellec (2004: 14–15), when Barth came across this never before recorded art, he interpreted the symbolism of the works according to Greek legends peopled by figures such as the Garamante, Apollo and Hermes (Le Quellec 2004: 14). Subsequent scholars such as Amadou Hamp té Bâ (a Fulani scholar and ex-ambassador of Mali) produced highly contested interpretations (in the early 1990s) about the meaning of these paintings.

When early European explorer Dr Felix Jacquot encountered Saharan rock art depicting overt sexual imagery, his European Calvinism overruled any further interpretation when he wrote in 1847:

> … as for lewd pictures, they will never emerge from our albums. One can see, in full view and with no secrecy, the unnatural intercourse that brought the storm of fire down on the cities whose names you know well; a hideous coupling which was far from unknown to the Latins. (Le Quellec 2004: 33)

His words are echoed by Henri Lhote, who repeatedly used words like 'indescribable … particularly depraved scenes with figures expressing customs that go beyond wholesome nature' (Le Quellec 2004: 33).

It is, however, from the rock art at the Wadi Djerat in the Sahara that we encounter the subject closest to our understanding of cultural fault lines: the intentional depiction of a man in a sexual relationship to a black rhinoceros. What can be interpreted from these rock art depictions can only be imagined and, as aptly stated by Le Quellec (2004: 38), 'doubtless we shall never know, because the symbolic associations with sex can affect a wide variety of cultural or natural objects, and take on unforeseeable meanings.' However, Henri Lhote (in Le Quellec 2004: 37) provides a detailed description that leaves little to the imagination. In an engraving of yet another rhinoceros, the animal's tail is touched by a dog-headed ithyphallic figure with 'the phallus pointing towards the rhinoceros, and the hand towards the anus, as if to enter it'. This scene of zoophilia seems to be a description of a direct sexual link between man and animal. We can conclude that the information coming from this ancient art work is obscured by time and provides a tantalizing communication challenge.

Rhino horn is used to cure a variety of ailments in the traditional medicine systems of many Asian countries, from Malaysia and South Korea to India and China. In traditional Chinese medicine, the horn, which is shaved or ground into a powder and dissolved in boiling water, is used to treat fever, rheumatism, gout and other disorders. According to 16th century Chinese pharmacist Li Shi Chen, the horn could also cure snakebites, hallucinations, typhoid, headaches, carbuncles, vomiting, food poisoning and ‘devil possession’ (it is not, as commonly believed, prescribed as an aphrodisiac). Historical mentions of other uses for rhino horns date back thousands of years. In Greek mythology, the horns were said to possess the ability to purify water. Persians of the 5th century BCE thought that vessels carved from the horns could be used to detect poison in liquids by causing the liquid to bubble – a belief that persisted into the 18th and 19th centuries among the royal courts of Europe!

11.3 Rhino horn and science

Science is now stepping in to dispel some of the mystery and fiction surrounding the use of rhino horn. It is believed that there may be some truth behind the rhino horn’s reputed ability to detect poisons, which is linked to the composition of the horn. Rhino horn is composed largely of the protein keratin, which is also the chief component in hair, fingernails and animal hooves. Many poisons are strongly alkaline (or basic), and may have reacted chemically with the keratin. Unlike the horns of most animals, which have a bony core covered by a relatively thin layer of keratin, rhino horn is keratin all the way through (although the precise chemical composition of the keratin varies depending on the rhino’s diet and geographical location). This fact has allowed ecologist Raj Amin of the Zoological Society of London and his colleagues to take ‘fingerprints’ of horn samples and determine which animal populations they came from, which has helped law enforcement officials target and crack down on poaching.

Rhino horn is not, as once believed, made simply from a clump of compressed or modified hair. Recent studies by researchers at Ohio University using computerized tomography (CT) scans have shown that the horns are, in fact, similar in structure to horses' hooves and turtle's and cockatoos' beaks. The studies also revealed that the centres of the horns have dense mineral deposits of calcium and melanin – a finding that may explain the curve and sharp tip of the horns. The calcium would strengthen the horn, while the melanin would protect the core from being degraded by ultraviolet radiation from the sun. As the softer outer portion is worn away over time by the sun and typical rhino activities (bashing horns with rhinos and other animals or rubbing the horn on the ground), the inner core would be sharpened into a point (much like a wooden pencil).

Overall, there is not much evidence to support the plethora of claims about the healing properties of the horns. In 1990, researchers at the Chinese University in Hong Kong found that large doses of rhino horn extract could slightly lower fever in rats (as could extracts from saiga antelope and water buffalo horn), but the concentrations of horn given by a traditional Chinese medicine specialist are many times lower than used in those experiments. In short, you would do just as well chewing on your fingernails.

11.4 Indigenous knowledge systems

By definition, 'indigenous knowledge'[5] is local knowledge generated by people living within a particular community – hence, it is unique to a particular society or culture. Indigenous knowledge is tacit knowledge and therefore not easily documented. Generating an indigenous knowledge system (IKS) is a dynamic process and is based on innovation, adaptation and experimentation, as well as the

5. Paulin Hountondji reported in 1997 that the term 'endogenous knowledge' was accepted during a seminar organized for masters degree students in philosophy and sociology at the Université Nationale du Benin, Cotonou, in 1987. For the purpose of this paper, I use the term 'indigenous knowledge system' (IKS) despite the conditions attached to this term as having local curiosity value for the foreign observer, and hence encompassing a derogatory connotation that refers to 'a specific, historical experience, precisely one of integration of autochthonous cultures into a world-wide "market" in which these perforce are pushed down to inferior positions' (Hountondji 1997: 18). As my hypothesis strives to overcome negative perceptions about traditional practices and technological knowledge, I consider it appropriate to use the term IKS in an effort to overcome political constraints.

'common-sense' survival strategies of a community.[6] The fact that an IKS is not generally and widely acknowledged should not deter us from investigating the validity of the knowledge that it produces. Nor should the localized nature of these systems of knowledge be used as an ideological excuse to dismiss their scientific nature by referring to them as merely 'traditional arrangements'. There is sufficient confirmation that a variety of sound scientific knowledge is usually embedded in such systems (Sardar 1998, 2002; Raza 2002, 2003; Riana & Habib 2004).

However, the information available on IKSs is still predominantly descriptive, is based on case studies and sometimes lacks intellectual consideration. At the same time, science, by definition, is seen as a reflection of a (western) society's level of development, and the non-western world is considered to be at a developmental disadvantage. An IKS provides the platform for an open system of enquiry because it is based on the 'common-sense' survival strategies of a community in which scientific knowledge is applied in a specific locale to cope with specific agroecological, economic and sociocultural environments. Most importantly, it is knowledge that develops from the experience and the humanist 'right to life' of people.

Another important contribution to furthering understanding of the role of IKSs has been made by Edward Said (1978, 1994), when he pointed out that the valorization and defence of IKSs in a world dominated by western science is ultimately about the affirmation and recognition of the self in relation to the 'other'. Said (1994) uses the term 'culture' (culture as the 'other') to address problems in the Eurocentric understanding of IKSs. In this regard, he points out that research on IKSs has been linked to aesthetic theory and practices of interpretation in which the relative autonomy of the aes-

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6. Among efforts to define IKSs succinctly, one can refer to Anthony Starkey's attempts to capture the complexity of IKSs through defining local knowledge as 'knowledge generated and transmitted over time, by those who reside in a specific locale, to cope with their agro-ecological, economic and socio-cultural environments. Such knowledge is passed on from generation to generation. It is knowledge that develops from the experience of the people and is influenced, but not dictated to, by specific ideologies. IKS is stored in peoples' memories and quotidian (daily) activities and is expressed in stories, folklore, proverbs, myths, cultural values, belief systems, rituals, metaphors, idioms, local language, artefacts and, above all, in production systems and innovation chains' (Starkey 2001).

thetic discourse has been separate from, and dogmatically defended against, the economic, social and political discourse. According to Said (1994), IKSs have often been represented, in the Kantian sense, as an aesthetic form of judgement, the principal aim of which is to provide aesthetic pleasure. This Kantian demarcation of the transcendental form of judgement aimed at aesthetic pleasure has contributed significantly to disciplines such as ethnography, historiography, philology, sociology and literary history, in which the cultural 'other' has been reduced to the level of providing aesthetic (exotic) pleasure for the western observer.

11.5 Indigenous knowledge systems versus modernity in science communication: establishing the fault lines

Africa is too often thought to stay frozen in a traditional state of 'being primitive' as a counter to the western modernity project of fluid 'developed capability'. However, African communities are progressively being considered as part of a global matrix with 'trans-national contacts and macro-scale linkages' (Steiner 1994: 1). Christopher Steiner refers to the rebellion against the so-called 'primitive isolates' promoted by earlier anthropologists whose studies followed a 'bounded system' in which, in a single society, one isolated community within one remote village was studied. Today, this 'system of investigation' has been revised to contain 'processes of investigation' consisting of the history as well as social changes in the given community. This includes the replacement of old key words such as 'homeostasis, cohesion and balance' by new concepts such as 'pluralism, heterogeneity, crisis, conflict and transformation' (Steiner 1994: 1).

We can safely say that IKSs emerge not only in developing societies, but in all societies.[7] This point is made by Appleby and Covington (1995) in their assessment of John Dewey's *Common*

7. The phrase 'indigenous knowledge systems' was introduced within an ideological vacuum in developing countries (such as in Africa). It is still associated with contradictory definitions and conceptual pitfalls that remain intellectually as well as ideologically unresolved. There are, for instance, calls from academics such

sense and scientific inquiry (1938), in which Dewey claims that the 'common sense world' forms the basis for the development of all scientific enquiry. For Appleby and Covington, scientific enquiry is inconceivable without the prior understanding arising from the common-sense inquiries that inform our daily interactions with our environment. However, that approach to the understanding of scientific knowledge (as having its origin in common-sense inquiries) requires a conceptual distinction between knowledge in the practical sense and knowledge in the theoretical (second order level) sense of scientific reflection and self-criticism. IKSs do provide for the theoretical possibility of validating (and invalidating) the knowledge claims that derive from common-sense enquiries.

Considering Dewey's ideas as set out in *Common sense and scientific inquiry*, two distinct orders of scientific thinking become prominent. One is based on 'common sense' and 'experiential knowledge', in which experience develops into science. This order is mostly considered to retain and contain traditional knowledge. The other order is based on so-called 'modern science', which developed a higher order of theoretical models aimed at the justification and validation of all knowledge claims. These two orders of knowledge have for the most part been treated as two incommensurable types of knowledge – an argument I find extremely problematic, given the fluid nature of mutual exchanges between the two orders of knowledge (which have invariably characterized the production and understanding of knowledge as a whole).

Ideas about 'common sense' were also explored in the Scottish school by Reid and Steward, who saw the 'deliverances of common sense as if they were a body of settled truths' (Appleby & Covington 1995: 267). Therefore, common sense was considered as an ultimate authority and arbiter of philosophical questions. However, when *common* sense becomes *general* sense, leading to a universal application of common sense, which includes all people, it loses its specific or localized nature. This has often been the case where the western experience of common sense has been imposed on other traditional forms of knowledge. It should be emphasized that knowledge is firstly of a cultural nature and, as such, arises

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Paulin Hountondji (1997) and other African scholars to replace the term 'indigenous knowledge' with 'endogenous knowledge' as a more representative description.

within specific cultural environments. This 'cultural level knowledge' is synonymous with common sense practices and local sets of meaning. According to Appleby and Covington (1995: 268), knowledge as a common set of practices and as localized knowledge is 'so deeply embedded in its customs, occupations, traditions and ways of interpreting its physical environment and group life, that they form the basic categories of the language system by which details are interpreted'.

It is, however, somewhat awkward to claim that IKSs are exclusively concerned with 'common-sense' knowledge or that they focus only on traditional systems of knowledge. This perception leads to the implication that the validity and field of application of IKSs are restricted to the 'embedded common sense' of local traditional communities in the non-western world. Given the popular conceptual differentiation between tradition and modernity, IKSs have often been associated with outdated and anachronistic forms of knowledge, characterized essentially by their perceived static and conservative nature. It should be pointed out that the attempt to define tradition already presupposes the possibility of a post-traditional (modern) understanding of tradition from the perspective of modernity. From this perspective, definitional accounts of modernity as well as tradition can only be offered from a modern perspective. If modernity is characterized by constant flux and change, it lacks the philosophical capabilities to deal with a tradition in which the essential characteristic is non-change.

Arising from the conceptual difficulties that take place when the definition of modernity portrays itself as an event of constant flux, Hobsbawn and Ranger looked at tradition as an 'invention' or a 'construct'. They use the term 'invented tradition' as a:

> Set of practices, normally governed by overtly or tacitly accepted rules and of a ritual or symbolic nature, which seek to inculcate certain values and norms of behaviour by repetition, which automatically implies continuity with the past. (Hobsbawm & Ranger 1983: 1)

According to Hobsbawm and Ranger (1983: 2), tradition, characterized by invariance, is not to be confused with custom, which does not preclude innovation and change, and facilitates change (or even resistance to innovation) to provide:

> … the sanction of precedent, social continuity and, in order to understand the full significance of IKS, we also need to go beyond the current conception opposition between empirical knowledge systems versus rationalist knowledge systems. It needs to be emphasised that these two forms of knowledge do not constitute or represent mutually alternative approaches to knowledge but that they are co-implicative. Furthermore, when we succeed in moving beyond ideological arguments that seek to relegate traditional knowledge systems to the sphere of experiential (practical) knowledge, and correspondingly elevate western scientific knowledge to the level of theory, the possibility of communication and dialogue between these two forms of knowledge is made extremely difficult.

In conclusion, an IKS is more than the application of a primitive form of technical knowledge; it also seeks to continuously authorize the scientific status and validity of knowledge claims that arise within the context of people's 'right to life' activities.

11.6 Science communication and the public understanding of science: creating a framework of inclusivity

Here I introduce three aspects that are based on existing fault lines that require our attention in our efforts to construct a continuity between the sciences and IKSs:

- the development of a science communication model that will bridge what is referred to as the 'cultural distance' between structures of formal science education and local knowledge(s)
- the importance of incorporating the role of the 'aesthetic of knowledge'
- the value provided to the development of a theoretical framework by a transdisciplinary research approach.

11.6.1 A model that can handle 'cultural distance'

Up to this point I have argued that, although there is a perception of a distinction between science and IKSs, reality does not allow for such a separation. Most often this perceived but artificial separation manifests itself in geographically allocated locations occupied by, as Roger Scruton (2002) states, 'the west and the rest'. We are therefore tasked to explore areas of convergence and localities of neglect between what are called IKSs and what is marked as 'science'. For this task, we can consider the argument by Gauhar Raza that it is not adequate to consider the knowledge base of a community as the only factor that is influenced by (scientific) intervention. Raza (2002: 59) states that the determinants of a community's 'thought complexities need to be investigated' when conducting surveys:

> … thus, one of the most important exercises before commencing any IKS research project is to identify the factors that might have a direct bearing on the knowledge system of an individual or a group. It is in the course of this 'action' research that the processes involved in the generation, retention and configuration of bits and pieces of information may be understood. However, the broad cognitive framework or world-view in which the acquired knowledge is configured is a socio-cultural construct shaped by quotidian episodes experienced over generations.

Raza proposes two conditions for the execution of empirical studies. First, no study should be divorced from the social, cultural or historical context in which the (knowledge) system operates. By ignoring this, we produce erroneous conclusions. Second, to enable the research to feed into policy mechanisms, the study needs to be community-centric and take into account the worldview and 'spectrum' of the communities. Raza (2002: 59–60) says that exactly what constitutes the 'spectrum' of communities in the developing world is complicated and ranges from:

> … communities which live in harmony to nature without disturbing the regenerative capabilities of eco-systems and who, for example, practice indigenous systems of medicine developed over centuries. On the other hand there are those artisans who have developed what is often referred to as innovative 'rural or indigenous' technologies. The varied pace of the struggle for survival and the intrinsic human need to innovate have given birth to sub-social and cultural systems in these communities. These subsystems, especially technology or trade-based structures, more often than not, continually interact with other systems

including the ‘modern’. This organic link makes the task of developing categories of control as well as of dependent variables quite difficult.

11.6.2 The role of the ‘aesthetic of knowledge’

The second area of incorporation to ensure inclusivity is what Jacques Rancière (2006) refers to as an aesthetic dimension of knowledge. This notion of an aesthetic is not an obligation. It divides the idea from the practice of knowledge and is a historically determined concept designating a specific regime of visibility and intelligibility of art inscribed in the reconfiguration of the categories of sense experience and interpretation. The aesthetic dimension overrules the Bourdian notion of ‘you know or you do not’ (*on connaît ou on méconnaît*). As Rancière (2006: 3) explains:

> … the aesthetic illusion confirms that subjects are subjected to a system because they do not understand how it works. And if they do not understand, it is because the very functioning of the system is misrecognition. The *savant* is the one who understands this identity of systemic reasons and the reasons for its misrecognition.

Rancière talks of *two* knowledge(s): the configuration of knowledge rests on a simple alternative that tells us that there is a true knowledge (*savoir)* which is aware and a false knowledge (*savoir*) which ignores. Each knowledge (*savoir*) is accompanied by a certain ignorance, and therefore there is a knowledge that represses and an ignorance that liberates. In other words, knowledge is always double: it is an ensemble of knowledge(s) (*connaissances*) and it is also an organized distribution (*partage*) of positions. This argument stems from the individual’s ability to take pleasure from within their own identity (as, for example, being an artisan) to take on a different identity (political, social class, race) and thereby become capable of being assigned from a private (individual) condition to one capable of intervening in the affairs of the community. This capability has a profound influence in facilitating the bridging of paradigms from ‘science for society’ to ‘science and society’ to ‘science in society’.

11.6.3 A transdisciplinary research approach

As a final point, the theoretical framework proposed by Basarab Nicolescu (1996) provides new challenges in the solution it poses in our exploration of the ecology of knowledge. Nicolescu argued that modern science was born through a violent break with the ancient vision of the world, and that in the process we changed the status of the Subject to one of Object. This change is caused by the total separation between the knowing subject and reality. Therefore, Nicolescu promotes a transdisciplinary approach to current global research themes.

Instead of looking at transdisciplinarity as an approach that is promoting continuity, he advises the consideration of discontinuity, since what he calls 'the middle ground' (of knowledge) consists of a vacuum. That vacuum, according to him, is filled with possibilities of the 'unknown'. Reinforced by the ability of mankind to exist and adapt within different layers of reality – an ability that Nicolescu aptly describes as following a methodology of three axioms (ontological, logical and complexity) – we move into a combination/ separation of different knowledge spaces:

- The 'ontological axiom' refers to what we encounter in nature and in our knowledge of nature: there are different levels of reality and, correspondingly, different levels of perception.
- The 'logical axiom' refers to the passage from one level of reality to another, ensured by the logic of the included middle.
- The 'complexity axiom' forms the structure of the totality of levels of reality or perception and has a complex structure: every level is what it is because all the levels exist at the same time.

Nicolescu argues that these axioms are not theorems and cannot be demonstrated; they have their roots in experimental data and theoretical approaches, and their validity is judged by the results of their application.

The Charter of Transdisciplinarity drafted during the First World Congress of Transdisciplinarity in 1994 serves as an example. The charter, in reaction against '8530 definable fields of knowledge, was the result of resistance against both increasing specialisation and the growing overlapping of disciplinary knowledge domains'. Article 13 of the charter states:

> The transdisciplinary ethic rejects any attitude which refuses dialogue and discussion, no matter whether the origin of this attitude is ideological, scientistic, religious, economic, political or philosophical. Shared knowledge should lead to a shared understanding based on an absolute respect for the collective and individual diversities united by our common life on one and the same Earth.
>
> – Adopted at the First World Congress of Transdisciplinarity, Convento da Arrábida, Portugal, November 1994.

11.7 Conclusion

Reference to 'science' in this paper takes into consideration activities that are essentially reflective and enable the development of an intellectual ecology of knowledge. Through an intellectual ecology of knowledge we endeavour, as Davies and Meskimmon (2003: 9) argue, to focus on who uses knowledge and in what ways and for what purposes knowledge is needed, in order to expose the automatic habits of thinking and the technocratic nature of current knowledge production. Though we are good at asking questions about knowledge that we already know and excel in advising society on the knowledge it needs, we seldom stand back and reflect on the use and appropriateness of such knowledge. For the same purpose, we communicate science within frameworks of application, such as in policy development, without considering appropriate measures and models to establish the level of impact of such policies.

I have explored a number of aspects, such as what constitutes 'community' as part of the public(s) often mentioned by science communicators, to define communities' retention and application of traditional knowledge in so far as it contributes to a global lexicon of knowledge. I have proposed three possible focus areas to understand the fault lines between modern science and IKSs: the constructing of a science communication model, the importance of incorporating the role of the 'aesthetic of knowledge', and the value provided by a transdisciplinary research approach to the development of a theoretical framework.

The current mass poaching of rhinos for their allegedly medically valuable horns demonstrates the complexity of understanding and addressing the fault lines that exist between IKSs and science.

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12

Engaging people in controversial science: A climate change case study

Jenni Metcalfe

Abstract: Engaging the public in controversial science which has been politicized, as climate change science has, can be challenging. This paper explores the nature of science engagement by looking at some of the results of the 2012 Australian national audit of science engagement activities. It goes on to look at the three dominant models of science communication and engagement – deficit, dialogue and participatory – and how they might be applied to engaging the public in climate change science. It highlights the application of these models with specific examples of climate change communication directed at farmers in Australia or with the general public through the use of blogs.

Keywords: science engagement, science communication, controversial science engagement, climate change communication, climate change engagement, science communication models.

WHEN CATCHING a taxi recently to give a talk about how to communicate climate change, I asked the taxi driver whether he believed in climate change. ‘No,’ he replied firmly, ‘I do not get into politics.’

This anecdote reflects the increasing politicization of science issues such as climate change. No longer is the science of climate change at the forefront of public consciousness and discussions, but rather the politics associated with climate change policies have taken centre stage.

There are many players and agendas in such controversial issues. And the controversy inherent in them can generate increased public engagement in shaping the debate around the science and the politics when existing institutions, such as science organizations, governments, advocacy groups and the media, fail to resolve matters (Marres 2007).

Engaging the 'public' in science has been and continues to be an objective of scientists. This has been driven by the perceived need to interest the public in science, educate it about science and, lately, to obtain its support for science. When the science is controversial, or even politicized, such as is the case for climate change, support may be needed to legitimize continued research or to advocate for behaviour and policy changes (Few et al. 2007, Hoppner 2010, Marquart-Pyatt et al. 2011).

This paper uses data from a 2012 national audit of science engagement activities in Australia to explore the nature and perceptions of science 'engagement'. The paper then looks at the various models of science engagement and the place of those models in the practice of engaging people in climate change science. It uses specific examples to illustrate the use of these models in engaging various people, particularly farmers, on climate change in Australia.

12.1 The public's need to engage with climate science

After Antarctica, Australia has the world's most variable climate. Climate science predicts that the climate will become more variable under climate change, that rainfall with decrease across southern Australia and that more extreme weather events are likely. All Australians are affected by climate change. Most live in cities on our eastern coastline, and most of those cities have experienced or are still experiencing restrictions in their water use. Those who live right on the coast are affected by more frequent storm surges and rising sea levels.

However, arguably those most directly affected on a day-to-day basis are Australia's farmers, who generate about A$39 billion a year for the Australian economy and employ about 370,000 people.[1]

1. http://www.cultureandrecreation.gov.au/articles/farms/.

While agriculture is not as extensive as it was in the mid-1970s, farms still make up about 60 % of all the land in Australia.

However, climate change remains a controversial issue in Australia, despite the majority of peer-reviewed climate scientists agreeing with the basic theory that the climate is changing and that this is being caused by people's actions. This controversy has been heightened by political debate about the recent (1 July 2012) introduction of a carbon tax in Australia.

The public debate about climate change is an important one, as it has the power to affect our survival. The recognised experts largely agree that 'it will take massive changes in agriculture, energy production and more to avert a potential disaster [from climate change]' (Lemonick 2010: 80).

The success of climate change policies and international treaties to reduce emissions is likely to depend on broad public support (Swain 2012). Likewise, if people are to adopt new behaviours to mitigate or adapt to climate change they need to be engaged with the science and technology behind recommended changes.

Unfortunately, with polarized views on climate change science (Brin 2010) and quality traditional news coverage only reaching a small audience of already engaged citizens (Swain 2012), most of the public reinterprets such science based on their own perceptions and cultural norms. People strenuously defend their own positions on climate change as being evidence based and the opposing position as being either conspiratorial or ill-informed (Brin 2010).

In high-profile and controversial science fields, like climate change, there is widespread confusion and misunderstanding about the science (Schmidt 2008), which is often brought on by the inability of the mediators of science, such as media and science communicators, to communicate the complexities and uncertainties of the science clearly or to engage people with the science to create action.

12.2 What is 'public engagement' in science?

I define 'public engagement' in science as the 'motivated affective state of individual members of publics' (Kang 2012) when interacting with scientists or at events about science. Thus, for me, public engagement goes beyond the mere one-way dissemination of information (the deficit model) to a more participatory approach in which people are affected and motivated by their participation in science.

Theories of science communication have considered the various means of engaging the public in science, and most theoreticians agree that a more participatory approach is more likely to succeed than a one-way – from scientists to the public – means of communication (Chilvers 2008; Irwin 2006, 2008; Taylor 2007).

However, like beauty, engagement can lie in the eye of the beholder. When conducting a national audit of science engagement activities in Australia, we let the respondents define how they perceived 'engagement'.

One of the first questions asked them to describe their activity. A content analysis of the 411 activities entered indicated that, out of the seven most common responses, most were about one-way dissemination or demonstration of science:

1. Presentation/seminar/lecture
2. Education/school based activity
3. Visit / tour of research
4. Skills workshop / course
5. Hands-on activity
6. Shows/demonstrations
7. Exhibits/posters.

When looking at their responses to how they engaged people in their activities, as shown in Figure 12.1, it was also clear that learning by watching, listening or viewing was a much larger component of their activities than consulting and sharing views or group problem solving. This observation shows that for many people 'science engagement' is still about one-way dissemination.

The tools that survey respondents chose to use to engage people in science, as shown in Figure 12.2, were also often about one-way dissemination through websites, newsletters, brochures, seminars and exhibitions. However, the dominance of face-to-face interactions and the strong use of social media may indicate that people are moving towards a more participatory approach to science engagement.

Figure 12.1 Responses to the Australian national audit survey asking respondents how people were engaged in their activities, from 5 (a major component) to 1 (not a part of it)

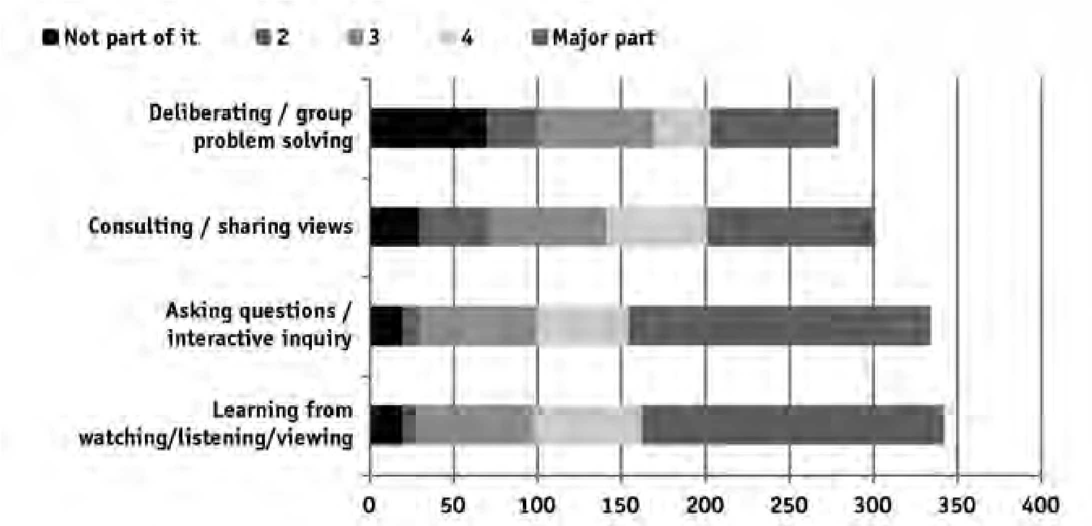
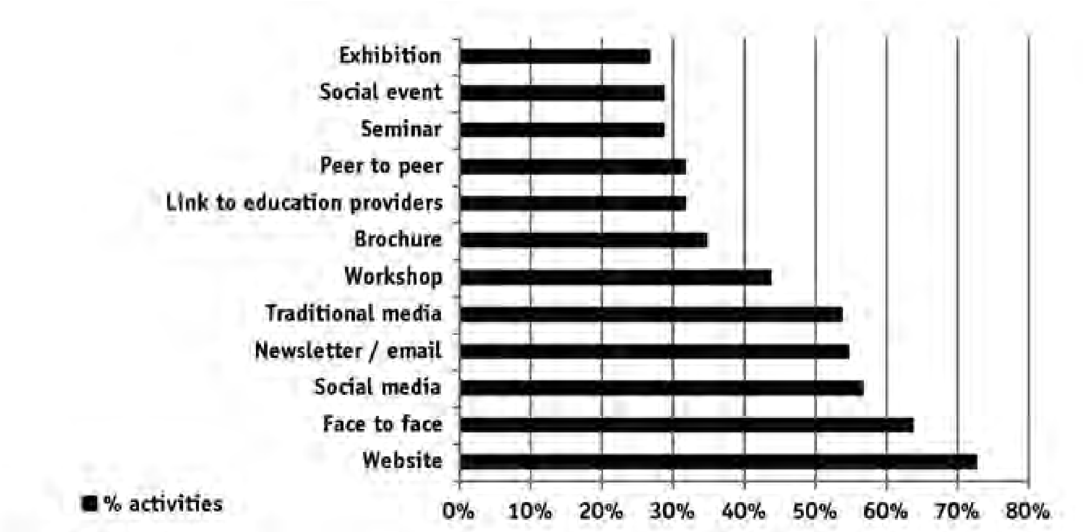


Figure 12.2 Responses to the Australian national audit survey asking respondents what tools they commonly used to engage people in their activities



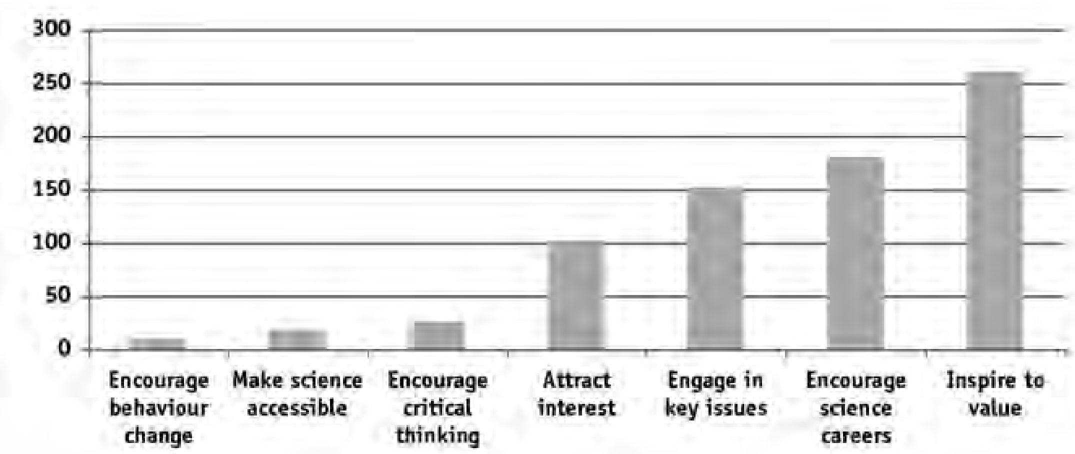
The Australian national audit survey asked respondents to rate how important the four outcomes of the Australian Government's Inspiring Australia strategy were to their own activity:

1. Inspire target groups and get them to value scientific endeavour
2. Attract increasing national and international interest in science

3. Critically engage target groups with key scientific issues
4. Encourage young people to pursue scientific studies/careers.

Survey respondents could also list 'other' outcomes and their importance. The results, as shown in Figure 12.3, show that the most important outcome nominated by the government was the first listed above. It appears that for most of those directing public engagement in science in Australia it is about celebrating and promoting science, rather than about getting people to participate in the science and critically evaluate it. However, the most common 'other' responses indicate that at least some are moving their public engagement towards more critical thinking and openness and as a means of encouraging behavioural change.

Figure 12.3 Responses to the Australian national audit survey asking respondents how important four outcomes were to their engagement activity (number of activities for which respondent said the outcome was of 'high importance' to their activity)



This paper uses Alan Irwin's (2008) three orders of thinking to look at science engagement models and how each can have application for engaging people in controversial science issues, such as climate change.

12.2.1 'First order thinking' – the deficit model

For much of the history of the communication of science, scientists and more recently professional 'mediators' called science communicators have seen the amorphous 'public', often referred to as the 'general public', as empty vessels who needed to be filled with science knowledge (Irwin 2006, Pouliot 2009, Trench 2008). The goal of science communication was and often still is very much directed at creating a science-literate public. With controversial science issues, such as climate change, many continue to believe that 'if only the public understood the science' they would be able to accept it and understand the need for action or policy change. And there is still a dominant assumption that science literacy is both the problem and the solution to societal debates and conflicts (Nisbet & Scheufele 2009).

Science communication researchers have theorized this research as the 'deficit' model of science communication (Jolly & Kaufmann 2008, Trench 2008). In this model, scientists speak with certainty and science has centrality in scientists – public interactions (Irwin 2008). The communication is one-way from scientists to the public, and assumes that the public lack any valuable knowledge of their own. 'Science is presented as the embodiment of truth and the task of governments (or scientists) becomes one of bringing rationality to human affairs' (Irwin 2008).

However, as a part of engaging the public in controversial science, there is a need for the credible one-way dissemination of the best available information. As such, the deficit model can coexist with other communication models (Trench 2008).

Case-study: www.climatekelpie.com.au

In 2007, my company, Econnect Communication, conducted a web survey on farmers' needs for seasonal climate forecast tools and climate information on the internet.[2] This research and analysis gave us a good understanding of where farmers like to get information, how they like to receive it, and why they do not find current information useful.

We found that farmers like information that is, in order of importance:

- reliable
- relevant to their region
- timely
- practical

2. http://lwa.gov.au/products/pf081456.

- relevant to their industry
- simple and easy to follow.

Most (94 %) of farmers we surveyed agreed that they would like a one-stop shop website about climate. Aside from the crucial importance of the information for managing their enterprises, the farmers responding to the survey also believed it would save them valuable time. To that end, they requested that the website be kept as concise as possible to maximize its efficient use and make it accessible to everyone.

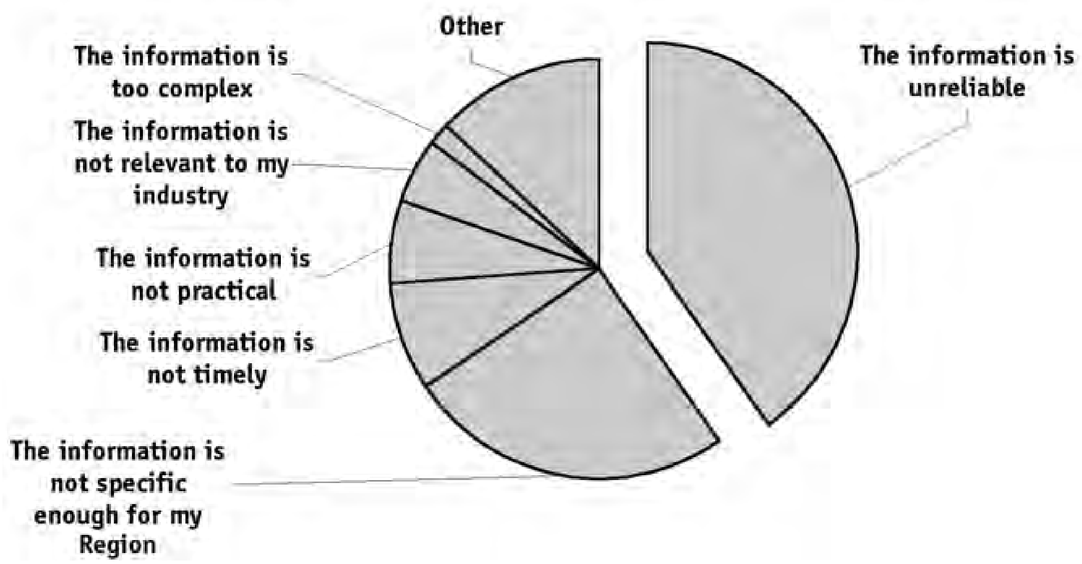
They stressed that the information presented needed to be simple, clear and credible. Some people admitted that they were ill-equipped for using currently available sources of information, and would be interested in having the website offer more detailed education and training that included information on interpreting probabilities and climate risk.

The accuracy and reliability of the information were of primary concern to the people we consulted.

There were some regional concerns about information being valid for only some parts of Australia. For example, one survey respondent pointed out that managing climate risk in northern Australia was very different from managing it in the southern part of the country.

Figure 12.4 shows why some farmers we surveyed in 2007 did not use seasonal forecast information available through websites such as the Bureau of Meteorology.

Figure 12.4 Why farmers do not use available seasonal forecasting information



In response to this information, we developed Climate Kelpie as a website for Australian farmers. It aims to act as a one-stop shop linking them to relevant climate-based information and tools. A kelpie is an Australian dog that rounds up sheep and cattle, and this site is designed to make it easy for farmers and their advisers to quickly access the tools and information to help them better manage and understand their climate.

To make sure Climate Kelpie was useful for farmers, we developed the site with the input of a reference group of 12 farmers from Australia who provided us with feedback.

The site was launched in February 2010, but is still under development. New regional and commodity-based information, tools and links are being researched and added to the site regularly. The site was developed to reflect the information needs of farmers, in that users of the site can filter the content of the site according to their:

- specific weather region of Australia
- commodity of interest
- topic of interest.

The website contains four main topics. The main topic is 'Manage climate', which gives information, links and tools for adapting to a more variable climate, making decisions and reducing emissions.

The topic 'See forecasts' makes it easy for users to quickly link to the Bureau of Meteorology website for their region. It also provides information about global circulation model forecasts and climate change projections. 'Understand climate' provides simple, direct explanations of climate change science and weather and climate drivers. 'Ask a farmer' provides case study stories of farmers' experiences of managing climate for their region and commodity.

Climate Kelpie is an example of a tool that provides credible one-way science information to farmers. It was developed after consulting about farmers' perception, needs and concerns, and we continually receive feedback and ideas for developing the site from farmers, researchers and advisers across Australia.

12.2.2 'Second order thinking' – the dialogue model

In the early 2000s, there was a reaction against the deficit model, which was perceived by many to have failed, especially when science communication campaigns about contentious science issues such as genetic modification failed to convince the public to support this research (Horst 2010, Kleinman et al 2011). At the time, science researchers began to theorize that this engagement had not appeared to lead to more literate citizens who were engaged in science or able to participate in democratic decision-making about science's directions or its impacts on their lives (Jackson et al. 2006, Benneworth 2009).

This led to governments and research organizations encouraging two-way communication, in which scientists and science communicators were encouraged to listen to and acknowledge public concerns and needs through a dialogue about the nature of risk. This model postulated that public trust could be gained by being more open and transparent about scientific uncertainties. It assumed that the public, which was now deemed to have some knowledge and resources of value to scientific dialogue, would respond rationally to such openness (Irwin 2008). The dialogue model of science communication 'may have become a practical necessity if public policy is to be made – and justified – in circumstances of social and technical uncertainty' (Irwin 2008).

In looking at the issue of climate change, it is interesting to investigate the possible role of Web 2.0 technologies, particularly blogs, in mobilizing public participation in such debates.

Case-study: Blogs

A key claim from blog proponents is that they empower and 'amplify the political voice of ordinary citizens' (Hindman 2009). This claim often stems from the fact that blogs have the potential to reach millions of people instantaneously and simultaneously. Certainly, many have noted the potential of blogs to provide a more 'authentic and personal voice' (Stone, cited in Hindman 2009) to issues and debates. Ordinary people now have ready access to some of the information and research resources once only available to journalists (Cahill & Ward 2007).

Blogs have the potential to empower people to participate in climate change debates and dialogue on equal terms with traditional media, big government and perhaps even the ivory towers of science (Cahill & Ward 2007). Blogs and other Web 2.0 technologies can give ordinary people the power to break down such 'elites' and participate in science – policy debates alongside journalists, editors, news directors, scientists and activists.

Scientist David Brin (2010) coined the term 'Age of Amateurs' to reflect the access that new digital technologies give: 'I've long held that elites and experts will have to adapt to a 21st century filled with eager, savvy question-asking citizens.' Shirky (2008) takes it a step further by arguing that new media, such as blogs, by changing the way we communicate also change society: 'We now have the communications tools that are flexible enough to match our social capabilities and we are witnessing the rise of new ways of coordinating action.'

Blogs can provide scientists, science journalists and citizens with the ability to directly engage with each other and can provide forums for more in-depth analysis than traditional media (Readfearn 2010). Indeed, blogs 'provide a rapid, casual, interactive and occasionally authoritative way of commenting on current issues, new [scientific] papers and old controversies' (Schmidt 2008: 208).

However, while there is no doubt that blogs make discourse about issues such as climate change less exclusive and that there are now more points of view being raised, the impact of those points of view is likely to be low, as most blogs have few readers. As research conducted by Rubicon, a US marketing firm (Turner 2009: 134), shows, 'only 1 per cent of [internet content] consumers are enthusiastic [internet content] producers [and] … what might look like an open conversation on blogs is therefore dominated by the same 1 per cent of participants.'

Unfortunately, while ordinary people wanting to post blogs can do so, unless they have recognized influence in the mass commercial media or an influential network or organization, they are still unlikely to be read by many people. The top 10 to 20 blogs have the most followers, but most blogs, especially those by ordinary people, have very few followers (Shirky 2008, Hindman 2009). Indeed, the majority of bloggers work in relative obscurity: 'The mere *potential* to reach a mass audience with little or no marginal costs means nothing if bloggers cannot *attract* readers' (Cahill & Ward 2007, italics by authors).

Most widely read bloggers tend to be well-educated male professionals who generally write for a living and having some association with the mainstream media. Bloggers are generally ‘from professors to public relations specialists, from lawyers to lobbyists, from fiction authors to management consultants to technical writers’ (Hindman 2009: 123).

Mainstream media have recognized the power of blogs and the following that independent bloggers have, and have adopted the medium on their own websites or have invited independent bloggers to be associated with their sites. However, there are problems with journalists being involved in public online debates through media such as blogs. They are often too close to the powerful media interests that employ them; they can find it hard to veer too far from mainstream public and political sentiment; and the very nature of journalistic news writing means that they write as if from an objective rather than a subjective point of view (Flew & Wilson 2010).

Some powerful media outlets, such as *The Australian* newspaper that Rupert Murdoch owns, and which is part of his Fox News Corporation conglomeration, are pushing the climate denier barrow. Many of these media outlets are largely ‘owned by the same petro-moguls who have benefited from delayed energy independence … The Climate Deniers … hitch their wagons to the Fox – Limbaugh machine’ (Brin 2010: 16). Research into media coverage of climate change by Swain (2012: 176) shows that:

> While the intensity of commentary about climate change varied across media outlets owned by [Fox] News Corporation, its corporate view framed the issue as one of political correctness rather than science. Scientific knowledge was portrayed as an orthodoxy and climate scepticism as courageous dissent.

Some media companies appear to be using the new technologies to promote and represent their own interests and to further increase their ‘source of power’, (Turner 2009). This may be changing the media’s role from being a mediator of others’ interests to being an advocate of their own and associated interests, so that many journalists may become the ‘authors rather than the mediators of cultural identity’.

A further concern with blogs, which is exacerbated by the fact that many are written by journalists using a seemingly objective news style, is that the information posted on them often appears to constitute 'authoritative evidence … When you look at a blog, however, all you have is an expression of the blogger's opinion with very little in the way of verifiable or authoritative evidence' (Turner 2009: 133).

This has certainly been the case with climate change deniers' blogs, and has in some cases stimulated scientists to enter the blogosphere. Some of the most popular blogs have misrepresented climate science. Readfern (2010) quotes leading coral reef scientist Professor Ove Hoegh-Guldberg, who started his own blog, Climate Shifts: 'Some of this is simply a consequence of online "experts" being ill-informed, while others stem from a well-organized and well-funded disinformation campaign proliferated by special interest groups.'

Despite the inevitable conclusion that for climate change science the blogosphere debate has been largely driven by the elites and that the sceptics' agenda is presented most loudly, there may still be opportunities for both scientists and ordinary citizens to become more engaged in blogs to get clearer information about climate science into the public dialogue and decision making.

US climate scientist Judith Curry controversially uses blogs like Climate Audit, Air Vent and Blackboard to engage in a dialogue with climate sceptics and deniers (Lemonick 2010). She believes that while many of the claims of climate deniers have long been disproved, others make valid points that should be examined, and that too many climate scientists are unwilling to examine others' views. Perhaps there is a case for more active engagement of climate scientists with sceptics in the blogosphere – something which (I know anecdotally through my work with researchers) many scientists avoid.

Scientists writing blogs can make the context of science much more accessible to people than the traditional media. 'A science blog can explain … the difference between a weather forecast and a climate projection. Over time, their archives provide a repository of knowledge that readers – both lay and scientific – can find invaluable' (Schmidt 2008: 208).

The RealClimate blog is an example of an apparently successful blog generated by scientists.[3] It was launched in late 2004 by a group of nine US climate scientists who aimed to rebut the claims of many of the industry-funded US 'think tanks' seeking to downplay

3. www.realclimate.org.

the dangers of global warming in both mainstream and new media.[4] Almost eight years later, this blog is still active and provides an authoritative source of information about climate change in response to breaking issues and questions and discussions with the public. The blog is written by individual climate scientists in their own time. They make clear that what they write is not necessarily the views of their organizations or funders. They say in the 'About us' section of the website:

> RealClimate is a commentary site on climate science by working climate scientists for the interested public and journalists. We aim to provide a quick response to developing stories and provide the context sometimes missing in mainstream commentary. The discussion here is restricted to scientific topics and will not get involved in any political or economic implications of the science. (RealClimate n.d.)

There is no easily obtainable data on how many readers and participants RealClimate attracts to its dialogue, or whether they are ordinary citizens, but it does seem to have survived for eight years and anecdotally appears to be having a positive impact on the debate.

If reputable scientists and ordinary citizens can build online networks about climate change science that are linked with influential others, including mainstream media, perhaps their blogs would be more successful in breaking the hold of the blogosphere elites. Terry Flew and Jason Wilson (2010: 141), in reporting on the Australian *youdecide* project associated with the 2007 Australian federal election, noted that 'making advantageous connections with existing, established news outlets, ensuring the content [of blogs] is delivered and sourced across a number of platforms, and mobilising online and personal networks to build community and bring users and their content to a site' will help make blogs more successful.

A more open and diverse blogosphere on climate change science is very likely to offer a means of 'keeping public engagement with science authentically alive and not under the control of agents whose own culturally embedded assumptions, imaginations and practices may well be part of the problem' (Felt & Wynne, cited in Nerlich et al. 2010). However, achieving this type of blogosphere is chal-

4. Welcome climate bloggers, *Nature*, 432 (7020), December 2004, p. 933.

lenging, given the current constraints of media ownership, the influence of celebrity bloggers and the reluctance of credible scientists to engage in debate.

12.2.3 'Third order thinking' – the participatory model

More recently, it has become clear that dialogue alone is not enough if science is to truly inform people's decision-making and behaviour choices (Benneworth 2009, Williams 2010). And to go even further, some have recently called for the public's values to have more influence over what science actually gets done or not in the first place (Wilsdon & Willis 2004, Rogers-Hayden & Pidgeon, 2008). This participatory model of science communication, which appears to have the potential to lead to the true democratization of science, has particularly gained traction in recent years (Joly & Kaufmann 2008, Miller et al. 2009).

Irwin (2008) takes the participatory model further to call for 'third order' thinking about science engagement:

> [T]hird-order thinking invites us to consider what is at stake within societal decisions over science and technology and to build on the notion that different forms of expertise and understanding represent an important resource for change rather than an impediment or burden.

Third order thinking places science – public relations in the wider context by:

- raising profound questions of scientific and political culture
- recognizing that disagreement and controversy bring energy, excitement and focused attention to debates, and as such are an important resource
- providing more meaningful scrutiny of the prevailing modes of scientific governance
- critically evaluating current approaches to scientific governance and science communication.

Such public engagement in science will 'open up fresh interconnections between public, scientific, institutional, political and ethical visions of change in all their heterogeneity, conditionality and disagreement' (Irwin 2008).

Others have called for participatory models to move 'upstream' beyond just consultation and more into the co-creation of science and technologies (Rogers-Hayden & Pidgeon 2008).

Case-study: Climate Champion programme

The Climate Champion programme involves 37 farmers across Australia working in a variety of commodities who are nominated through a competitive process, promoted in the media and through other networks, to be part of the programme.

Climate Champion builds on our understanding that most farmers will change their practices based on what leading farmers in their region and commodity sector are doing. The successful nominees for the programme are farmers who:

- are already using tools and technologies, which they may have developed themselves, to better manage climate on their properties
- have well-established networks with other farmers in their regions and commodity groups
- are using science and technology on their farms for economic and environmental outcomes
- want to communicate about climate to other farmers
- are recognized leaders in their communities.

The programme is about farmers learning from each other (most farmers gain, trust and use new knowledge by interacting with other farmers). It is about getting farmers talking to other farmers. It is also about farmers and scientists learning from each other. The farmers help the scientists shape their research and the products from that research. The programme is about valuing and recognizing the knowledge that farmers already have about managing climate. It aims to help farmers to have the knowledge and tools they need to adapt to inevitable climate change and mitigate their own greenhouse gas emissions.

The programme is very much driven from the grassroots. While the idea was Econnect's and it is funded by government and industry, we have handed it over to the participating farmers to drive the programme itself. During their first workshop together, they articulated the objectives, target groups, messages and actions they wanted as part of the programme. They said they wanted to:

- build farmer networks and communication
- use new tools to manage and adapt to climate variability and change
- gain an even better understanding of the climate
- participate in climate research.

The Climate Champion participants work with researchers to articulate the needs of farmers in their regions with respect to climate, report on the success or failures of new tools and practices promoted by scientists, and facilitate research on farms.

This example of science engagement is moving towards the third order thinking that Irwin espouses. It still has a way to go, which will include a shifting of power away from the scientists and funders and a reallocation of resources, but it is helping farmers better manage a variable and changing climate.

12.3 Conclusion

Clearly, all the science communication models described in this paper have a place in engaging people in controversial science such as climate change. However, greater efforts need to be made to increase third order thinking engagement. Such engagement will help people to participate more fully in the science that affects their lives and to more critically examine and understand scientific processes and culture.

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13

Science communication in research institutes in France: The stakes and the interplay of social stakeholders

Patrick Baranger

Abstract: Today, French universities and research organizations are intensifying communication on their work and the results of their research. Researchers are called upon more and more frequently to take part in this communication, which is aimed at the economic world and political decision-makers, and which corresponds to institutional objectives. At the same time, universities and research organizations are more and more often challenged by the 'general public', who ask them to account for the economic, social or environmental effects of their work. What is at stake in the supply of and demand for science communication? Who are the various actors involved and what conditions their actions? Why and how are new forms of communication being built?

Keywords: attitudes to science, French universities and research organizations, knowledge economy, lay public expectations, risk psychoeducation, science and participatory democracy, scientific and technical culture, scientific citizenship, technoscience.

TODAY, French universities and research organizations are intensifying their scientific communication with the economic world, policymakers and, as it is commonly called, the 'general public'. This scientific communication is traditionally entrusted to internal communication services and, increasingly often, 'scientific and technical culture' assignments or services are created in French research institutions.

This can be considered relatively new, even if it is in touch with historical practices:

- The scientific community has always been closely linked to the world of 'informed connoisseurs', gathered together most often in 'learned societies'.
- Critical analysis of the deficit model has studied the practices of science popularization and updated its limits in a relevant way.

In both cases, the relationship of research with its partners is asymmetrical, based on the expertise that gives an undeniable authority to the scientist.

There is something new: these authorities and expertise are sometimes disputed or, worse yet, unrecognized and not taken into account by some when it comes to basing their choice of positions, even taking action. The world of research discovers, sometimes painfully, that some have taken it down off its pedestal and it must now deal with audiences who pose a challenge, questioning the omniscience / omnipotence relationship.

We will try to explain the context and context determinants in which this new situation is rooted. We will try to identify the different actors operating in this context and the games they play, which result mostly in tenders or requests to other actors. And behind this, what face-offs, policy options and strategies for action produce that result? What are the underlying issues in this new situation?

13.1 Knowledge has become an economy

The links between the world of research and the economy have only strengthened.

First, research is at the service of an economy that aims to meet human needs. This link is not new: the history of science shows us how, through the scientific innovations which it could give rise to, science was closely linked to the notion of progress in its industrial, social and human dimensions. However, science has long maintained a certain degree of autonomy from its industrial applications. More precisely, a predominance – often thought of as prior and logical, as it was chronological – was affirmed through the distinction between ‘pure’ or ‘basic’ science and ‘applied’ science. This dichotomy is hardly tenable today: ‘basic’ and ‘applied’ are intertwined and enrich each other. Basic research prior to its application is only rhetorical or a *petitio principii*. Just to be convinced, look at the number of research programmes in direct contact with objects and industrial processes and, especially, quantify the volume of credits that this type of research mobilizes. The current concept of ‘technoscience’ reflects the obsolescence of the basic /applied dichotomy.

In addition to R&D in private companies, public research – even in the humanities and social sciences – is almost always a partnership: partners and sponsors are financing much of the research in which they engage. Research has economic value today as long as it is accompanied by a process of ‘innovation’. The research director of a major French car company defined these two concepts this way. Research is the transformation of money into knowledge (and we still spend too much), and innovation is the transformation of knowledge into money (and it does not bring in enough). Research alone is not enough; it comes along with an innovation requirement and all French public research organizations expect much of their ‘innovation – commercialization of research’ services. The economy is not only related to research as a satisfier of needs but also as a producer of profit.

This relationship is embodied in the patent race. The result is a subtle alchemy between competition and cooperation in research. For this research to be efficient, two conditions are now highlighted: international networking and openness to interdisciplinarity. But, aside from these recommendations, the requirement for paternity, for being recognized as the first to have ‘found’ something, has an essential impact on profit. As a result, a scientific communication policy is somewhat paradoxical. In some ways, it emphasizes the culture of secrecy so that the research is not hijacked by competitors. In another way, every research laboratory of a certain size has secured the services of a communication officer. This person has a mission to build the ‘communication plan’ of any research, in which we pass, suddenly and dramatically, from the culture of secrecy to ‘media over-coverage’. It is in this way that we can organize the ‘paternity’ so essential in this knowledge economy.

Thus we see that, alongside scientific communication to the scholarly community of belonging, institutional communication for specific publics, goals and targets is developed. However, this institutional communication is also addressed to the 'general public' by manipulating it, and engaging it, in the processes of competition and recognition of primacy/paternity that the institutional communication serves.

Science and technology are fully and completely socialized. However, researchers and research institutions rarely leave their 'ivory towers'.

13.2 The image of science and the public's expectations

Beyond sensational communication, beyond the 'scientific scoop' that the media are so fond of, public expectations (or, more precisely, different audiences' expectations) of science communication are largely governed by the ambivalent attitude that they develop towards research and, more generally, scientific, technical and industrial culture.

In some ways, trust in science remains untouched. Scientific research will find out things, and those results will have implications for major changes that, ultimately, will improve well-being. Science still carries the image of a vector for technological, industrial, economic and social human progress. As the remains of a scientist ideology, omnipotent since the 19th century, this view of science is still very much present.

In other ways, for some, since a little over a quarter of a century ago in France, the attitude to science has gradually deteriorated to at best indifference and at worst outright hostility, often mistrust, suspicion, or even the feeling that it has deceived, betrayed.

Several reasons are highlighted; all refer in some way to the concept of well-being.

The first – probably the oldest and best shared – focuses on a number of adverse environmental or public health impacts of certain research results, or rather the technical, industrial, economic or social consequences that result. These consequences are considered as generating as much discomfort as well-being.

The second stems from the impression that the world of research and technoscience is corrupted by – or at least in collusion with – the world of the profit-making economy. The idea is that scientific and technical research is now serving more special interests than the general interest.

These two factors combined suggest that the scientific world has something to hide, that 'it' is hiding something.

The third reason is different and almost seems to contradict the previous two. Researchers are treated as 'doomsayers' who put rationality in the service of the announcement of possible disasters or at least of the need for vigilance and behavioural ethics if we want to avoid them. For example, research on climate change belongs to this problem. Science and its results become, again, an obstacle to well-being, in the sense of immediate and especially carefree gratification, even when the people do 'care' about the results.

This ambivalence (hope/mistrust) towards the technosphere does not, as some officials can believe naively, come from a cleavage of the French population into two separate classes. A subtle combination of these two seemingly antagonistic positions is possible. The same people may, at different times, in different situations, in different company and, especially, on different subjects, switch from one posture to another. For example, the majority of French people accept genetic engineering for medical purposes while refusing it for food.

However, from this nebula of social representations emerge some lines of force. Scientific research continues to enjoy a mostly positive image. On the other hand, research institutions, sponsors, policy-makers and users of results – even the government – have a poor image mainly associated with high suspicion. About researchers (as professionals and as citizens) 'we' ask questions, and 'we' strongly urge them to ask questions!

13.3 The wrong track of risk psychoeducation

Beyond frequent attitudes of misoneism or the refusal of uncertainty, the mistrust, even hostility, that can be shown towards technoscience and its innovations can only be perceived as irrational by the supporters of those innovations.

Hence the assimilation of these manifestations of hostility at worst with new forms of obscurantism, at best with fear – in other words, with chosen irrationality or passive irrationality.

Faced with this neo-obscurantism, the scientific community must respond in the most rational way possible. This is what ‘risk assessment’, this new science, tries to do. If fear is irrational, rationality must be reintroduced by mobilizing the concept of risk to study that fear: the subjectivity of irrational fear is objectified by the concept of risk.

So a new discipline is created, analysing and measuring risk. Rigorous techniques of risk assessment are implemented. Thus, institutional vigilance (often formulated in terms of the precautionary principle) introduces still more science, because technoscientific innovation is supplemented by scientific evaluation of the potential risks it may entail.

This scientific approach is accompanied by risk psychoeducation. What is this psychoeducation?

The distinction is made between ‘natural’ risk and ‘technological’ risk, which is assigned to a human cause. The line taken consists in promoting the idea that natural risks are more dangerous than most technological risks.

Risk for me, risk for another, risk for all; individual risk and collective risk. The concept of risk, although chosen because it is more rational than fear, would also be subjective. The proof is that each of us would be willing to choose and implement daily behaviour much riskier than that we denounce in some technoscientific choices.

Then there is the relationship between the severity and probability of occurrence of risk. Thus, a risk, even very serious, may become acceptable if it has little chance of happening (provided some statistical scientificity is ensured).

Moreover, a kind of ‘economy’ of risk is highlighted. It comes down to choosing the risk – benefit balance of a technology. Risk can be acceptable in terms of the intensity of the socioeconomic benefits that a technology can provide. In an overall context of opportunity, it is the question of whether the risk is worth taking.

This psychoeducation of risk tirelessly repeats that ‘zero risk does not exist.’ And some are likely to never want to take any risk. To say the least, this reluctance to take risks is selective: many are willing to take risks for health care but not for food.

The primary goal of this psychoeducation is to make everybody accept that any techno-innovation is intrinsically associated with risks and potential losses.

Finally, a number of risks would be very much exaggerated (if not purely fantasies) in the present cultural climate of 'risk phobia'. Experts – because they are better educated and informed than any layperson – would be constantly challenged in their attempt at rigorous and accurate assessment of any risk.

A 'barometer of risk perception and safety' has been established. The results show that the French are very likely to think we are not being told the truth about the dangers of a number of technologies. Making protocols public and multiplying agencies of independent experts do not seem to restore confidence. The 'crisis of scientific authority' has led some to question the merits of such protocols and the independence and reliability of such agencies for risk assessment. It is useless to attempt a rigorous approach to risk: the impossibility of proof (other than statistical), mistrust about scientific, political and economic institutions, and the impression that they are not telling the truth leave the door open to subjective beliefs.

Should we then continue to hide behind the objectivity of risk science even when it is not considered and much less accepted as such?

If the implementation of technical risk assessment is absolutely necessary prior to any public use of technoscientific innovation, communication in any way fails to meet the societal role that some would like to see it play. It does not contribute to reassuring 'the general public' and has no power of conviction.

Research institutions will have to use other methods of 'science information / communication'.

13.4 Science in a democratic society

If this communication of the results of risk studies failed to bring most people back to more rational thought, maybe we should advance the hypothesis that it is not (only) the technoscientific choices that are rejected but how those choices were made. Maybe many people expect research organizations to highlight not the virtues of rationality but those of ethics and democracy because we are in a society that has made democracy its working principle and its supreme value.

However, the world of science is not a world of democratic tradition, but rather ‘aristocratic’ tradition. The scientific elite is based on the principle of distinction conferred by the possession of knowledge. This distinction allows us to decide who is a scientist (members of the scholarly community inducted by solid rites of passage, such as examinations and competitions), and who is not. But this distinction is also prevalent within the scholarly community itself, which must establish a hierarchy of power of the ‘more’ learned and the ‘less’ learned.

We cannot change the fundamental nature of science to make it democratic, but rather combine science and democracy in two ways:

- The use that we make of scientific research results is likely to be determined democratically, and in this sense democracy is positioned against technocracy.
- Like any practice having collective implications, science is not outside the scope of policy and therefore cannot escape democratic control; in this sense, democracy is opposed to any aspiration of (scientific) bureaucracy.

In France there are lots of bodies which have legitimacy through democratic delegation. The most important is undoubtedly the Parliamentary Office for Evaluation of Scientific and Technical Choices. Many bureaus, many ethics committees are officially mandated by our democratically elected institutions.

Today that situation does not seem satisfactory to a large number of our citizens, for two interlinked reasons.

The first takes the form of a questioning of the practice of experts. Chosen for their expertise, many experts are now suspected of having conflicts of interest. Mistrust of experts is as significant as mistrust of the scientific research work they are supposed to assess and control. Thus we should begin by assessing the legitimacy of experts.

The second reason relates to the ideas some have of democracy. A current of opinion is no longer satisfied with a representative democracy today but would like to see our society move towards more participatory democracy. This means that these people no longer give full legitimacy to the choices made by their democratically elected representatives (or experts they have designated to do that).

Regarding technoscientific choices, it is with this in mind that some denounce a lack of democracy. For them, in what they see as a participatory democracy, we cannot deprive the citizen of his sovereignty even on the pretext of the lack of rigour, subjectivity, irrationality (or even irresponsibility) of his decisions. That is why citizens demand to be personally associated with technoscientific choices that are made.

Democratic consultation procedures exist in French society (the most emblematic is probably the public inquiry), but a process of consultation is not a decision process, or even negotiation. And we might not take account of its results, so many projects are implemented following a public inquiry the results of which are largely unfavourable.

Some initiatives of citizens associations have appeared (consensus conferences, hybrid forums, and so on), but we are in France, far from the political public engagement that we know in the countries of northern Europe and in Anglo-Saxon countries. In addition, these timid attempts have difficulties in the face of centralizing and technocratic French tradition that is reluctant to delegate to local and non-expert decision making. In this regard, the practice of research organizations is no more advanced than the government's.

For some (fewer, but very active), the challenging of technoscientific choices and the criticism of current research directions are only indications of a more radical questioning of the social model associated with them. Their position becomes explicitly ideological, questioning socioeconomic needs judged as artificial and strongly opposing the theory of planned obsolescence. For them, the debate should not be reduced to a discussion about risks but should become a discussion about societal choices.

13.5 Practices of scientific information and communication in research organizations

In universities and research organizations, the naive deficit model is not out of fashion as much as you might think. Many teachers and researchers – uninformed of assessments and research on this topic – still think that solid, relevant and effective compensatory teaching would be enough to see non-experts overwhelmingly (and magically!) embrace the technoscientific choices they offer.

Most managers are better informed and accept that it is better to shift towards public debate procedures. However (in a return of the repressed?), many of them condition this debate on prior information / teaching. The argument used is strong: there is no serious debate without the mastery of information and knowledge that will base the debate on the rule of reason. We cannot seriously debate about what we do not know. Thus ‘citizens’ conferences’ set up a preparatory teaching on several weekends for a panel of citizens before they discuss with experts. In addition to the heaviness of such a procedure, it has the drawback of being part of a democracy which is more representational than participatory.

But if we want to reach the greatest number, it is necessary to recognize that mental functioning is not like that: it does not require prior instruction. When we are faced with a problem, we first try to resolve it with the intellectual resources we have. It is only when those means do not seem sufficient or appropriate that we make an effort to seek out and try to acquire new ones. The need to learn is never before, but always following, a problematic situation.

As long as the public debate on scientifically and socially controversial issues is organized in the form of a debate of opinions, there is no chance that non-experts will be willing to make the effort of resorting to prior information / training. Hence the sense of sterility that this kind of debate generates. On the contrary, if the debate is intended to address a social, economic, technical, industrial, environmental or scientific problem, informational, notional, methodological and conceptual supports will be necessary.

Yet, even when attempts are made to organize a debate within a framework of rationality, another cultural context, more archetypal, cannot be eliminated. If we take the example of non-acceptance of genetically modified organisms (GMOs) in France, we must be aware of the significance of such a cultural framework. In this context, the French gladly accept genetic engineering for medical treatment, but refuse it for food. GMOs appear, in France, incompatible with the French culinary heritage (recognized by UNESCO!). GMOs, pesticides and other treatments, dyes and food preservatives (even if studies show they install a hygiene protecting us from infections) are at present not accepted. Most French citizens have an intolerance for all food that can be seen as artificial, and do not believe that this research will improve the taste and organoleptic, nutritional or cosmetic aspects of food. Even obtaining new varieties by conventional hybridization is disputed. However, the attraction to 'ancient' varieties of fruits and vegetables is strong.

GMOs will always be an insoluble lump in the paste of French gastronomy. French politicians, who have not followed scientists on this point, have not made a mistake. They agreed that the cultural argument might have more weight than scientific or economic arguments. This is not the return of irrationality or obscurantism (as some proclaim). It is rather an analysis in which the rational / irrational value has no meaning: we are in a field of 'a-rationality'.

13.6 Towards new scientific communication practices

The French 'general public' is not demanding further scientific learning; nor is it satisfied with risk information. It wants to debate rather than learn. While it accepts that new information can nourish the debate, it does not take this imposed information as a prerequisite for the debate.

But what can or should be the topic and form of this debate?

It is by focusing information on the societal impacts of any results of technoscientific research that the debate can focus on the issues involved. The debate is not, strictly speaking, a scientific debate; rather, it is a political, economic, industrial debate, most often with an ideological, a philosophical and (especially sought) an ethical colouring. It is in this sense that we can qualify this discussion as 'public debate'.

In this type of debate, scientists have a special status in that they carry information that others do not have. Nevertheless, this does not confer on them any prerogative over the conclusions of the debate or the choices and decisions that might ensue.

Yet it is the scientists, and even more the researchers, who are requested to debate. Mediators, facilitators, museums, science centres, scientific associations and the media (specialized or not) are accepted by default.

The request does not concern research institutions but the researchers themselves, almost personally, because they are not asked to communicate their results or ongoing research projects.

But about what, then? The answers may seem grotesque. They have to tell us what ‘they’ are hiding from us (because there is necessarily something hidden from us)! They must tell us! They have to be accountable! What game are they playing?

Some might consider this demand as childish, paranoid, or both, and thus unworthy of interest. Others may refuse to venture into this so irrational field.

Ultimately, the demand is a demand for reassurance. Many are waiting to talk with researchers to be reassured and finally have their confidence in science restored, when so many situations of abuse have been publicized.

However, this demand for reassurance is closely related to citizen participation in technoscientific choice in our society. It may appear contradictory: the idea of participatory democracy means responsibility, but reassurance evokes the idea of dependence on a scientific ‘power’. In fact, the paradoxical duality of this demand echoes the ambivalent image of trust/distrust of scientific research, of which we spoke earlier.

We need to ask: is it really for research institutions to do this work, to implement this type of debate?

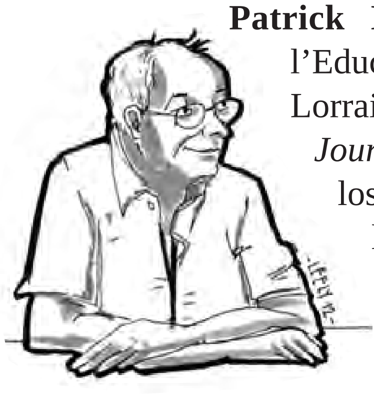
This question is not technical: have they the financial and human material, know-how and tools to do this? This is a substantive issue.

Nobody else can do it for them. Professional mediators are not considered legitimate (they have no ‘mandate’ to intervene in this field of ethics and deontology), and the political and economic powers are not considered trustworthy.

In fact, research institutions respond more readily to the demand for reassurance rather than the request for participatory democracy – a ‘lazier’, more ‘comfortable’ response, to the extent that it does not involve an inquiry into the sociopolitical space of research in our society and the institutions that do it.

Ultimately, the political stakes are high: the ‘general public’ becoming a full scientific citizen. That is to say that citizens may and can build positions and make choices in the full knowledge of causes and consequences.

The author



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14

Science communication in India at a crossroads, yet again

Gauhar Raza and Surjit Singh

Abstract: In India, as in any society, scepticism runs in parallel with dogmatism throughout history. A society must be judged by the dominant philosophical consciousness that determines the social, cultural and intellectual thought structures and consequently the actions of the common citizen. In societies with histories stretching back to antiquity, thought structures form along a continuum that undergoes phase shifts and, at times, discontinuities. This paper deals with the history of the two trends in ancient and medieval India and places science communication in India into a historical perspective. It then briefly discusses the introduction of the communication of modern scientific ideas. We argue that during the colonial period the freedom movement operated as the most effective channel for spreading the 'scientific temper'. After independence, resolutions passed by the Indian parliament became the guiding force shaping Indian science. In recent times, the search for a stable ideological basis that could form the basis for the construction of science communication models has led to intense debate on scientific temper. The paper analyses recent new initiatives in this area.

Keywords: scientific temper, public understanding of science, communication, media.

14.1 Introduction

14.1.1 Cross-fertilization of ideas and information before the British Raj

ON THE INDIAN subcontinent, both philosophical and methodological scepticism have their roots in the ancient era. Many schools of thought – such as Buddhism, Charvaka philosophy (Chattopadhyay 2009) and Jainism (Kalghati 1969) – had strong undercurrents of scepticism. However, the dominant philosophical stream did not accept scepticism during either the ancient period or the medieval era. An 11th century traveller, Alberuni, a mathematician, gave a detailed account of developments that were taking place in social, religious, philosophical and scientific spheres of intellectual endeavour. He vehemently criticized Indian scholars for their 'haughtiness' and said '… if you tell them of any science or scholar, in Khurasan [north-eastern Iran] and Perisis [south-western Iran], they will think you to be both an ignoramus and a liar.' He attributed this 'haughtiness' to socially constructed caste rigidity, which forbids Hindus (Indians) from mixing with intellectuals of other countries or even members of other castes within India. He acknowledged that 'their ancestors were not so narrow-minded as the present generation is' (Sachau 2002: 6).

Rigid socially and culturally constructed religious caste boundaries were porous (Raza et al. 2002) and could never completely stop cross-fertilization, so the flow of ideas and information from other cultures to India continued. Virk Zakaria informs us that 'During the Mughal rule of India, science & technology developed mainly due to the interests of Emperors and Sultans, particularly in astronomy, agriculture, engineering, architecture and medicine' (Zakaria n.d.). Despite cultural and attitudinal barriers, the flow of information was never unidirectional. Instead, it increased as the modes of communication improved. For example, Zakaria points out that 'Maharajah Sawai Jai Singh (d. 1743) was an astronomer of the first order. He had some Greek works on mathematics (including Euclid) translated into Sanskrit as well as more recent European works on trigonometry, logarithms and Arabic texts on astronomy.'[1]

1. Maharajah Sawai Jai Singh established five observatories in five cities (Delhi, Mathura, Banaras, Ujain and Jaipur).

Tipu Sultan (d. 1799) was probably the first Indian king to acquire a telescope, and is also credited with the invention of solid-fuel-propelled rockets with iron casings. This could not have been possible without a flow of scientific and technological information from other cultures.

14.1.2 The British Raj, the resistance movement and the scientific temper

The 16th, 17th and 18th centuries were the most productive period in the history of ideas. The European Renaissance, followed by the scientific, technological and industrial revolutions, unleashed human cognitive energy.

British imperialism established its military, political and economic hegemony over the Indian subcontinent by the mid-19th century (Raza et al. 2012). On the one hand, in order to provide an ideological basis for the continued exploitation of the subjugated people, the imperialists appropriated the 'enlightenment project'.[2] On the other hand, the resistance movement taking shape on the subcontinent enabled the communication of modern scientific information from west to east at a much faster pace. In order to administer the Raj, an education system was put in place and colleges and universities with science and mathematics departments were established (Sen 2002: 47–48). The Indian resistance movement, represented by Indian National Congress, needed to construct an inclusive Indian identity that would embrace the aspirations of all sections of an utterly fragmented mass of people. That identity, based on modern ideas travelling from the west, had to be secular.

Many of the ideas that the Indian freedom movement committed itself to were opposed to the shared cultural, philosophical and religious tenets that were practised on the subcontinent. For example, a hierarchy of caste and untouchability stood in direct conflict with the notion of equality of humans. Similarly, equal voting rights,

2. The 'white man's burden' – to civilize the uncivilized world – was an ideological tool to subjugate the minds of the people. However, reluctantly, Christian missionaries communicated scientific ideas to the uncivilized. Eventually, for the efficient exploitation of the enslaved, this led to establishment of modern systems of education in most colonies.

democracy, gender equality, universal education, health for all and science and technology (S&T) for building the nation were notions alien to the native population.

It was during the freedom struggle that the Indian identity was constructed, and the scientific leadership played a major role in forging it. The notion of 'scientific temper' was not just a by-product of this struggle: it gradually became the essential component defining the *self* (India) against the *other* (British imperialism).

14.1.3 The scientific temper

Discussions on issues of science and its relationship with society, science education and its role in building the future India, and the importance of communicating science to the lay public began with the emergence of science societies in the 19th century (Venkateswaran 2007).

As stated by Jairam Ramesh (2011), the first Prime Minister of India, Jawaharlal Nehru, who had long been thinking about these issues, articulated the notion of scientific temper during his imprisonment from 1942 to 1945. He wrote that:

> Science has dominated the Western world and every one there pays homage to it, yet the West is still far from having developed the real temper of science. It has still to bring the spirit and flesh into the creative harmony of science. (Nehru 2004)

He pointed out that in India we were at a greater distance from the scientific temper and that there was an urgent need to inculcate it among the masses. Let us look again at Nehru's carefully chosen words and the context in which he wrote them. In 1945 the Raj was about to end, and Nehru's prime concern was that the temper of science in India had not yet fully developed, while the *other* (the west) to an extent already had it. He went beyond merely recognizing what he considered to be an important feature of the *other* and defined the direction of indigenous efforts. He asserted that, first of all, every citizen should pay 'homage' to science and then try 'to bring the spirit and flesh into the creative harmony of science'. Nehru saw 'creative harmony in science', which for him was the basis of the scientific temper. Nehru's scientific temper reveals itself in individual and collective attitudes towards all problems, mundane or complex, local or national or even international.

14.2 India wins freedom

India as a nation state was born in 1947. Indian identity, until then a theoretical construct, was to be translated into reality. The exercise of writing the constitution of India was an effort in that direction. The constitution granted rights and listed duties that were not rooted in Indian culture or the dominant philosophy[3] – such as the notion of equality of human beings, gender parity, jobs for all, equal democratic rights, universal education, and S&T for nation building – and were the antithesis of the prevailing social order that determined and still determines the consciousness of the majority. Soon after independence, the debate on the Scientific Policy Resolution began. The resolution was published on 13 March 1958 and placed before the two houses of the parliament. India was the first country to pass such a resolution (Vasantha 2000).

The resolution focused on harnessing natural resources, overcoming resource deficiencies, cultivating science on a large scale, building an industrialized country, training scientific professionals and creating an environment of respect for scientists. It also recognized that science 'has not only radically altered man's material environment, but, what is of still deeper significance, it has provided new tools of thought and has extended man's mental horizon.'[4]

Three major national conferences of scientists, technologists and educationalists were held in 1958, 1963 and 1970 to seek their advice and to monitor the implementation of the resolution. Referring to the 1970 conference, B.M. Udgaonkar wrote that the resolution was 'an admirable document' and credited it for a five-fold increase in spending on S&T. The large increase in the number of universities

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3. Constitution of India. Retrieved 28 July 2012 from http://www.india.gov.in/gov/documents/english/coi_content.pdf.

4. Scientific Policy Resolution, New Delhi, 4 March 1958. Retrieved 28 July 2012 from www.dst.gov.in/stsysindia/spr1958.htm.

and scientific and technical institutions and in S&T manpower over the 12 years to 1970 was also attributed to the impact of the Scientific Policy Resolution (Udgaonkar 1970). Udgaonkar put the number of these institutions in 1979 at 900, and the stock of S&T manpower at two million (Udgaonkar 1980). This phenomenal growth was dotted with discussion, disputes, criticisms and disappointments (King 1982).

14.2.1 Institution building

India's S&T infrastructure grew rapidly during the first 30 years of independence. Jayaraman (2009) argues that 'By the 1980s India had already developed a science and technology establishment that had few parallels among developing countries.'. During this period, six major focus areas emerged: industrial, nuclear, defence, space, agricultural and health. S&T education was also expanding through the establishment of central and provincial universities. Indian institutes of technology were established in various corners of the country as centres of excellence.

The tension between the Soviet Union and the west determined the nature of international relations in that period. Secrecy, animosity, lack of trust between countries and espionage were the hallmarks of the era. For the western countries, India was a big market, but they refused to transfer technology that could make it self-reliant. For example, the United States refused to supply technology to produce ordinary balloons for fear that India might use it for military purposes (Raza et al. 1994). Thus, for India this period was one of reverse engineering, 'appropriate' technology, rural technology, and so on. Scientific organizations, including those working on cutting-edge technologies, were often called on to solve ordinary problems. The Council of Scientific and Industrial Research developed technology to produce milk powder for baby food (Mashelkar 1998). High-yielding varieties of agricultural products (ICAR 2010) and drugs for common diseases (ICMR 2010) had to be developed indigenously.

There were many other denials of technology transfers. However, this kept working Indian scientists in touch with the common people, and in the process a lot of science was communicated to the people. Many large networks communicated S&T information to the people in their own language (and often in their dialect), such as the networks of primary health care units (of which there were 23,109 in 2005) and agricultural extension centres (49 research institutes, 17 national research centres, 607 Krishi Vigan Kendra (Agricultural Science Centres) and 52 state agricultural universities in the 1970s and 1980s). A UN report observed that 'Agricultural research and extension has undoubtedly contributed profoundly to development, as demonstrated by the Green Revolution' (FAO 1996). The education system became the largest channel for science communication (Raza & Singh 2007).

14.2.3 The Statement of Scientific Temper

The 1970s and 1980s were a period of political turmoil. The state was unable to match the aspirations that the Indian people had developed during the days of the freedom movement. Grappling with adversities, the political leadership tried to bring about many constitutional changes. In 1976, through an act of parliament, India became the first country in the world to declare that 'it shall be the duty of every citizen of India to develop the scientific temper, humanism and the spirit of inquiry and reform.'[5]

Nehru's vision of a nation with a scientific temper went beyond the laboratory. He wrote:

> The scientific approach and temper are, or should be, a way of life, a process of thinking, a method of acting and associating with our fellow men … Science deals with the domain of positive knowledge but the temper which it should produce goes beyond that domain.

This vision was being pushed to the back burner, but a group of concerned scientists and social scientists took a plunge to reassert it. In 1981, the Statement of Scientific Temper was published, signed by about 40 leading scientists and social scientists.

5. Part IV-A, Article 51-A (h), Constitution of India. See also Jahagirdar (undated ebook).

14.2.4 The People's Science Movement

In 2009, we proposed that the interests of the state and the interests of the left-of-centre resistance movement were synchronized in the initial period after independence. Although the two forces had different reasons for propagating science and the scientific temper among the common citizens, both committed themselves to the effort (Raza & Singh 2009).

That cooperation reached its zenith in the mid-1980s and, despite cracks, continued until the mid-1990s (Parameswaran n.d.). With the financial support of the state, a group of science NGOs came together in 1983 to conceive a mammoth mass contact programme for communicating science. It took four years of planning and coordination to organize what is known as Jan Vigyan Jatha (1987), a massive procession of scientists and artists in which 50 million citizens participated over a period of one month. It was probably the largest science communication project undertaken anywhere in the world up to that time. The intense campaign unleashed human energy that resulted into many spin-offs, such as the National Literacy Campaign, Joy of Learning, the Solar Eclipse Campaign, the Anti-Superstition Campaign and an anti-arrack (anti-alcoholism) campaign (Raza 2010).

14.3 The end of bonhomie

By the mid-1990s, the bonhomie between the state and the resistance movement had started withering away. The cause could be located in the widening of the ideological rift between the two.

This phase – the second half of the 1990s and the first decade of this century – was typified by the spread of the 'market economy', globalization and the withdrawal of state intervention in the market. The Indian state drifted rapidly towards privatizing the education sector, health services, water and power distribution systems, and other state assets. Disinvestment in the public sector was popularized as a virtue, and the dismantling of the Nehruvian structure of the economy gained pace.

The left political parties and their mass organizations opposed globalization, privatization and public sector disinvestment; the right, when it came to power, accelerated all three processes. Notions of the welfare state and the public good were no longer part of the nation's intellectual discussions.

As the Nehruvian model of development was dismantled, the constitutional duty to develop the scientific temper, the spirit of enquiry and reform also disappeared from popular and political discourse.

However, India's gross domestic product rose quickly and has since been maintained. Many scholars argue that that once we achieve a high level of technological growth, the common citizen will necessarily acquire the scientific temper.

14.3.1 Mass media: structural changes in TV and print

In India, telecasts began in 1959 on government-owned channels. The industry was relatively underdeveloped until the 1970s, when the Doordarshan national channel expanded its coverage. Colour TV arrived in the mid-1980s.[6] In 1991, for the first time, private companies were allowed to establish TV channels and produce and telecast programmes and news. The number of channels grew phenomenally over the next 20 years, from five in 1992 to 600 in 2010 (Deloitte 2011).

The industry's revenue increased from US$4.5 million in 2007 to US$8 million in 2010. Its reach increased from 45 million households in 1993 to 131 million in 2010.

This expansion provides opportunities not previously available to communicate science to the mass of the people more effectively. However, since their inception, the private channels have operated on an advertising-based business model. Nine of the top 10 advertisers on TV sell fast-moving consumer goods, and between them account for over 45 % of TV advertising volume. The telecommunications, automobile and consumer durables sectors have also taken to TV advertising in a big way (ASSOCHAM 2010: 10). A major share of advertising revenue flows to a handful of channels, and the advertisers are interested in selling their product, not in supporting any public science communication effort.

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6. http://www.ddindia.gov.in/Kendra/Delhi/Program+Column+3/delhi.htm, retrieved 16 August 2012.

Vigorous competition to survive has led to unethical practices, including paid-for programmes and appearances by anti-science gurus (palmists, fortune-tellers, Ayurveda drug sellers, etc.) and religious leaders.

Private investors have not come forward to launch science channels, and of course no scientist is ever likely to pay to appear on television. In this situation, the bandwidth for communicating science through TV is quite narrow. Therefore, it is government's responsibility to reach the citizen through this medium.

14.3.2 The impact of the private TV channel business model on mass print media

The number of registered newspapers in India during the 2011–12 financial year was 82,222.[7] In contrast to the reduction in mastheads and circulation in the United States (Varian 2010), both have increased rapidly in India over the past few years (Hansa Research 2010).

The Indian press, including both English and Indian language newspapers, began early in the 19th century, before the Indian freedom movement began to coalesce into an organized political force, and became the mouthpiece for public opposition to the British Raj (Dutta 2011). The press played a crucial role in strengthening the freedom movement and continued to reinforce modern values even after independence.

The character of the state has been reflected in the print media. The press often compromised with anti-science forces and at times became a vehicle for spreading superstitions, but by and large these were aberrations (Raza & Singh 2009). Almost all newspapers included horoscopes, but never reported astrological predictions as fact.[8] Science was always allocated a very small space – less than 1.2 % across the newspapers (Arya 2007) – but was always treated with care (Dutt & Garg 2000).

Globalization, privatization and structural adjustment, which completely changed the nature of India's electronic media, also had a

7. Registrar of Newspapers for India, Government of India, http://rni.nic.in/

8. Indian print media is not alone in publishing horoscopes – see Allum & Stoneman (2012).

serious impact on the private print media (Nagaraj 1997). Before the 1980s, the privately owned newspaper and magazine industry ran on subscriptions, so the advertising revenue merely subsidized the cost of production and circulation. This meant that every newspaper focused on increasing circulation and reaching out to new sections of society.

The emerging television industry presented a different business model. Soon the leaders of the print media realized that they, too, could sustain themselves from advertising. This realization brought about a conscious structural shift in the newspaper industry. First, a price war began between leading newspapers, bringing down the cost per copy to the consumer. Second, competition for advertising share became more vigorous. Third, the number of pages in each edition increased to accommodate advertisements. Fourth, those newspapers that could not attract enough advertising revenue went out of production.

A typical Indian national daily consists of 50 to 100 pages. The cost of production, including infrastructure costs, salaries and other costs, varies between 25 and 40 rupees per copy.[9] The per-copy price varies from about 2.5 to 6 rupees (US$0.05–$0.11). This means that every copy or news item printed that does not bring additional advertising is a substantial loss to the newspaper. Advertisers will not pay to advertise to readers who do not have the purchasing power to buy their products. Therefore, the news, feature and editorial content is reduced to devices that help advertisers reach the potential buyer.

By 2000, the marketing division had gradually become the most important department of every newspaper. The freedom of editorial staff to decide the content or even column space is quite limited. An advertisement gets precedence over a news item, and last-minute changes in content at the direction of the marketing department are a daily occurrence in most newspapers.[10] The space available for

9. It is not possible to compute the real cost of production more accurately because reliable data is not available. The media corporations have broken their publishing operations into smaller segments, and their balance sheets do not reflect real income and expenditure. The figures quoted are based on an interview with Nilabh Mishra, who is the editor of a reputable magazine, *Hindi Outlook*. He has served many newspapers in different capacities.

10. Interview with Siraj Naqvi, senior journalist, *Sahara Urdu* daily. Naqvi said that on 14 August 2012 he received instructions from the marketing division

editorial content is restricted and the content and nature of stories is determined by the interests of the advertiser. For example, a story that shows the adverse effects of a particular pesticide or a drug is not likely to be published if it is going to adversely affect the market share of a company that is advertising its products in the print media.

14.3.3 Four national agencies with mandates to communicate science

We hypothesize that the new commercial paradigm structurally restricts space for S&T communication through print media, and that the mass print media have become increasingly opaque as channels for transmitting scientific information. We share the concern expressed by Dutt and Garg (2000) that 'Science hardly gets coverage in a prominent position unless it has socio-political ramifications at national or international level. Only a very small proportion of items get front page positioning …'.[11]

In these circumstances, the role of India's national institutions involved in science communication becomes even more important.

National Institute of Science Communication and Information Resources

During its initial phase, the debate on scientific temper was carried out among India's practising scientists, who felt the need to communicate more efficiently among themselves and with the public at large. Consequently, the Council of Scientific and Industrial Research established the Publication and Information Directorate in 1951.

The directorate's mandate included publishing research journals in specialized areas of science[12], along with three popular science

of his paper that three full-page advertisements had come in. He removed three pages of articles and news stories for the 15 August edition. In such cases, S&T news and features are often the first to be spiked.

11. Max Boykoff, in an article about Indian media representations of climate change, reinforces this view: 'The general increase across all regions to end 2009 is clear. The volume of coverage at the end of 2009 was about five times greater than that at the turn of the millennium' (Boykoff 2010).

12. The number of journals rose to 19 over 50 years.

magazines, *Science Reporter*, *Science Ki Dunyan* and *Vigyan Pragati*, in three Indian languages and with a combined circulation of more than 100,000 copies a month. Practising scientists have since continued to publish popular science articles in these magazines.

The directorate was given the status of an institute in 1996, and in 2002 it became the National Institute of Science Communication and Information Resources. The institute's mandate now includes the construction of a national database of science and the popularization of science through new media.[13]

National Council for Science and Technology Communication

The Department of Science and Technology (DST) was established in 1971 with mandates to popularize S&T and to frame policy and guidelines (DST 2005). Publishing popular science magazines was not sufficient to cater to emerging needs, so the National Council for Science and Technology Communication (NCSTC) was carved out from within DST, with a separate budget, to communicate S&T, stimulate the scientific and technological temper, and coordinate and orchestrate communication efforts.

During its life, the NCSTC has been through many phase shifts. We can place its projects into three categories, according to how they have been executed: through the NCSTC itself, through NGOs and individuals, and through government agencies and universities. Over the past few years, the NCSTC has supported regional and local-level projects, rather than undertaking national-level programmes.

The overwhelming majority of NCSTC projects are small in terms of funding. During the period from 2004 to 2011, only 1.8 % of all projects were worth more than US$100,000. The council's efforts are thinly spread, and today it stands at a crossroads in its decisions about future policies.

Vigyan Prasar

Another organization entrusted with science communication is Vigyan Prasar, which is an autonomous organization under the DST. The main objectives of Vigyan Prasar are to take up large-scale

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13. www.niscair.res.in/ScienceCommunication/sci.asp.

science popularization tasks and activities, to promote and propagate a scientific and rational outlook, and to act as a resource-cum-facility centre for S&T communication.[14] Its main activities have been the production of popular science books and video documentaries, but it has also run many national-level programmes.

However, many Vigyan Prasar activities overlap with those of the NCSTC, and recently there has been a realization that the two bodies must demarcate their spheres of responsibilities and action.

National Council of Science Museums

The National Council of Science Museums, an autonomous society under the Ministry of Culture, was formed in 1978. The council's major objective is to portray the growth of S&T and their applications in industry and human welfare. Its mandate includes developing the scientific attitude and temper; creating, inculcating and sustaining a general awareness among the people; and popularizing S&T in cities and rural areas for the benefit of students and the common man by organizing exhibitions, seminars, popular lectures, science camps and various other programmes. Today, the council administers 27 science centres, museums and planetariums all over India.[15] These centres are visited by 12.5 million visitors yearly (Rautela 2012).

14.3.4 Other large organizations that communicate science

In addition to these four main organizations with responsibilities for communicating science in India, other groups that contribute to scientific awareness include the Indian Council of Agricultural Research, the Indian Council of Medical Research, the Indian Space and Research Organisation, the Department of Atomic Energy, the Defence Research and Development Organisation and the University Grants Commission.

14. http://www.vigyanprasar.gov.in/index.asp.
15. http://www.ncsm.gov.in/about.aspx.

14.3.5 New initiatives

The four apex bodies responsible for S&T communication in India have come together during the past year to pool their expertise, experience and resources so that they can make a bigger impact.

This has led to a search for the ideological basis of the scientific temper and the organization of one national and two international conferences on the subject. The 1981 Statement of Scientific Temper was revisited and the Scientific Temper Statement 2011 (which is known as the Palampur Statement) was adopted in an effort to regenerate the debate about the notion of scientific temper and to direct activities and fulfil the constitutional obligation to communicate S&T.

14.4 Conclusions

India, with a tradition of scepticism and a heavy baggage of superstitions and religious dogmatism, has repeatedly rediscovered itself.

After independence, 'spreading the scientific temper' was propounded as the basis for science communication. Instead of reinforcing the efforts to communicate science, globalization, privatization and economic structural changes have pushed the agenda to construct a scientifically tempered society onto the back burner.

India needs to redefine the notion of scientific temper in the current context, and the state needs to carry out its constitutional duty to spread the 'scientific temper, spirit of enquiry and humanism'. India's four leading institutions with responsibilities for S&T communication have pondered over these tasks and revised the Statement of Scientific Temper. Their emerging shared understanding will be the foundation for all their future science communication activities.

The most important lesson that can be drawn from the Indian experience is that scholars, communicators and researchers must continuously discuss the ideological basis for current and potential communication methodologies. Science cannot be communicated in an ideological vacuum.

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15

Science communication in Latin American countries: Some comments on its current strengths and weaknesses

Carmelo Polino

Abstract: The recent economic growth of Latin American countries has revitalized science and technology policies and allowed the issue of innovation to be incorporated into the agenda. Despite the fact that theoretical and empirical research on contemporary science communication is not fully articulated and consolidated in the region, the evidence suggests that in the countries where national S&T systems have grown faster science communication practices have also increased in size and reach. This paper outlines a preliminary evaluation of the field in the region. However, my comments are not intended to reflect the situation in all the countries. To do that it, would be necessary to have a large comparative programme of empirical research, which is not available yet. Nor is the idea to map the huge diversity of communicative practices exhaustively: they also vary greatly depending on levels and contexts (national, institutional, commercial, etc.). Therefore, I focus mainly on Argentina, Brazil, Colombia and Mexico, where S&T systems are more dynamic and account for most of the R&D done in the region. However, many of the observations I make could be used to describe other national circumstances. For practical reasons, I select a few areas of inquiry: science communication practices in universities; the mass media and the cultural industry; and the publics' level of interest, information and participation in S&T.

Keywords: science communication, Latin America, mediatization, mass media, scientific institutions, universities, public interest and participation.

15.1 Introduction

THIS PAPER outlines a preliminary evaluation of the science communication field in Latin America. However, it is necessary to make two clarifications. First, I comment here only on large tendencies; specific and even particularly important situations can be ignored or relegated. Second, although the scope of the paper is 'Latin America' as a region, with common ground and shared agendas at many different levels, I am not sure that my reflections can be extended to all the Latin American countries. For example, my comments apply well to countries such as Argentina, Brazil, Columbia and Mexico, but not so well to Bolivia, Panama or Paraguay.

S&T systems in Latin America and in specific national situations are extremely diverse, but it is essential to acknowledge that Latin American countries' capacity in science, technology and innovation is weak compared to capacities in other regions, particularly in industrialized countries.

The region today plays a very secondary role on the international S&T stage. In 2009, Latin America contributed only 2.2 % of the total global R&D effort (RICYT 2011). However, and this is not a contradiction, we must also say that the economic growth of Latin American countries in recent years has revitalized S&T policies and allowed the issue of innovation to be incorporated into the agenda. Regional R&D investment grew faster than in Europe, the United States and Canada, behind only Asia (RICYT 2011). There has been a political shift to develop knowledge economies. Some areas of biotechnology, nanotechnology, information technology and food technology have experienced considerable expansion.

Nevertheless, there has been extreme diversity among countries. Brazil, Mexico and Argentina have seen greater relative development, although with remarkable differences between them. Brazil, particularly, has played an important role in increasing funding and consolidating structures for science research and innovation. These countries are responsible for most of the regional expansion: they contributed more than 80 % of regional S&T investment. In addition, in 2009 Brazil accounted for close to half of the full-time researchers and engineers in Latin America. Together, these three countries accounted for over 85 % of the total number of researchers in the region (RICYT 2011).

I consider that these indicators are enough to give a general picture of the relative importance of countries like Argentina, Brazil and Mexico (and, behind them, Colombia and Chile) compared to the rest of countries in the region in terms of S&T capacities and institutional trajectories.

Moreover, despite the fact that theoretical and empirical research on contemporary science communication is not fully articulated and consolidated in the region, the evidence suggests that in the countries where national S&T systems have grown faster (Argentina, Brazil, Colombia and Mexico), science communication practices also have increased in size and reach (Polino & Castelfranchi 2012b).

Therefore, my comments do not reflect the situation in all the countries in the region. To do that it, would be necessary to have a large comparative programme of empirical research, which is not available yet. Nor is the idea to map the huge diversity of communicative practices exhaustively: they also vary greatly depending on levels and contexts (national, institutional, commercial etc.). For that reason, I focus mainly on the mentioned countries where S&T systems are more dynamic and account for most of the R&D in the region. Obviously, despite this, many scholars could also agree on the fact that some of my observations could be used to describe other national circumstances. For practical reasons, I select a few areas of inquiry: science communication practices in universities; the mass media and the cultural industry; and the publics' level of interest, information and participation in S&T.

15.2 Universities: technoscience and science communication

It has been repeatedly said in the context of technoscience that 'scientists communicate in new ways, for new purposes and in a more profound way to play a role in public discourse about science' (Castelfranchi & Pitrelli 2007: 94). The new institutional sociology of science, when examining university environments for new forms of knowledge production and institutionalization, appreciates the extent of this phenomenon (Vinck 2010). Laredo and Mustar (2000), for example, claim that 'scientific culture' is one of the five vertices of relationships that organize the activities of modern laboratories. They understand scientific culture as the practices in which laboratories cultivate information, public scientific knowledge, and popularization processes of participation and relationships with the media.[1]

Actually, the spectrum of science communication practices has experienced incremental transformations according to the emergence of new forms of knowledge production, orientation and validation (Etzkowitz & Webster 1995; Gibbons et al. 1997, Nowotny et al. 2001). Concurrently, it has also been affected by social groups and social movements that have established new forms of relationship in which 'society' has increasingly become the key to understanding the political evolution of modern democracies (risk, participation, regulation, deliberation, governance, etc., are common words within this framework). Finally, science communication practices reflect global changes modulated and, in certain aspects, controlled by the mass media and the new technologies of information and communication.

As a consequence of these interconnected processes, science communication has become a structural attribute in technoscience: S&T practices are today hard to imagine apart from communicational strategies in the public arena. Just as it can be argued that technoscience has reduced the distance between basic research, application and use (Gibbons 2000), this phenomenon can be seen in the field of communication: technoscience has shortened the spatial and temporal distance between scientific and academic institutions and social communication.

The universities are distinctive agents in Latin America and play an important role in R&D. They execute 36.6 % of regional R&D, compared with averages of 17.1 % in the OECD countries, 14.3 % in the United States and 22.1 % in the European Union (EU-27). It is acknowledged that these institutions have three duties: to teach, to research, and to engage in 'extension' (that is, to diffuse and transfer knowledge to generate social inclusion and social transformation).

1. The remaining vertices are described as 'certified knowledge' in the form of peer reviewed papers published by academic journals; 'embodied knowledge', present in individuals through education and socialization processes; 'innovations', through cooperation with other actors who have different operating logic (industries, hospitals, etc.); and 'collective profits' – the ways in which laboratories contribute through knowledge production and expert advice to the objectives pursued by the authorities in public health, the environment, safety (health, food and defence) and transport.

Therefore, the seminal idea of communicating science is not new at all. In fact, science popularization is deeply connected with the emergence of the universities as crucial social institutions in the framework of the independent processes and the construction of the Latin American states.

Traditional university science communication practices associated with ‘diffusion’ or ‘popularization’ have experienced a strong impetus over the past 10 years. This is particularly true in Argentina and Brazil if one takes into account the expansion of the editorial market or the creation of TV programmes and shows devoted to S&T. However, in some aspects science communication has also been reinterpreted and reinforced – at least discursively – due to external pressures that claim new roles for the universities. Communicative practices in technoscience cannot be dissociated from the urgencies and, therefore, from the conflicts that typify the evolution of the new economy of innovation. These pressing situations have solidified the relationships among governments, industries and universities, as exemplified by the ‘triple helix’ metaphor. Etzkowitz (2001), among others, indicates that knowledge utilization, social impact, innovation and commercialization have gained importance within the context of classic universities. However:

> [T]he region is exposed to global pressures and trends similar to those in the developed countries (S&T policies; intellectual property rights; relationships between government, university and market; public participation, inclusion and engagement in S&T etc.) but, at the same time, is subject to very diverse and very specific boundary conditions and historical trajectories. (Polino & Castelfranchi 2012b)

Because S&T in Latin America mainly occurs inside the universities, in many fundamental aspects it is academically oriented in its practices and values. This framework allows us to understand why many science communication activities are conceived and still follow the ‘deficit’ model.

If one takes a quick look at what happens in the main universities, one can see how many of the international trends that affect science communication have also appeared in Latin America. The structural conditions outlined above have altered the purposes and ways in which universities communicate with society. It is quite common to hear or read that public communication is today not only a cultural duty but an essential need. The search for visibility, legitimization, funding and alliances – and the need for negotiations and dialogue with different stakeholders – generate new impulses for science communication. This comes out more clearly in those countries where R&D is stronger or where public policies are being incrementally oriented to innovative processes:

- More and more faculties, research labs and universities are consolidating formal structures for science communication.
- Scientists and managers acknowledge the importance of training scientists to communicate.
- Linkages between scientists and journalists are more common than in the past.
- In recent years, some universities and scientific institutions have called for projects on science communication launched by governments. This is well consolidated in Brazil, has gained weight in Colombia and Mexico, and has taken its first steps in Argentina.
- The rhetoric of engagement, dialogue and public inclusion is on the stage.
- Scientists have tended to gain salience in the public sphere and are participating in wider social debates. This phenomenon is connected with new political tendencies and has gained particular force in Argentina, at the same time that intellectuals, scientists and public figures in general have recovered their public role.

Nevertheless, there are major restrictions that must be pointed out:

- 'Everybody' acknowledges the importance of the institutionalization of science communication groups and press offices. However, despite this, scarce funding is a fundamental restriction: most of these groups have no guaranteed budgets or permanent positions to produce science communication materials, so many of their practices are voluntary.
- Another structural and quite important restriction is the lack of institutional recognition. Despite things changing very slowly, scientists are not clearly stimulated to communicate. Often, these practices are considered to be 'decorative' from the scientific career perspective. The consequence of this is evident: the system tends to incorporate only those who are already convinced and to reject new talent.
- Finally, another problem is the conception of communication and the perception of the public that underline many institutional

initiatives in science communication and science popularization. Even with strong evidence showing why the deficit model does not work and how it produces a distorted image of S&T (Bucchi & Trench 2008), many university efforts in science communication are still inspired by or oriented to that model. Many scientists often deal with journalists in pedagogical terms: they assume that journalists need to be educated (obviously, by the scientists). This produces an obvious tension, which is recreated many times in public lectures, talks and media interventions.

15.3 The mediatization process: technoscience and mass media

The second aspect goes directly to another structural condition that affects science communication in very different ways. I refer to all the remarkable qualitative aspects that have changed over the years because of the influence of the mass media. Today there is nothing controversial in affirming, as Habermas (1981), Thompson (1995) and many others stated long ago, that the mass media are one of the most important modern institutions. The expansion of traditional mass media within industrial society (newspapers, radio, TV) and, later, the new media from the information society, have produced that media industry and the economy that it supports. The mass media now have an extraordinary capacity to influence political and personal life: they affect economies, power structures and social representations of the world, public affairs and everyday life.

The tradition of media and cultural studies has been in part a history of developing models, theories and concepts to explain the ways in which the mass media exert influence. The concept of 'mediatization' has recently been coined to indicate that, in so far as the mass media have emerged as one of the key institutions of modernity, many other social institutions (such as political and economic structures) have suffered an incremental process of mediatization. This process has two main aspects: on the one hand, the mass media has incrementally conditioned many other social institutions and spheres (politics, economy, sports, religion, etc.); on the other hand, different social institutions and spheres have progressively incorporated media operating logics. These operational principles, following Hjarvard (2008: 105), include practices, values and institutional and technological modes that use the media to operate, including ways to distribute material and symbolic resources, supported by formal and informal rules. Therefore, the mediatization process in different fields of science involves a strong relationship among scientific institutions and the mass media system (Weingart 1998, Väliverronen 2001, Peters et al. 2008).

A crucial element in strengthening the links between the mass media and science was the fact that the media system began to participate more strongly on science and its social legitimacy. As Weingart (1998: 172) pointed out, the growing importance of the media in shaping public opinion is connected with the increasing dependence that science has on the media for its social acceptance in a context of limited resources. What is more, science also seems to be more closely linked to the media not only in order to gain legitimacy and political influence but in cases of disputes within science itself. Thus, many of the practices outlined in the previous section can be better understood by appealing to the notion of mediatization.

As empirical research has shown, the mass media have been progressively interested in the social consequences of S&T development and have gradually become communicative agents (see, for instance, Kiernan 1997, 2000, 2003; Bucchi 2002; Phillips et al. 1991). Within this framework, the mass media also exert an influence on the dynamics of the production, validation and dissemination of knowledge. Some interesting cases have been investigated with respect to this issue – Clemens (1986) could nowadays be considered a canonical example. In many cases, moreover, that power of influence is higher because of the expansion and growing importance of information technology and the formation of a global society based on economic globalization.

What is the situation in Latin America? Regarding the mass media as a cultural industry, I will reuse part of the description for Argentina and Brazil included in Polino & Castelfranchi (2012b). We affirmed that science communication has been growing through both public and private activities. For instance, in Argentina a public TV channel (Encuentro) has for nearly 10 years produced a high-quality scientific programme (*Científicos Industria Argentina)* with very good ratings. Other private sector channels are launching special programmes on S&T. One of the most popular infotainment TV programmes in Brazil, *Fantástico*, has a very strong S&T component and is broadcast by Globo Network to a huge audience. Other private enterprises also see an important niche market in popular science: increasingly, the main publishing houses in Argentina and Brazil produce popular science books covering a huge range of issues and publics, as do the publishing arms of public universities and other institutions. There are Argentine and Brazilian editions of *Scientific American* magazine, as well as several other very popular science magazines.

Regarding the mass media and, particularly, science journalism, the empirical evidence collected during the past 10 years highlights some important facets of science communication. Several studies conducted in Argentina (Polino & Fazio 2004, Polino et al. 2006, Vara 2008, Massarani & Polino 2008, Polino 2009), Brazil (Fapesp 2002, Amorim 2006, Massarani et al. 2007, Masasarani & Polino 2008, Ramalho et al. 2012), Colombia (Arboleda et al. 2011, Almeida et al. 2011) and Mexico (CONACYT 2002, Rosen & Cruz-Mena 2008) discredit some conceptions still strongly defended by many scientists, managers and politicians. These misconceptions indicate that science and technology are not given press coverage (or, when they are, it is more an anomalous fact outside of the customary news agenda). In the same manner, there is a strong belief that the agenda of the media, when it touches on scientific or technological topics, is to offer coverage of news or information coming from industrialized countries, and that research produced by local scientific institutions is practically ignored.

Such assertions are probably more in line with past situations. One of the few studies conducted for CIESPAL during the 1970s demonstrated that 'only five [newspapers] occasionally published items on biological science, especially medicine; seven gave space to the physical sciences, five spread the advances of the Space Age, and thirteen did not include any type of scientific material' (Abramczyk 1990: 112).

On the contrary, current academic research suggests that science journalism is becoming incrementally professionalized and institutionalized. In general terms – and still taking into account differences between media and countries – it is possible to appreciate that S&T have gained space and are part of the agenda that the media offer to their audiences. This manifests itself in some basic indicators, such as the critical mass of information, the number of editions in which these topics are included, and the temporal patterns of distribution and sustained publication.

But it can also be seen in the incorporation of staff journalists who produce the articles, which can be seen as an expressive feature of an incipient process of institutionalization of journalistic practice (a phenomenon quite well developed in the most important newspapers, TV and radio programmes).

In fact, the mere existence of specific sections in at least the most important newspapers of the region makes it increasingly difficult to support the idea that science has not penetrated into the professional practice of Latin American journalism.

An analysis of the orientation of the agenda also offers other relevant results. It is true that, in some mass media, the science done in the most advanced countries has a major leading role: this happens in some Colombian or Mexican newspapers. But the picture cannot be generalized. Other mass media have a clear orientation towards national research. Science journalism in Argentina and Brazil more often represents this trend. At least in Argentina, the existence of a dynamic network of science journalists has undoubtedly contributed to the consolidation of the profession.

However, the empirical research also confirms that regional science journalism has some weaknesses:

- Descriptive rather than analytical perspectives tend to predominate in media coverage.
- Science news is often reduced to 'scientific discoveries'. This way, there is little space to discuss certain important social issues that would need a more balanced and complex treatment, taking into account risks, interests, connections with business, environmental and social impacts, science for policy and policies for science, and so on.
- Many journalists use few sources of information and therefore have little ability to contrast the information.
- The training of journalists is still a problem, with important consequences for science coverage.

These results certainly suggest theoretical – methodological research lines to carry out in parallel with studies of news offerings. In particular, it would be especially relevant to study the conditions of news production and their impact on the configuration of the agenda. More specifically, comparative studies could focus on the structure of the news coverage of science (human resources, formation, etc.); analyses of the professional and publishing criteria that guide news-making; approaches and relations between journalists and scientists; the institutional system of S&T; managerial restrictions; conflicts of interest; the perceptions of the audience; the interest of the public in S&T; the valuation on the social function of science and science journalism; and the relations between journalists and those working in press offices in scientific institutions. The regional agenda of media studies on S&T is starting to move in that direction.

15.4 S&T: THE PUBLICS' LEVEL OF INTEREST, INFORMATION AND PARTICIPATION

This section of the paper is dedicated to the public(s) of S&T. The first question is related to the interests and information habits of the population. Public understanding of science surveys in Latin American countries, following the structures of international survey questionnaires (Eurobarometer, NSF etc.), also include specific indicators to measure information behaviours: television; radio; newspapers; the internet; books and magazines on popular science; visits to museums, centres and exhibitions; casual conversations with friends on these topics; and participation in events such as protests, signed declarations, forums of debate, letters to newspapers etc., which might have been motivated by a topic concerning science, technology or the environment. In general terms, national surveys in Argentina (2003, 2007), Brazil (2006, 2010), Colombia (2012, 2005) and Mexico (2005, 2009) indicate that society has a moderate or relatively high interest in science in general (accentuated in the case of 'hot topics' such as climate change). Surveys also show that society has a low level of scientific information in terms of cultural habits as well (Polino & Castelfranchi 2012a).[2] The data for interest and information is quite similar when compared at the regional level, as shown by the 2007 Iberoamerican Survey (FECYT-RICYT-OEI 2009) and the 2009 Iberoamerican Young Students Survey (Polino 2011).

2. We could find the same tendencies in the results from other countries, such as Chile (2007), the Dominican Republic (2009), Ecuador (2006), Panama (2001, 2007), Uruguay (2008) and Venezuela (2004, 2007).

Many times, the lack of information (or interest) is interpreted according to the deficit lineal model. The emphasis is on highlighting the asymmetry of knowledge (and thus, discursive legitimacy) among experts and the audiences. This has been, and largely still is, the dominant model naturally assumed by many Latin American scientists and experts (Hiltgarner 1990). The deficit model also succeeds because it fits both with technocratic visions of society and with the linear model of innovation. The idea of cognitive deficit also assumes a lineal interpretation by the public and reduces communication to a matter of popular education. In accordance with this, science popularization would be the vector for popular education. It is not unusual to find public declarations – even public documents – in which scientists use the 'two cultures' argument to emphasize that science is on one side and 'the homogeneous public' is on the other side.

There are many arguments to confront the deficit model. Mass communication research, media analysis (Moragas 1986, Wolf 1994, Laughey 2007) and cultural studies (García Canclini 1990, Barbero 1997, Williams 2003) are amazing counter-examples of the heterogeneity of the public and of how people process information they receive, negotiating and reinterpreting its meaning and integrating it into the context of their beliefs, values and interests.

The 'complexity of the public' argument refers equally to the problem of the variability of attitudes and positions that citizens can take towards science or scientific knowledge. A review of empirical studies focusing on the transmission of scientific knowledge has identified situations, ranging from rejection to active searches for information, according to expectations derived from membership in specific social universes (Einsiedel & Thorne 1999). The controversies over S&T show particularly well the variety of groups with different concerns and interests that are involved. The influence of these groups on the direction and control of science and its applications has been increasing over time and, as they have become organized, their concerns have become demands for participation. At the same time, it is necessary to remember that in the analysis of the public we should not forget that subjective dispositions are mediated by the particular position that individuals (or groups) occupy in the social space and the symbolic and material resources available to them (Bourdieu 1997, 2008).

Technoscience also makes the complexity of the audiences more visible: in fact, the evolution of public S&T policy shows that science, and political and economic power, react to specific social demands of agents, institutions and representatives of social movements. These agents, according to Eltzinga & Jameson (1995), represent the 'civic political culture' and struggle to discuss the research agenda and regulate the effects of the socio-environmental impacts of S&T development. The phenomenon of participation has forced some scholars to describe this historic moment as a 'participatory explosion' (Einsiedel 2008).

Once again, the national surveys on S&T in Latin America display an interesting scenario. Despite the low level of information, a very important aspect of public perception is the fact that Latin American societies have a complex vision about the consequences, risks and benefits of S&T. The results of the 2007 Iberoamerican Survey, for instance, supported criticisms of some linear assumptions linked to the deficit model: the relationships between knowledge, educational level, interests and attitudes to S&T are actually complex and often non-linear. For example, while the idea that the benefits of S&T outweigh the risks is more diffused at high levels of education, the claim that science today poses as many benefits as risks is distributed in a quite uniform manner among the population (Polino & Castelfranchi 2012a). Furthermore, Latin American populations also express wide agreement that citizens must be listened to and their opinions considered: for example, seven out of every ten interviewees in the Iberoamerican Survey demanded greater access to the decision-making sphere. In Europe, the same proportion of people think that way (Eurobarometer 2005, 2010).

How do the public powers respond to citizens' demands? In Europe, according to the public participation paradigm, administrations, scientific institutions and public policies on S&T increasingly emphasize that the public are not only users or consumers but citizens with political responsibilities. The idea of governance and many public initiatives are tending to promote dialogue and participation.

This scenario has begun to emerge in Latin America, although perhaps very slowly. There are still very few real mechanisms for 'public participation' sponsored by scientific and technological institutions or administrations. In some cases, the rhetoric of the deficit model inhibits thinking about participatory mechanisms or the democratization of decision-making processes in S&T.

Nonetheless, social reality will be likely to demand open spaces for discussion and the development of new social practices. Some remarkable recent events have put civil society into the centre of the technological development discussion and, more widely, of debates on democracy and sustainable development. Examples include social resistance to open-pit mining in Argentina, Chile, Bolivia and Peru (Svampa & Antonelli 2009), social mobilization and organization against the installation of pulp mills on the margins of the River Uruguay (Vara 2007), and public discussion on lithium extraction in Bolivia (Polino & Castelfranchi 2012b).

In many aspects, these conflicts refer to the original process of modernization in Latin America, in which science popularization played an important role. Both modernization and popularization occurred within a framework of social conflict involving the emergence of different social movements but also mass education, anti-colonialism, anti-imperialism and, more recently, anti-capitalism and anti-globalization. Therefore, public participation in Latin America could not be divorced from political-historical movements and social conflicts. This should be better understood by scientific institutions and governments. Public opinion, current social movements and spontaneous participation, deeply connected with a strong tradition of social mobilization, indicate that Latin Americans are talking much more strongly to science and public authorities.

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16

Science communication in China: Current status and effects

Ren Fujun

Abstract: Since the beginning of the 21st century, advances in science communication in China have increased at a rapid pace and on a large scale. This paper uses a brief historical review of science communication, a description of current operating mechanisms, and case studies on several large-scale projects to describe from both the macro and the micro perspectives how science communication enterprises are conducted and promoted in China.

Keywords: science communication, historical review, working system, science communication policy, farmers' scientific literacy, basic facilities for science communication.

IN THE EARLY PART of the 21st century, China has witnessed the increasingly broad participation of ministries, social organizations and the general public in science communication.

As Chinese society has begun to embrace science communication more fully in recent years, it has become clear that there is a clear need for guidance both on how to engage in science communication and on how to reach specific audiences. Chinese governments have begun developing and distributing a number of guidelines on these matters at both the national and regional levels, with the aim of driving science communication in a standardized manner. As it stands today, effective science communication in China relies on a close association between the government and the public. The desired results are systematic, well-organized communication and a well-educated public.

Why the government should attach such significance to science communication and why such communication is becoming more important in today's society must be understood in the context of scientific literacy. In recent years, it has become increasingly clear that the public's general lack of scientific literacy is hindering China's economic development and social sustainability. According to the results of the 2010 Survey on the Scientific Literacy of Chinese Citizens, there is a significant gap in scientific literacy between China and developed countries. Although the scientific literacy level of Chinese citizens has reached 3.27 % (which is 1.67 % and 1.02 % higher than the 1.60 % recorded in 2005 and 2.25 % in 2007), that is only the level reached in the main developed economies by the end of 1980s or the beginning of the 1990s, such as Japan (3 % in 1991), Canada (4 % in 1991) and the European Union (5 % in 1992) (CRISP 2010).

China's uneven economic, cultural and resource development in rural and urban communities contributes to socioeconomic disparities between different regions. Furthermore, the lack of scientific literacy in China's population of working-age adults has made it difficult for China's workforce to keep up with the world's ever-changing scientific and technological demands.

China's demand for better science communication is on the rise. At the national level, greater public scientific literacy is necessary to help China achieve continuing economic growth, bolster its international competitive edge, and establish a harmonious society.

In addition, citizens with high levels of scientific literacy will more easily acquire a variety of valuable scientific and technological skills. This will help them to solve difficult real-life problems and to participate more effectively in public affairs and democratic institutions.

16.1 A historical review of science communication in China

As modern science flourished in the western world and technological advances moved eastward in the second half of the 19th century and the early 20th century, China began its own scientific transformation. Gradually, an understanding of such issues as the nature, function, value and implications of science began to take shape in China, and the Chinese scientific community started to focus on popularizing scientific knowledge, introducing the scientific method, and calling for the establishment of modern scientific enterprises. Just as China's modern science academy began to emerge in the early 20th century, the country witnessed a major expansion in the publication of scientific newspapers and magazines and the subsequent incorporation of science education into schools.

However, China has endured numerous wars and tumultuous times since then, and science communication was not institutionalized until the founding of New China in 1949. The China Association for Science and Technology (CAST) was established in 1958, when a series of regulations and laws relevant to science were promulgated. Thereafter, the science community established its own association to enhance the country's science communication and map out clear-cut goals. In this context, messaging work conducted by scientists, science communication activities conducted by professionals or practitioners and experimental activities carried out by workers were closely interlinked. The popularization of technological topics became a major part of science popularization at that time, making it a striking feature of Chinese science communication.

Science communication entered into a new stage of development in 1978, following Deng Xiaoping's keynote speech at the National Conference for Science in March of that year, when he proposed the concept of 'four modernizations'. Of the four, the modernization of technology was the key. Deng proposed the concept that science and technology combined to represent the primary productive force, along with the idea that science communication should be pushed forward with great vigour (Deng 1992). He also stressed that public servants and the general public should be equipped with science and technology; that advanced scientific expertise and the latest scientific achievements should be learned from well-developed countries; and that a favourable social atmosphere should be cultivated for loving, studying and using science. These efforts led directly to the country's subsequent significant achievements in science communication.

Science communication developed rapidly during the 1990s. The Central Government of the People's Republic of China (PRC) and the State Council issued the first guiding document on strengthening science communication in 1994 – *Instructions on strengthening engagement in science and technology communication* (CCPC – SC 1994). The document illustrated the work that had been done on science communication since the founding of New China in 1949, emphasizing the significance of conducting science communication in recent years.

Science communication became an issue of national and strategic importance because science and technology were considered to be the absolute productive force. This new line of thinking affirmed the notion that China should be rejuvenated through science and education. After the *Law of the People's Republic of China on Science Communication* (NPC 2002) and the *Outline of a national scheme for scientific literacy (2006–2010–2020)* (State Council 2006) were put into place, the work on science popularization established a social atmosphere in which many related government departments stood ready to provide help in a coordinated and mutual effort, and people from all walks of life became actively involved in science communication.

16.2 China's working system of science communication

China is a populous nation with unbalanced socioeconomic development across the country's many regions. Given these conditions, Chinese science communication should be conducted a way that meets to the needs of people from diverse areas and that fully reflects and ensures its non-profit and public nature. The three main features of current Chinese science communication are China's system of policies covering science popularization, social platforms for large-scale cooperation and collaboration, and action plans for targeted social groups and capacity-building projects.

16.2.1 Coherent and interlinked science communication policies

Science communication is a non-profit enterprise carried out under the overall guidance and regulation of the Chinese Government.

China formed its science communication system with a main focus on science communication policies and other relevant policies at the central government, ministry and grassroots (city, county and district) levels. These top-down policies have provided much-needed guidance on communication matters for government agencies and the institutions that are involved in science communication.

No exclusive policies were established for science communication before 1994. We can ascertain the origins of today's science communication guidelines by examining previous leaders' keynote speeches and other policies of various types. For instance, the 43rd article of the 5th chapter (Policy on culture and education) in the *Joint guiding document of the Political Consultative Conference of the PRC* (29 September 1949) stated that efforts should be made to develop the natural sciences to contribute to the construction of agriculture, industry and national defence, and to reward scientific discoveries and inventions in order to popularize science and technology (CPPCC 1949). It is obvious that the instruction 'to popularize science and technology' embodies the spirit of science communication.

Upon its establishment in 1958, CAST became the only specialized institute to engage in science communication in China. CAST's fundamental tasks include integrating science communication with production in practice and actively connecting to the technological activities conducted by the masses. The group clearly established that we should sum up, accumulate and promote the advanced experiences gained from scientific inventions and discoveries, that we should vigorously popularize scientific knowledge, and that we should make full use of the methods gleaned from continuing education to foster scientific and technological talents (CAST 1998). Although science communication was thus raised to the level of a governmental function in line with its embodiment in various policies, it was a supplementary function at that time, contributing to the country's development in science, economics and culture.

The year 1994 ushered in an era of specific science communication policies originating from the central government, ministry and local government levels. Since then, a policy system characteristic of specific science communication policy, along with other policies relevant to science communication, has been formed to guide operations in this field.

The State Council under the Central Government issued *Instructions on strengthening engagement in science and technology popularization* in December 1994 (CCPC – SC 1994). This was the first guiding document to discuss science communication work comprehensively since the founding of New China, and was also the first officially and publicly issued document guiding the work. The *Law of the People's Republic of China on Science Communication,* which was first disseminated in June 2002, was the world's first nationally enacted law on science communication.

The State Council enhanced the *Outline of a national scheme for scientific literacy (2006–2010–2020)* in March 2006. This was the first guiding document designed to improve scientific literacy among the general public. Without a doubt, the new concept, principle and plan set out in this document were bound to exert far-reaching influences on the improvement of scientific literacy, the enhancement of national competitiveness and the establishment of a harmonious society.

Various ministries and local governments implemented policies on science communication at that time. These policies provided some guidance on the content, operating methods and nature of science popularization activities carried out as functions of one or several ministries. For example, the Central Committee Propaganda Department of the PRC led efforts to have ministries and other agencies work together. This produced, among other results, the following:

- The State Science and Technology Commission and CAST jointly issued the *Notice on propaganda work of strengthening science communication* in 1996, specifying ways to popularize science among the public.
- The Ministry for Science and Technology, the Division of Radio, Film and Television (under the Ministry of Culture) and CAST jointly issued the *Notice on propaganda work for the furtherance of strengthening science communication*, which also specified popularization techniques.
- The Ministry of Finance issued the *Notice on tax policy about encouraging the development of science communication* in May 2003, in which all social sectors were mobilized to promote science communication by applying preferential tax policies to support groups developing science-related newspaper, audio and

video productions and to encourage the sale of tickets to attractions at science and technology museums. In some instances, these tax policies also benefited those giving monetary donations related to scientific and technological advances.

- The National Development and Reform Commission, the Ministry of Science and Technology, the Ministry of Finance and CAST jointly issued the Development Plan for the Basic Facilities for Science Communication (2008–2010–2015) in November 2008. This highlighted the leading role of the government in science communication and strengthened the national macro-level guidance on the construction and operation of basic facilities for science communication.

At the same time, requirements and support for science communication could be found in policies relating to such fields as science and agriculture; in this regard, those policies, along with some exclusive policies, jointly contribute to the comprehensive development of such types of work.

For instance, the *Long-term and middle-term planning outline on the development of science and technology (2006–2020)*, published in February 2006, states that we should realize the goal of promoting the comprehensive development of human beings and contributing to the scientific literacy of all people, and that we should popularize scientific ideology and knowledge and promote scientific approaches. In addition, this document stated that we should organize and conduct a variety of systematic, science-focused school and after-school activities, strengthen innovation-based education to cultivate creative awareness and the practical ability of youths, and strengthen scientific training for public servants (State Council 2006).

Some opinions on strengthening agriculture and the countryside by the State Council, published in January 2000, stressed that efforts should be made to accelerate scientific progress in agriculture and to constantly optimize the training system for agricultural education to improve scientific literacy among farmers and other citizens living in rural areas. The document also stated that concepts of science should be upheld, superstition and ignorance should be eliminated, and civilized or well-mannered behaviours should be advocated. This document advocated that all of these concepts should be upheld through the simultaneous process of increasing efforts to develop grass-roots organizations and to improve society's democratic rights, legal system and spirit of scientific enquiry (State Council 2000).

All in all, this well-arranged and coherent science communication policy with its different emphases has given rise to a complete science communication policy constitution, which provides guidance and support to science communicators who are developing it in various areas.

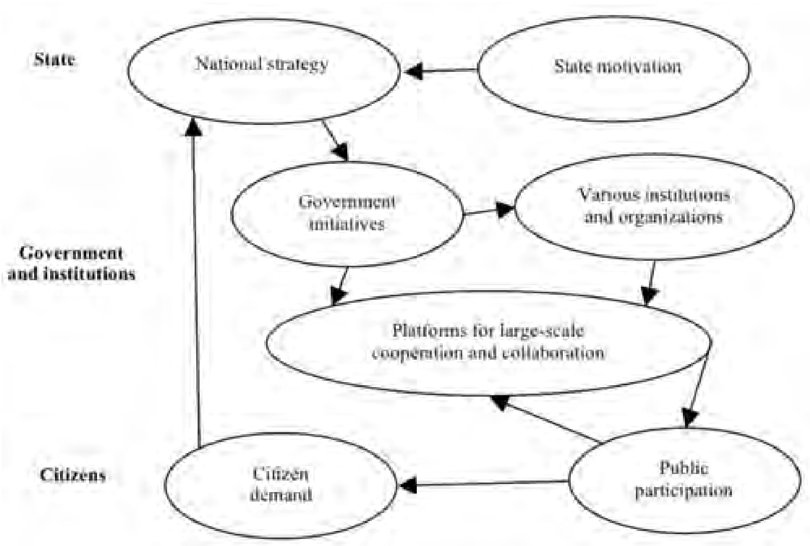
16.2.2 Public social platform of large-scale cooperation and collaboration

The science communication policy system in China arose due to demands at the national and the public levels. Those policies that obtain government support mobilize the engagement of a variety of social organizations, in which the government and the public jointly construct various platforms for public involvement. At the same time, the instant feedback and new demands of 'new media' technologies – which in turn give impetus to the development of new policies – are generated during participation in these activities. Figure 16.1 illustrates the overall operating mechanisms of science communication in China.

In order to mobilize the active involvement of the general public into this activity, a practical model featuring large-scale cooperation and collaboration is adopted. Specifically, more than 20 state ministries, research institutions and non-government organizations are involved, such as the Ministry of Science and Technology, the Ministry of Culture, the Ministry of Finance, the Ministry of Agriculture, the Ministry of Education, CAST and the Chinese Academy of Sciences. These groups all play a leading role in promoting this social undertaking, and one or more of the ministries or institutions listed above play a pioneering role in the promotion or launching of large-scale science popularization projects. At the same time, these ministries or institutions invite and encourage other social institutions to construct vast platforms for the engagement of the general public in the science popularization project.

As an example, the science popularization infrastructure project was initially organized by CAST, the Ministry of Science and Technology, the Ministry of Finance and the National Development and Reform Commission, along with coordinated efforts of the Ministry of Education and 10 other ministries. The intent of this collaborative effort was to increase both the ministry's infrastructure capacity and the number of opportunities for the general public to improve their scientific literacy.

Figure 16.1 The system of science communication operations in China



Source: Adapted from Cheng & Yin (2012)

16.2.3 Some practical routes for prioritization of five target groups and a specific infrastructure project

Thanks to the guidance of the science communication policies outlined above and to large-scale cooperation and collaboration at various levels of government, science communication's implementation path and action plan have been set to address five targeted groups of people (farmers; the urban workforce; youth; leaders and public servants; community residents), and the country's science communication capacity has taken shape. This path exerted a huge influence on people from all walks of life, contributing to an overall improvement in the public's scientific literacy.

The five target groups were selected for the following reasons:

- *Farmers* make up the greatest portion of China's workforce and are the primary force behind the construction of the new socialist countryside. Educational opportunities remain out of reach for many farmers.

- The *urban workforce* is the main source of labour for modern and tertiary industries, and is the main force behind modern lifestyles and economic growth.
- At any given time, China's *youth* are being actively exposed to educational opportunities. They are expected to become the leaders of tomorrow, which will require a strong grounding in science.
- The nation's *leaders and public servants* provide numerous services to their communities and thus must be engaged in all facets of community life, including scientific discourse.
- *Community residents* spread throughout the country represent the ever-growing population in China's emerging urban areas.

Improving the scientific literacy of people in these five groups is certain to lead to a similar increase in scientific literacy for the whole of Chinese society.

The basic project outlined here concerns five areas that need to be strengthened:

- *Science education and training:* The main tasks are to improve on current efforts to develop teaching faculties, textbooks and teaching methodology and training, and to transform the model of exam-oriented education.
- *Exploration and sharing of science communication resources:* The main tasks are to constantly explore high-quality science popularization products and information resources, construct a public platform for science popularization resources, and provide those public resources.
- *Capacity-building for mass media-based science communication:* The main tasks are to make significant investments in science popularization in order to establish representative brands, cultivate website brands, and build virtual museums of science and technology for access by a wide online audience.
- *The establishment of a basic facility for science communication:* The main tasks are to expand and improve on the science popularization role or function of existing facilities, establish several new museums of science and technology, and develop basic facilities at the grassroots level.

- *Scientific talent building:* The main tasks are to improve overall quality, optimize the structure of individual facilities' talent, attract and cultivate highly qualified people, and construct a well-structured, moderately sized team of highly qualified talent.

The effective implementation of these measures will lay a solid foundation for the prospective development of science popularization work in China.

16.3 Case studies

The following case studies examine some typical action plans for improving the scientific literacy of farmers (a key target group), and the basic project in science popularization.

16.3.1 Action plan for farmers' scientific literacy

The Action Plan for Improving Farmers' Scientific Literacy attaches great importance to understanding existing problems. It focuses on the construction of science and technology training systems in rural areas, the carrying out of science popularization activities, the expansion of available media channels, and the promotion of a demonstration project in this area. The main goal of the plan is to improve farmers' ability in scientific production and making a good living. This plan not only takes into consideration the improvement of the subjects' practical techniques, but also encourages them to increase their capability in non-agriculture sectors; at the same time, special attention should be paid to the improvement of scientific literacy among people from minority groups and women in rural areas.

A working model featuring extensive cooperation and collaboration among different ministries and institutions was formed during this action plan. Because this is a large-scale, systematic project that must take into consideration issues such as the countryside's high population and weak educational foundation, a leading team was established in 2006 to manage the project. The collaboration was extensive, involving the Ministry of Agriculture and CAST, along with assistance from the Propaganda Department of the Central Committee of the Communist Party of China; the Ministry of Science and Technology; the Ministry of Education; the State Department of Radio, Film and Television; the Ministry of Human Resources and Social Security; the Ministry of Environmental Protection; the Ministry of Safety Supervision; the All China Federation of Trade Unions; the Central Committee of the Communist Youth League; the All China Women's Federation; the Chinese Academy of Engineering; the State Forestry Bureau; the State Ethnic Affairs Commission; the Chinese Academy of Sciences; the Ministry of Health; and China's Meteorological Administration. This has provided strong organizational assurance for the establishment of an effective action plan to improve farmers' scientific literacy. Various participating ministries and organizations are involved in the joint promotion and implementation of the plan.

The Ministry of Agriculture and others developed and promulgated the *Education outline for farmers' scientific literacy*, the first such publication in Chinese history, promoting the education of farmers in scientific literacy in a clear and easily understandable way. A scientific training project for new farmers was conducted in 63,500 villages nationwide by the Ministry of Agriculture from 2006 to 2008; a total of 3.67 million farmers participated in this exercise. An additional 2.86 million agricultural science and technology demonstration households were trained under a separate agricultural science and technology project, benefiting 6 million households. In addition, the Sunshine Project, which transfers and trains labour forces in the rural areas, trained a total of 0.165 billion farmers. (EONSSL 2011: 72–76)

To help industry adjust structurally, upgrade technology and strengthen special-skills training for migrant workers, the Ministry of Labour and Social Security coordinated with the Ministry of Education, the Ministry of Science and Technology, the Ministry of Housing and Urban – Rural Development and the Department of Poverty Reduction under the State Council to carry out a training project for labour transfer in rural areas, employment-specific skills improvement, etc. All in all, these projects or training opportunities helped to improve farmers' scientific literacy tremendously.

CAST and the Ministry of Finance jointly conducted a plan benefiting farmers and their rural homelands through science communication by means of adopting an incentive 'to replace subsidized help with awards and to combine rewards and subsidized help'. This incentive rewarded 4,659 high-performing science communication organizations and certain individuals who played a pioneering role in science communication. It played a crucial role in making farmers rich through science and technology and in the development of public service in science popularization in rural areas. The number of science popularization demonstrations in more than 2,800 counties in which scientific literacy was studied increased from 407 to 713 (EONSSL 2011: 84–89). This has become an effective route for the implementation of scientific literacy training at the grassroots level in the regions.

A plan to benefit farmers through science communication that was enacted by CAST and the Ministry of Science and Technology for the implementation of the national scheme is an effective template for farmers, agriculture and rural areas nationwide. By replacing subsidies with rewards to farmers and worthy organizations and individuals, this plan also encourages the promotion of science and technology. Under this plan, farmers are encouraged to draw upon their experiences in order to strengthen their awareness of and interest in science and technology; enhance their scientific literacy, which will in turn help them to get out of poverty and improve their lives; and guide them to adopt a scientific, civilized and healthy way of life. All in all, we expect that this methodology will prove instrumental in promoting economic development in rural areas and in constructing the new socialist countryside. Table 16.1 shows the numbers of areas receiving these rewards, along with the amount of money awarded to them by government agencies so far in 2012.

Table 16.1 Number of areas receiving rewards and the amount of money awarded to them through this plan

By 2012	Rural special technology associations	Rural science communication exemplary bases	Science communicators in rural areas	Minority science communication teams	Total (10,000 RMB)	
	No.	No.	No.	No.	No.	Funds
Total	4132	1982	2049	45	8253	135,000

16.3.2 Construction of basic facilities for science communication

Basic facilities for science communication are regarded as important carriers for science popularization work and important components of the national service system for public culture and the construction of the national science popularization capability. Through this work, the general public comes to gain an idea of scientific knowledge, comprehend the scientific method, establish scientific concepts, promote scientific literacy, boost their ability by adopting scientific methods to tackle practical issues, and gain access to public affairs. As a result, this project has become one of the basic facilities for the development of scientific literacy in China.

The main tasks of the project are to expand and improve the educational function of existing basic facilities, integrate and make use of relevant social resources, and develop an educational training base for science communication and science popularization facilities at the grassroots level. The main measurable parameters are:

- to increase input into facility construction and operations for the public
- to improve and upgrade science popularization educational functions
- to mobilize the participation of individuals from non-government groups and other communities.

Following the implementation of the *Outline of the National Scheme for Scientific Literacy*, the National Development and Reform Commission, the Ministry of Finance, and CAST jointly issued *Planning for the development of facilities for science communication (2008–2010–2015)*. This document directed that the overall service capability of science popularization facilities should increase tremendously by 2015, and that opportunities and routes for the public to improve their scientific literacy should become more and more readily available (NDRC, MOF and CAST 2008). The goal of this plan is to further the comprehensive, coordinated and sustainable development of science popularization facilities, which should play a crucial role in the implementation of this task.

In the area of science communication, the term ‘facilities’ refers to services such as those provided by science museums, science popularization at the grass-roots level, circulating science popularization, web science popularization, educational bases for science popularization, and venues that provide educational opportunities. Among these facilities, science museums can be further divided into traditional museums; mobile, vehicle-based museums; and virtual museums. We will take traditional museums as an example to show how they function as one of the main channels of science communication activity.

At the end of 2010, China had 335 S&T museums with covered areas of more than 500 m^2, which was 24 more than at the end of 2009. The total covered area of the museums was 2,199,800 m^2, of which exhibition areas totalled 966,800 m^2 (or 43.95 % of the total covered area). On the national scale, the average covered area per 10,000 people was 16.4 m^2, which increased by 1.97 m^2 from 2009 (Table 16.2). The length of people's visits to S&T museums increased even more.

The S&T museums are of various sizes (as shown in Table 16.3) to serve the needs of people in different areas.

Table 16.2 Statistics for S&T museums, 2006 to 2010

	2006	**2008**	**2009**	**2010**	**2009–2010 growth rate (%)**
S&T museums	280	285	309	335	8.41
Covered area (m^2)	1,606,008	1,799,175	2,060,124	2,199,807	6.78
Exhibition area (m^2)	602,160	832,622	918,135	966,780	5.30
Visitors	16,618,717	2,821,901	25,659,632	30,441,894	18.64

Source: MST (2012: 29).

Table 16.3 Number of S&T museums in China, by size, 2010

Outsize (30,000m2+)	**Large (15,000~30,000m2)**	**Medium (8000~15,000m2)**	**Small (under 8000m2)**
11	27	27	270

In addition to S&T museums, China has more than 1400 ‘science wagons’, including 382 that were purchased and equipped by CAST, as well as many other types of popular science vehicles. Virtual museums provide additional access to scientific resources, and more than 600 popular science websites had been built by September 2010.

16.4 The effects of science communication in China

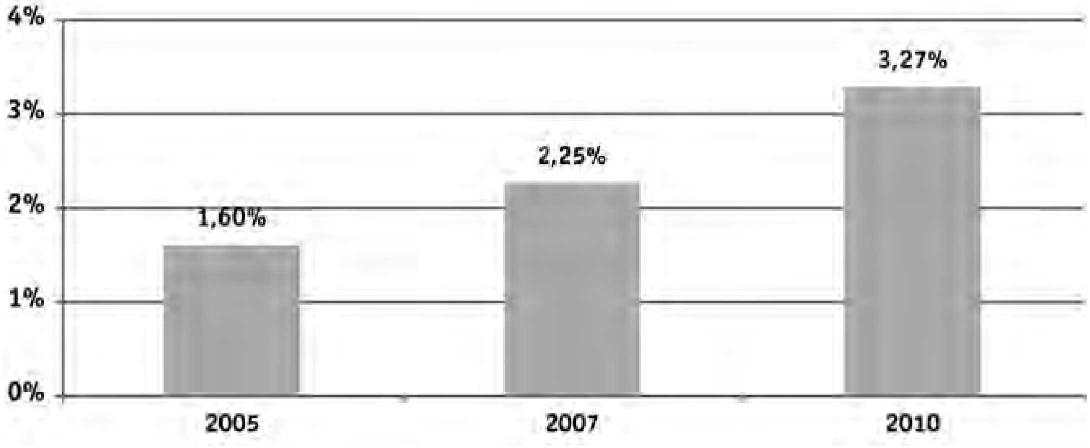
Scientific literacy has increased dramatically in China in recent years, greatly benefiting farmers and the other targeted groups. Many new S&T museums have been constructed at the local level, and the exhibits and functionality of existing museums have been improved. The public now has better access to the scientific and technological information needed for social, economic and technological success on the global stage. The involvement of the public in science communication has also increased dramatically.

The sections below detail the results of the eighth national survey of scientific literacy (CRISP 2010) and describe how recent changes in scientific literacy have influenced China at the national and regional levels.

16.4.1 The development of civic scientific literacy

The proportion of Chinese citizens who are considered to have basic scientific literacy reached 3.27 % in 2010 (Figure 16.2), which is considerably higher than in previous surveys (1.60 % in 2005 and 2.25 % in 2007). This demonstrates that recent civic scientific literacy efforts have achieved remarkable results.

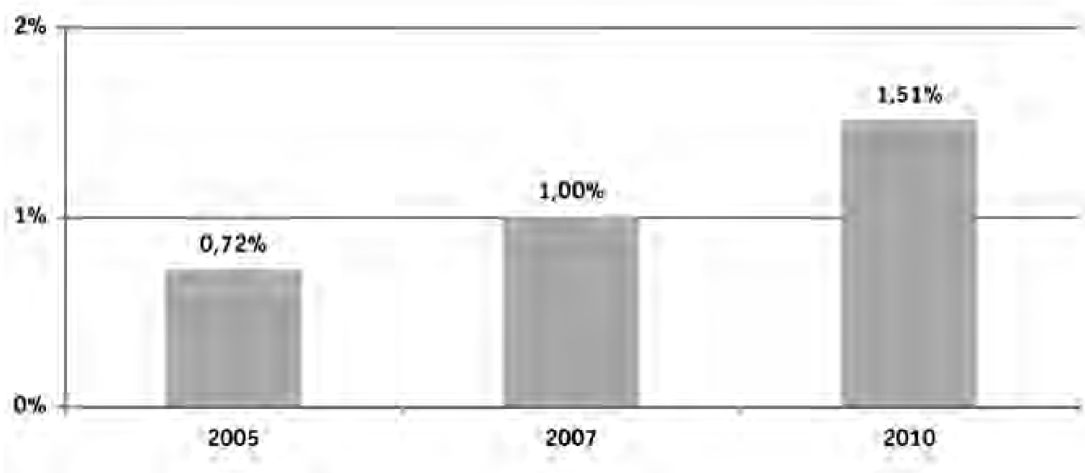
Figure 16.2 Scientific literacy of Chinese citizens, 2005, 2007 and 2010



16.4.2 The scientific literacy of farmers

The scientific literacy of China's farmers has increased steadily in recent years, from 0.72 % in 2005 to 1.51 % in 2010 (Figure 16.3). The promotion of scientific literacy within rural farming communities plays an important role in the improvement of overall civic scientific literacy.

Figure 16.3 Farmers' scientific literacy, 2005, 2007 and 2010



16.4.3 Public access to S&T activities

The 2010 survey included an investigation into the public use of science communication facilities in the previous year. The results showed that over 20 % of respondents had visited S&T museums, including museums of natural science (Figure 16.4). The proportion of citizens who had visited S&T museums increased significantly from the 2007 survey.

Figure 16.4 Public access to S&T museums, 2007 and 2010

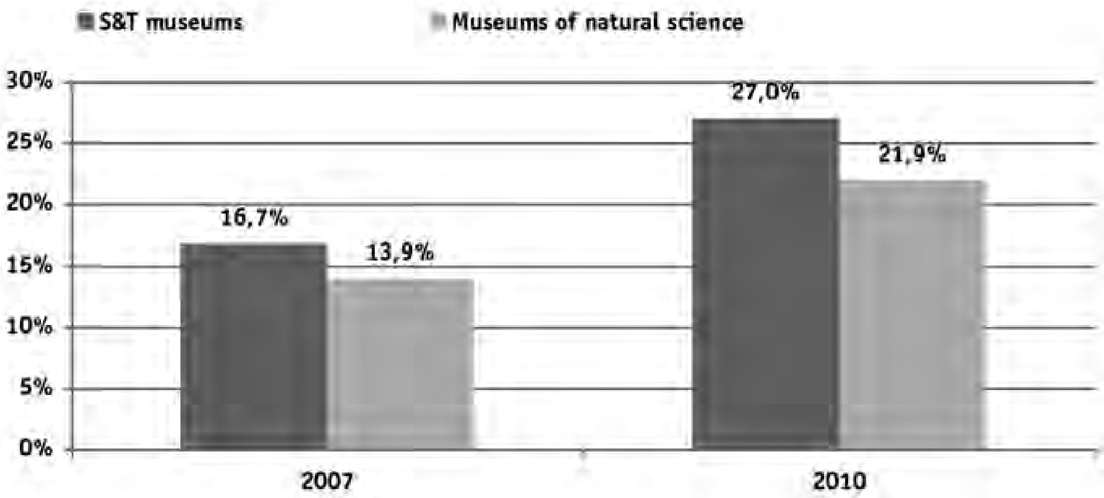
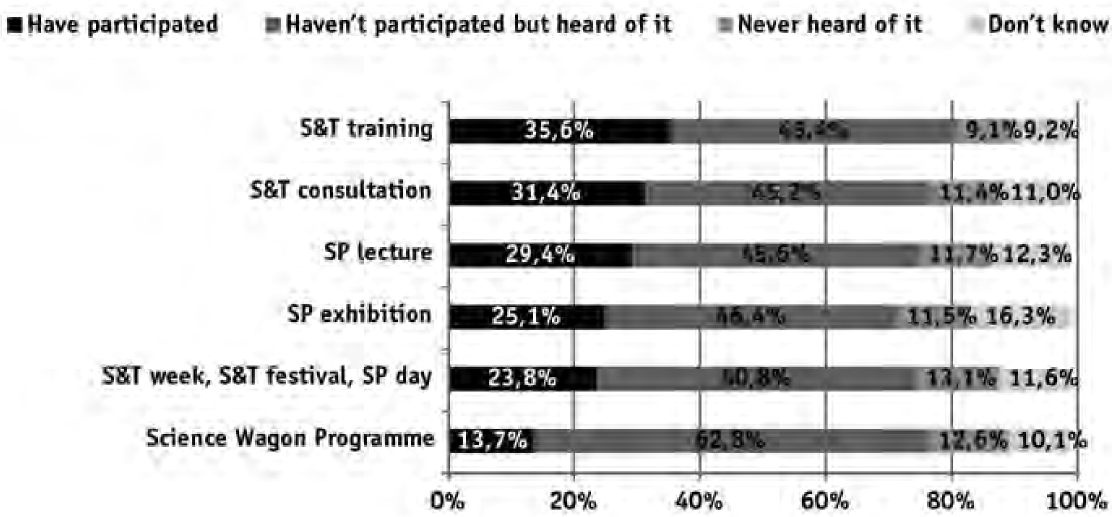


Figure 16.5 shows proportions of Chinese citizens who participated in various types of science communication activities in 2010.

Figure 16.5 Public engagement in science communication activities, 2010



SP = science popularization; S&T = science and technology.

16.5 Conclusions and discussion

Guided by science communication policies and supported by extensive cooperation and collaboration between social sectors, science communication in China is currently prioritizing projects for targeted social groups and capacity-building, contributing to the enhancement of scientific literacy among Chinese citizens.

The working system of public, non-profit science communication in China is managed at the three levels of the state, other social actors and citizens. The Action Plan for Farmers and the Capacity-building Project for S&T Museums show how government departments, academic institutions and non-government organizations are cooperating and collaborating.

China is not the only country in which science communication has developed rapidly. Science communication is gaining increasing attention in the global context: many important initiatives are being launched, new science centres are being built, and science weeks are attracting more visitors. There has been considerable new research into science communication (such as policy studies, scientific literacy surveys and science communication evaluations) in recent years, all with the goal of assessing and increasing scientific literacy and public access to S&T.

To better address future challenges in science communication, we in China will continue to collaborate in this important endeavour with other researchers, both in China and abroad.

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Part 4

Conclusion

17

Five things we must keep in mind when talking about the mediation of science

Bernard Schiele

Abstract: When talking about science mediation, five things must be kept in mind: 1) culture today is shaped by science; 2) scientific ignorance is growing; 3) scientific authority is challenged; 4) science, although omnipresent, remains distant; 5) on the internet, scientific truths and falsehoods keep coming back.

Keywords: mediation, participation, engagement, culture, internet, science.

TO ENGAGE in the mediation of science today is to interact with ambivalent publics, convinced of the benefits of science and yet weary of the risks its development conveys, adhering to science and yet criticizing it.

It is by keeping in mind the ambivalence of the public, central to today's issues and challenges of sharing knowledge, that I would like to conclude the 2012 edition of the *Journées Hubert Curien*. I would like to draw your attention to five issues central today that cannot be overlooked when we try to bridge the gap between science and the public, and vice versa.

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17.1 First issue: Culture today is first and foremost scientific

When we tackle the question of the mediation of science, the debate usually focuses on three aspects: formal diffusion of science through school, from elementary to university; non-formal diffusion and the mediation of science proper, encompassing all strategies outside school and the media; and scientific journalism, which concentrates its activities in the media.

Usually, we expect schools to perpetuate among the whole population the values of rationality upon which our modernity was built. We expect them to encourage the assimilation of reasoning processes central to scientific thought and the knowledge and abilities required by the evolution of society. This implies the double task of learning and socialization. This process is continuous: it rests on the gradual assimilation of notions, facts, conventions, methods, principles and so on, intertwined in order to form a coherent body of already established knowledge. Of course, today's pedagogical approaches, focused on projects, allow for greater individual initiative and teamwork, making learning an active rather than a passive activity. Yet, even with an active pedagogy, we still require schools to provide and guarantee the acquisition and mastery of the necessary knowledge and abilities for a successful professional insertion for those who wish to work in science and technology or in a job strongly related to it. Although the teaching of sciences has undergone a profound transformation, the canonical form remains programmes that are followed step by step. To succeed, schools train captive homogeneous (age and qualification) groups. Furthermore, they possesses coercive means: students must show up to the classes they are registered in and, ideally, face their difficulties with a comparable degree of preparation. They cannot (in theory) break or renounce the learning 'contract' once they have subscribed to it.

In contrast, we expect the mediation of science to fill in or extend school when scientific teaching is deficient, or when it appears incapable of keeping up with the development of scientific knowledge. Furthermore, we expect the mediation of science to stimulate interest in science in order to push a greater number of students towards scientific careers. This is why many initiatives in the mediation of science target young audiences. All in all, the mediation of science is considered more attractive than school, which is suspected of provoking disinterest because of its rigid design even with multiple modernization attempts. Also, scientific mediators do not refrain from lecturing and summoning schools to modernize themselves and seek other paths. It is true that the mediation of science has the freedom to take into consideration the interests of the public or to follow the news because it is bound neither by programmes nor by qualification requirements. Furthermore, its voluntary audience is neither homogeneous nor captive. Its framing of messages is mainly intended to awaken, capture attention and maintain the interest of its audience, and only incidentally to inform or cultivate it. A successful mediation is measured by the satisfaction and size of the audience. In this context, the question of assessments of what is learned is secondary. School takes place in limited time – school time – and is measured by the success of its students; by comparison, mediation takes place during the leisure time of its audience, without being bound by efficiency.

Scientific journalism, on the other hand, says something different. It sees in the monument erected by science one of the greatest achievements of the human mind, but in the hands of a small group living apart from society. In addition, scientific journalists hold the view that scientists are bad mediators, which further alienates them. Scientific journalism gave itself the mission of bridging the gap between science and the population. Furthermore, concerned with public interest, it wants to raise the population's awareness of the positive and negative yields of science and technology.

These modes of diffusion of science are not in opposition to each other, as one might assume: they are complementary. They have in common the diffusion of already established knowledge to different audiences. Knowledge is produced in different micro-milieus (universities, laboratories, research centres) and then reformulated according to different objectives that demand distinct and distinctive communication strategies: raise awareness, stimulate interest, inform, teach, and so on. Each form of diffusion, in its own way, contributes to the socialization of knowledge and, more broadly, of science. Thus, their combined actions bear witness to the impact of science and technology on society because, during the 20th century, 'science developed itself in an extraordinary way and organized itself in systems around communities, groups and areas of influence.' Furthermore, science has become linked with technology in such way that they are now nearly indissociable. Do we not now speak of technosciences to describe this interrelationship and the role it plays as a 'transformative agent' of society (Jantzen 1996: 10)?

In addition, today's cultural and social conjuncture, in many ways, is the result of the impact of the development of science and technology and their effects. Science 'is linked to modernity, with the emergence of so-called modern societies' and their evolution, and 'progress thus appears as the product of what could be called the effect of science, i.e. the imposition of a representation of nature and society that draws more and more on scientific knowledge' (Fournier 1995: 7). Progress is no longer seen as the capacity to move from a literary culture to a scientific one, or as the simple accumulation of individual abilities to adapt oneself to a new reality and thus contribute to collective development, but as the effect of a paradigm change that not only leads to a transformation of mentalities, of the organizational forms of society, but also of individual and collective abilities now required by the evolution of modern societies. Thus, the continuous socialization of knowledge is a necessity.

In other words, science is already here: it is materialized in every commonplace object; it is socialized in the representations that we mobilize to interact with others; and it is inscribed in a majority of modern organizational forms. Science, and the values it conveys, are neither removed from culture nor removed from society: they are at their heart.

Yet – and this is a paradox of our times – scientific knowledge does not spontaneously enrich the population's daily routine; furthermore, despite all the actions taken to bridge the gap between them, the gap widens. Thus the omnipresence of technosciences, which transforms our lives and requires new abilities from social actors, does not necessarily translate into a greater appropriation of knowledge by each and every one.

17.2 Second issue: Scientific ignorance grows with the development of knowledge

We no longer have the impossible task of trying to bridge one or a great many gaps that forever widen. Now, we engage in processes of cooperation.

In the traditional conception – vulgarization in opposition to mediation or participation – the public was suffering from a deficit of scientific knowledge.[1] The task was therefore to raise its level of knowledge. Furthermore, it was feared that a lack of scientific knowledge would translate into a negative stand towards science and scientists. Raising the overall level of knowledge thus became a major issue in order to prevent a potential change of perception. The strategies drafted to achieve this objective mainly revolved around the explanation of science and technical thought, outside of the official education system and its methods[2], to an audience seen as passive. In this approach, scientific culture was restricted to the amount of knowledge each and every one had to master in order to pretend to be a scientifically learned person, a person of culture.[3] The greater the amount of knowledge one mastered, the more cultured one was. In this encyclopaedic vision of culture, the issue was that of the best medium of communication. Since the 1980s, most government policies for the valorization of scientific culture have mainly revolved around the creation of new means of communication and the optimization of existing ones in order to reach all possible audiences.

Yet, this was nothing but a utopia: a knowledge deficit is structural, for two reasons. First, new knowledge is constantly produced in all fields at an ever-increasing pace, forever widening the gap not only between scientists and publics but also between scientists. Scientists are quite open about the difficulty of even mastering

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1. The Bodmer report, published in the UK in 1985, illustrates this conception, which greatly influenced programs of public understanding of science created in its wake to promote the development of scientific culture (also called 'scientific literacy' in English-speaking countries).

2. In France, F. Le Lionnais (1958) gave the simplest and most direct definition of vulgarization. Since then, new definitions that have been proposed are nothing but paraphrases.

3. To be the *honnête homme* of the French tradition.

their own field. How can we then expect the public to acquire an all-encompassing scientific culture far more complex than that tested in the Eurobarometer questionnaires, when scientists cannot do so themselves? Perhaps is it worth mentioning here that if science fiction still conveys the image of a lone scientist working in a remote dungeon, an obscure basement or a top-secret facility, science is nowadays a collective endeavour. The contributions of individual (not lone) scientists are building blocks in a structure of which none can apprehend anything but its overall architecture. We should not forget that thousands of scientists worked for over a decade at CERN to catch a mere glimpse of the Higgs boson. Furthermore, the development of knowledge gives birth to new fields and subfields of research, giving science the form of an ever-enlarging archipelago – to quote Jean-Marc Levy-Leblond – rather than a unified field.

Thus, a lack of scientific culture is the dominant feature of our ever more specialized modernity, and this ignorance cannot but further increase. Breaking with the encyclopaedic conception of knowledge and the so-called learned man has become inevitable.

Thus, those who still wish to limit themselves to strategies for the propagation, diffusion or transmission of scientific knowledge, after our field has undergone a paradigm shift, risk the reification of a concept that not only opposes culture and scientific culture and gives the latter an inferior status (Godin 1999), but would also keep scientists out of society and make them the keepers of a closed order. The issue has thus shifted from raising the level of scientific culture at least to the bare minimum required to become a credible interlocutor, to involving citizens in the scientific process. It is only collectively, with the participation and involvement of each and every citizen, regardless of background, that we will find solutions to the problems we face. It is thus the mobilization and involvement of the scientific community and of all social actors, invited to work alongside each other, that must be encouraged and brought about.[4]

4. On this point, see Bauer & Jensen (2011), Bucchi & Nerisini (2008) and Einsiedel (2008).

17.3 Third issue: Scientific authority is also questioned

Mediation is now synonymous with the involvement of the public – a public that does not want any more to be kept apart from the decision processes that may affect it, especially those involving social choices. The public is not stupid: what are usually advertised as purely scientific or technical questions usually involve questions of a social, economic and ethical nature. To exclude them from the debate only fosters doubt and resentment. When facing their consequences, no one as a greater say than the rest. The issue of nuclear energy illustrates this new mindset perfectly. In English-speaking countries, this movement is called 'citizen involvement', which is more to the point than 'public engagement'. The issue is thus no longer about an impossible rise in the individual and collective level of knowledge, but about the impacts of technoscience's encroachment on society. This is why the debate nowadays focuses more on issues of participation and dialogue, rather than on diffusion. Furthermore, the idea of dialogue implies reciprocity. In other words, it involves equal partners. Thus, it is not enough to be a scientist or an expert to be listened to, let alone to have the final say.

The mobilization of the public has become a major social phenomenon which bears witness to a confidence crisis that stunned the British House of Lords. In its *Science and society* report, it declared that 'Society's relationship with science is in a critical phase' (SCST 2000). Despite a great many activities of science promotion and a strong interest in science on the part of the population, a confidence crisis was patent. The 1990s had been the decade of 'mad cow' disease (Creutzfeldt – Jakob disease), which stunned peers and commoners alike.

As much can be said of the 2010 Gulf of Mexico oil spill and the 2011 Fukushima nuclear accident. In short, the recent controversies (including the notorious *Mediator*, for French audiences)[5] have their part in the shift in public opinion.

This movement towards participation must be understood as a reaction to the impact of science on society. In this context, with a

5. The Mediator, a medicine used to treat diabetes, had potential lethal side effects that were denied as long as possible, even in the face of scientific evidence.

public both expecting results from science and wary of it, it is difficult to imagine anything but direct interaction. This is the wager of the mediation of science.

Acknowledging this new reality, the Romanow Commission on the future of healthcare in Canada, breaking with the usual mechanisms of consultation, listened to the public by organizing, in addition to traditional consultations, televised forums in universities and online conversations. In addition to the one-way communication with the public, which in the case of vulgarization flows from the scientific elites to the public, new forms of participatory public engagement are emerging. These two-way approaches take place in forums that foster dialogue and mutual learning by researchers, experts, citizens and policymakers (Medlock 2011). These are thus new forms of interaction between scientists and the public one the one hand, and, more importantly, between social partners on the other. Among many examples, we can count national and local consultations, deliberative pollings[6], consultative committees, citizen forums, consensus forums, stakeholders' dialogues[7] and internet forums (Lemelin 2002). This multiform movement bears witness to the evolution of expectations, mindsets and public attitudes to science and technology, and more generally to scientific and economic development policies.

17.4 Fourth issue: An omnipresent and yet distant science

This sort of dialogue does not aim to raise the level of scientific knowledge of anyone, although it can lead to it. Taking place in another sphere, it bears witness to the fact that we live in a 'scientific age', to quote Richard Feynman, the renowned physicist, 'if by scientific age we mean an age marked by the rapid and full development of science, and as fast as it can'[8] (Feynman 1998). For some, such as the American futurist and transhumanist Ray Kurzweil, we are on the verge of the greatest and most thrilling

6. A representative group deliberating on an issue.
7. A consultation which groups only those directly affected by an issue.
8. Free translation.

transformation in human history, marked by a rate of technological development so fast and impacts so profound that it will irreversibly transform human life (Kurzweil 2005). Even those who are more nuanced tend to admit that science today is the main force driving the evolution of society.

Furthermore, scientific culture is not ‘something that comes after science, and that is added to it. It is first and foremost constituted by this science that resides in all of us before we even think of or become conscious of it’ (Godin 1999). In other words, we are inheriting scientific culture because we are initiated into it by the mere fact that we are living in societies shaped by science. We thus acquire patterns, structures and habits that ease our adaptation to the evolution of our sociotechnical environment. Furthermore, contrary to yesterday’s common sense, which held that ‘indispensable vocabulary and notions to describe daily experience … came from long accumulated language and wisdom by regional or professional communities … the genesis of the new common sense [is] henceforth associated [with] science’ (Moscovici 1976: 22). Because science ‘invents and proposes the great majority of objects, concepts, analogies and logical forms we rely on to face our economic, political and intellectual tasks’ (Moscovici 1976: 22), it is constantly present and familiar.

Yet – and this is the paradox – reality as described by modern science is removed from daily experience. Gaston Bachelard in his time underlined this divorce. Richard Feynman, in a public conference on quantum electrodynamics, said, in his inimitable style:

> [I]t is possible that you will not understand what I say about the way Nature works, because you do not see why it works in such a way. But, no one can explain why Nature behaves in this particular way rather in another … It is a problem physicists often encountered. In the long run, they understood that whether or not a theory is appealing is irrelevant. What matters, is that the theory accurately predicts what is observed during an experience. The question is not whether or not a theory is philosophically appealing, easy to understand, or acceptable from the standpoint of common sense. But if it is in perfect accord with experience. I thus hope that you will accept Nature as it is: nonsensical. (Feynman 1987: 24–25; my translation)

Thus science is both omnipresent and removed, inscribed in our ways of doing and thinking, and simultaneously abstract and intangible.

17.5 Fifth issue: the internet, a hall of mirrors with infinite reflections[9]

The speed and universality of the changes brought by this scientific age lead society to face challenges like never before.

The communication revolution, itself brought about by this scientific age, is one of those challenges. Because there is no other way to call the radical changes that happened over the past few years in the ways we interact and exchange information among ourselves. This revolution is characterized by the split and the blurring of the system of references. Neither David Suzuki in Canada, a scientist politically engaged in the defence of environment, nor Lisbeth Fog in Colombia, a scientific journalist who coordinates the international SciDev.Net network, nor other scientists, communicators or journalists can claim a monopoly of the legitimate voice in cyberspace. Each one is a mediator among many.

On the internet all speeches are equal, because they coexist with each other. If the internet can be an impressive information tool, it is an efficient disinformation tool as well. Information, true or misleading, is quoted from one website to the next, and from one post to the next, reappearing constantly in one form or another (Oreskes & Conway 2011), perpetuating both truths and falsehoods. From this point of view, one of the issues facing scientific communicators – which is also facing every scientist – is to ensure the reliability of the information exchanged over the net. Their task is comparable to that of Sisyphus.

With the internet, everyone has the world within his reach, so to speak. Such a possibility supports the thesis that each and every one of us is a potential communicator. This is evidently the end result of the accelerated development and penetration of society by the means of communication. This transformation is profound, as the means of communication have become pervasive and omnipresent; it

9. Thanks to Oreskes & Conway (2011) for the metaphor.

is long lasting, as it affects professional habits; and it is structural, as these changes are irreversible.

This is because cyberculture – one of the many avatars of which is scientific cybercommunication – rests upon the three central characteristics of the internet: a browsing capability that breaks with the traditional constraints of spatial and temporal writing modes; hypertext that allows 'a generalized looping of knowledge units'; and a multiplication of interactions, now 'permanent and retroactive', between information producers and users 'with any one point of the communication network' (Weissberg 1999; Pélissier 2002, passim). This cyberculture gives rise to new scientific culture actors and the marginalization of more traditional ones. The new actors come from a wide range of backgrounds – from scientists fully engaged in research to enthusiastic amateurs, all engaged in the production and circulation of scientific news. This multiplies the number of sources and so challenges traditional habits. Thus, there are today more actors taking part in the production of scientific news than there are certified journalists or communicators.

It follows that barriers between professions, unavoidable yesterday, are increasingly blurred. Furthermore, if traditional scientific communication targeted the public as a whole and did not intentionally split it up into specific audiences, the new communication regime focuses on linking well-defined interest groups, fostering such regrouping and, of course, gaining from it. The rules of the game have changed radically! Among all the material accumulating and circulating on the net, it is increasingly difficult to distinguish information strategies from those of valorization and promotion that organizations rely on. It is worth noticing that this confusion is not limited to the net, and tends to spread to every sphere of activity, thus accentuating the blurring.

Besides the loss of bearings, another major consequence of the development of the internet is the fragmentation of information. The cultural changes brought by the arrival of the network society are crucial. First there is the immediacy of the information, with which we are now familiar. The speed of information flows has modified both the production of knowledge and its diffusion. The best example is the immediate coordination and integration of scattered research teams across the world through the constant flow the information they exchange between themselves. In such a world, there is neither centre nor periphery. The relationship with time and space also takes on a whole new meaning: time becomes timeless, while space becomes a space of flux, according to Manuel Castells (1996). But this world of hypercommunication carries with it a break in sociability and the emergence of new forms of exclusion resulting from the individualization of messages, the fragmentation of societies, and the lack of common patterns of communication (Castells 2010).

Yet, nowadays, we get most of our news from media and the internet, to the point that making a clear demarcation between 'real' reality and virtual reality has lost any meaning because our representations and social habits are organized and framed by this continuous input of electronic communications. Thus, they remodel our patterns of cultural communication.

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This conference has decidedly acknowledged this new social reality; it wanted to break with a conception of the communication of science removed from our modernity and provoked a debate on the means to bridge the university and the public. By promoting dialogue and examining emerging practices likely to uphold it, it has proved receptive to the expectations of the public.

The game has changed. It is not enough any more to invite mediators to search for the best forms of communication, or to push scientists to become better communicators. Now, mediators, scientists and others must work together to confront collectively the problems and issues facing us all.

Perhaps is it Michael Mann who, after facing all the adversity[10] caused by his work on climate change and the ascertainment that man was its cause, expresses this new mindset best:

> When we first published our hockey stick work in the late 1990s, I was of the belief that the role of the scientist was, simply put, to do science … Everything I have experienced since then has gradually convinced me that my former viewpoint was misguided … I can continue to live with the cynical assaults against my integrity and character by the corporate-funded denial machine. What I could not live with is knowing

10. It is worth noting that most of the controversy surrounding climate change is fed by interest groups that oppose all state regulation, while the scientific community reached a consensus on its reality years ago.

> that I stood by silently as my fellow human beings, confused and misled by industry-funded propaganda, were unwittingly led down a tragic path that would mortgage future generations. (Mann 2012: 253–254)

This is the issue. This is the challenge.

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