AT THE HUMAN SCALE

INTERNATIONAL PRACTICES IN SCIENCE COMMUNICATION

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The production of science knowledge is doubling every seven years. As it expands, science splinters into new and unimagined strands. No one can keep up.

How can any ordinary citizens play a meaningful part in discussions on their future, in the face of this explosion of knowledge? Is it any surprise the public daily grows more sceptical about the benefits of science? Public demands for evidence and reassurance grow more strident, but most of all the public wants time to adjust to a world threatening to career out of their control.

At the Human Scale is a response from the public face of science, the science communicators. It stresses local action at community level and focus on long-term effects.

It's snapshot of ideas that work, a combination of theory and practice. It contains good ideas and the methodologies that lie behind them.

The papers in this book were presented at a symposium in Beijing, and voted by the international delegates as the most challenging, the most relevant and the most useful.

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Table of Contents

Part 3
Dialogue with communities

Part 4
Involving scientists

Appendixes

Communicating science
in the real context of society

Bernard SCHIELE

In a nutshell

This chapter provides an analytical view of the public communication of science and technology (PCST). It examines the history of such communication and the relationships that science has with the general public. Four key conclusions emerge from this analysis, and from the presentations and discussions at the symposium.

- **Trust** – The public's doubt about science, especially controversial science, needs to be recognized and taken into account by scientists, research organizations and government.

- **Knowledge gap** – Research is expanding into new fields so rapidly that no-one can keep up. The widening gap in knowledge between scientists and the general public needs to be accepted as a constant reality of the environment within which science communication will always work.

- **Local action** – Science communication needs to respond to clearly identified local issues, by fostering local actions focused on concrete situations.

- **Long-term actions** – Science communication is a long-term process that needs to take into account the time taken to develop social relationships and shared meanings.

Introduction

It's common to lament the chronic lack of science and technology (S&T) knowledge exhibited by a major portion of the general public.

The real challenge, often repeated by those in PCST, is to maintain individual and collective efforts in a society in which knowledge is increasingly complex to decipher and difficult to master. This theme relentlessly pleads for recognition of the value of PCST, and for it to be given its due along with the means to achieve its mission. As signalled in the symposium opening speech by Alan I. Leshner (Chief Executive Officer, American Association for the Advancement of Science): ‘ Science and technology are embedded in every aspect of modern society and contribute greatly to economic prosperity, national and individual security, health status and quality of life. ’

But it was also noted that, while science is held in high esteem by a majority, ‘ recent scientific advances, however, are approaching, and for some threatening, an array of core human values. ’ As a consequence, ‘ this is adding substantial tension to the historically strong relationship between science and society ’ and raises questions about the traditional reaction ‘ to try to increase public understanding of science in the hopes that understanding will yield acceptance ’. He added that ‘ in the current climate, simple education will not work. The scientific community needs to adopt a more effective strategy of truly engaging the public in a dialogue about science and its uses, where each party respectfully listens and responds to the needs and concerns of the other ’ (Leshner 2005).

The problem raised has three dimensions. The first is the question of raising the collective level of scientific and technical competence. The second involves choosing the means of dissemination to provide access to knowledge. Third, and most important, is the need to support the rapidly evolving relationships between science and society.

The symposium chose to approach these three dimensions head on, by adopting the objective to go beyond 'the traditional focus on "facts" to attempt to genuinely engage urban and rural communities'. This recognized the place of values and emotions, local and cultural contexts, and that sources of knowledge other than science can be just as important for effective communication. To achieve this, the notions of 'participation rather than promotion' and 'appropriation rather than learning' were 'emphasized in the context of growing pressures to ensure activities have broad-scale application'. Examples of dialogue, hands-on activities, practical involvement and participation were sought, 'mostly on a small scale at the local level'. From this perspective, initiatives driven by communities and peer-to-peer communication were believed to be essential for long-term impacts, even if 'evaluating these impacts effectively is still a challenge'.

The symposium wanted to bring into focus the fact that 'with a renewed emphasis on collaboration and partnerships across many disciplines and cultural pursuits, S&T communicators are moving into areas of engagement with urban and rural audiences that were unknown even a few years ago', while at the same time keeping in focus that ‘ achieving public trust and support for science is at the top of the list for many S&T communicators’. This was perceived to be best achieved through dialogue (or ‘trialogue’, emphasizing that information and idea sharing should occur among more than two groups, such as scientists, communities and policy makers). More traditional aims are still high on the agenda: spreading scientific knowledge for better quality of life, ensuring that knowledge matches progress, and promoting careers in science. But activities that 'share' with the public and incorporate different knowledge bases were actively sought (Metcalfe et al. 2005).

The approach adopted by the Beijing Symposium clearly added to our reflection on the relationships between science and society. These have been discussed at international conferences since the 1960s, when the science-society connection began to spark serious questioning amid disenchantment with progress. Concern gelled around the factors, conditions and means of access to scientific knowledge, and ways to promote sharing among scientists and the public in order to bring them closer together.

This paper explores the relationship between science and the public by looking at the history of PCST and the key points emerging from the Beijing Symposium.

The relationships between science and society

A consensus on science communication emerged from the Montreal PCST conference in 1994. The consensus was based on four pillars--four core meanings that yield a contemporary understanding of the relationship between science and society (Schiele 1994).

Science and technology, the ‘great actors and accelerators of the transformation of the world, are at the centre of the productive system, daily life and the reflection on the contemporary world’ (Jantzen 1996). To maintain this dynamic, they presuppose the perpetuation of values that make up the foundations on which this modernity is built. The contemporary expression of rationality occurs by assimilating modes of reasoning inherent in scientific thinking. This responsibility is primarily incumbent on the schools, and is maintained by S&T communication. The challenge is to reproduce the values and abilities on which our society is built.

Maintaining the collective economic capacity of a nation demands rapid and flexible adaptation to change; this adaptation relies on a constantly renewed mastery of scientific knowledge and areas of application. Raising the threshold of science literacy contributes to a nation's prosperity. Rapid adaptation to scientific, technical and industrial changes, which is the key to boosting competitive capacity, happens through development of new competencies, based on an understanding and mastery of fundamental principles of S&T. The challenge is to maintain, or even increase, the margin of economic competitiveness.

Advances in science (especially in biotechnology and genetic engineering, hot topics that grab the most media attention today) are revolutionizing our understanding of the living world, challenging our very concept of life, and progressively deconstructing the complex system of ideas, concepts and representations that were formulated and shaped in a slow process through history, enabling us to perceive and think of ourselves as 'human'. The challenge is the realization that 'human beings' define, understand and perceive themselves through the discoveries of science.

The democratic resolution of environmental, societal and philosophical debates sparked by these upheavals demands everyone's enlightened commitment. Access to S&T communication for the greatest number guarantees collective and individual integration in an ever more complex society. Science and its achievements, constantly revolutionizing relationships to the world and society, require everyone to act with knowledge in making the ethical, strategic, ecological and technological choices that engage the future (or at least understand the implications of those choices), to be acknowledged as full citizens. The challenge is democratic empowerment.

These four key dimensions form the cornerstone of all efforts to publicly communicate S&T. They have made it possible to develop and carry out projects, to fully or partly orient the actions of those engaged in conducting those projects, to channel the strategies and content choices, and to guide the ways to treat, present and develop them.

Science and PCST: a very short history

It may surprise some people that bringing science to the public is not new. Indeed, it has a long history, and continues with the contemporary will to publicize science.

PCST does not oppose scientific thinking in defining its expression and justification. On the contrary, PCST seemed necessary fast for scientists, so that science and disclosure could be reciprocal in the same structural moment, one which distinguishes scientific thinking (experimental thinking, then in the process of forming) from speculative thinking. Three moments in time, which are also historic milestones, must be considered. First, early science became less of an individual secret. From then on, it was a matter of sharing the product of scholarly activity as much to validate the knowledge produced as to disseminate it. Communication is therefore central to scientific practice. Second, throughout the 18th century, teaching (or research) and popularization were often confused. Science, notably less mathematized than today, was a large part of nature and remained readily accessible. Third, only in the 19th century did a gap form as the formalization and multiplication of disciplines became generalized. The 19th-century momentum, characterized by the affirmation of the social necessity of science, continued into the early 20th century and up to the 1960s.

Two ruptures occurred in the 1960s and 1970s. The first was characterized by a growing independence of science communication from science per se, which affirmed the legitimacy of S&T communication. Popularizers who had previously been auxiliary to the scientific community were demanded to be the exclusive mediators with the general public. They justified this demand by denouncing scientists as lacking the capability to address the public, decipher its expectations, and share the 'immense powers that knowledge gives'. Moles and Oulif (1967) summarized the vision of this era:

> A new function took hold in society: that of *mediation*. The intercessor would be responsible for the *communication* of elements of thought between those who make them, in an abstract but necessary language for a highly coherent system, and those who with information should have the right to examine the resulting decisions, be they on space policy or new theatre, decisions that too often are made only by distant authorities, whose reputedly infallible oracles have sole access to the *dossier*.

A 'third man' had to be substituted—one who was neither scientist nor layperson, who would be an intermediary between the scientific community and the public at large. The two would be brought into contact with each other, filling the knowledge gap that had opened up between science and ordinary knowledge.

The second rupture was marked by an increasing awareness that progress also brings problems and risks. In the 1960s came the stark realization of a progressive invasion by science and technology; their ramifications invaded the smallest niches of daily life, with concomitant social transformations, and they particularly affected the organization of work. This penetration was of course accompanied by accidents of dire consequence, such as the oil spill from the shipwrecking *Torrey Canyon* in 1967, or the March 1979 accident at the Three Mile Island nuclear plant. Add to this the persistent pollutants, such as PCBs, dioxins, furans, DDT and the multitude of pesticides present everywhere in the environment, whose effects represent serious and insidious threats to public health (and the balance of ecosystems), and which were already being denounced in the early 1960s (Carson 1962). Too many repeated incidents sparked a backlash against scientific development and the accompanying notion of progress. A systemic doubt grew progressively in people's minds and became a fact of society. The public became cautious, distrusting and critical.

The state enters the fray

Beginning in the early 1980s, promotion of PCST was seen as a challenge for society. Governments took matters in hand and were quick to make science communication their business.

The Bodmer Report, published in 1985 in the UK, sounded a serious alarm and encouraged scientists to make efforts to communicate with the public. The Committee for the Public Understanding of Science (COPUS) was set up the following year with a mandate to promote the broad visibility of PCST. In the scientific field, COPUS also helped enormously in legitimizing researchers' activities of dissemination to the general public[1]. From 1994 onward, the Office of Science and Technology (OST) continued and expanded the objectives of COPUS. In his opening address at the symposium, Roland Jackson (Chief Executive, British Association) recalled the still very active role of the OST, particularly in its efforts to involve the public during the launch of a research programme. Remarking on

1 For an assessment of the impact of COPUS, see http://www, evaluation, co. uk/pus/copus/COPUS, html and http://www. evaluation, co. uk/pus/evaluation/Ukevaluations.html.

a project in developments in cognitive systems, for which the British Association hoped to spur fruitful discussion right from the start, he said:

> We wanted to see if non-scientists, representative of those with an interest of science but not actively finding out about it, could sensibly discuss options and priorities with the researchers, and generate some common language for discussion, despite being unfamiliar with the detail of the leading-edge science. In other words we wanted to establish some sort of more anticipatory form of technology assessment which might, if introduced more generally, be expected to generate more trust and consent in comparison to the current position in which the public simply reacts on a case-by-case basis (such as GM food in the UK). Perhaps unsurprisingly, we found that if the discussion was organised around questions such as benefits, concerns and moral issues both the scientists and the non-scientists could have very constructive discussion (Jackson 2005).

In the US, a host of organizations pursued the same PCST objectives.[1] ‘ However, given local independence and the spirit of initiative that characterizes American life, no real attempt was made to systematically coordinate or catalogue these activities. There is no national policy for PCST; nor does there exist an information base or the political will to create it' (Lewenstein 1994). This doesn't stop federal government departments or national agencies from actively promoting PCST. Also deserving of mention are the American Association for the Advancement of Science (AAAS), with a hefty 141,000 members and 300 affiliated organizations, and the American Chemical Society, which organizes National Chemistry Week each year with the participation of its 200 local sections. In 1985, at the time of the passage of Halley's comet, the AAAS launched Project 2061. This involved, on the one hand, defining the national standards for PCST – in a country where the educational system is completely decentralized – and, on the other, working to achieve them by 2061,

[1] There should be a whole book to describe American initiatives. For an overview (which should be updated), see Lewenstein (1994).

the date the comet returns. [2] Europe has since followed suit, launching European Science and Technology Week in 1993.

One could cite other examples, but it's sufficient to point out that PCST has long been at the centre of the social project. Many countries have been on board in varying degrees. [3]They have programmes to increase the public's level of scientific information, to renew the image of the sciences, to involve the public in the discussions, and to engage youth to embark on careers in science. This is the essential theme of all the policies and measures adopted.

Doubt creeps in: science and technology are no longer a panacea

What did this mobilization yield? An overall assessment reveals the presence of more equipment, more projects, more professionals working in the sphere, and budgets that have generally remained stable from year to year. However, in Europe, PCST initiatives have always had a marginal effect in advancing researchers' careers, and science media jobs don't lead to careers offering the same benefits as those of researchers and teachers. But the European situation cannot be generalized. In Australia--for example, with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) – and in the UK, professionals are responsible for communicating the scientific aspects of organizations' work to the public; the profession of scientific communicator is well established.

Two overlapping constants emerge: the ongoing crisis of confidence, and the fact that science literacy remains below the desired level.

The House of Lords *Science and Society* report, published in February 2000, adamantly asserts:

[2] See http://projeet2061.aaas.org, AAAS (1993), and Rutherford and Ahlgren (1990).
[3] For a general survey of the development of PCST in Germany, Australia, Austria, Belgium, Cameroon, Canada,
Denmark, Spain, Finland, France, Greece, Italy, Japan, Mexico, Norway, the Netherlands, Portugal, the UK, Sweden and Switzerland, see Schiele (1994).

> Society's relationship with science is in a critical phase. Science today is exciting, and full of opportunities. Yet public confidence in scientific advance to Government has been rocked by bovine spongiform encephalopathy; and many people are uneasy about the rapid advance of areas such as biotechnology and IT – even though for everyday purposes they take science and technology for granted. This crisis of confidence is of great importance both to British society and to British science. (SCST 2000)

Roger-Gérard Schwartzenberg, Minister of Research, France, fully concurred at the launching of the Assises de la culture scientifique (Conferences for Scientific Culture) in November 2001, when he said:

> I had hoped that an overall reflection on scientific mediation would develop, with everyone involved in the production and dissemination of knowledge to strengthen the dissemination of scientific and technical culture, despite what has been accomplished ... today we must, 20 years later, move on to a second stage, to enlarge and renew this effort ... How can science and society be brought closer, when nowadays they are tending to become more distanced? How to reduce this distance and how was it created?[1]

Tony Blair, in turn and in the same spirit, declared in 2002:

> But there are three main reasons why I want to address the potential of this new age of discovery. First, science is vital to our country's continued future prosperity. Second, science is posing hard questions of moral judgement and of practical concern, which, if addressed in the wrong way, can lead to prejudice against science. Third, as a result, the benefits of science will only be exploited through a renewed compact between science and society, based on a proper understanding of what science is trying to achieve.[2]

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[1] Speech by Roger-Gérard Schwartzenberg, Minister of Research, CNRS, Paris, 12 November 2001, http://www.recherche.
gouv.fr/discours/2001/dass.htm.

[2] Science Matters: http://www.number-lO, gov.ukloutout/Pagel715.asp.

Governments observe that citizens are curious and have an interest in the sciences but at the same time exhibit certain scepticism and distrust. Why? They 'are lacking reference points to understand the world around them'. How, then, can we promote the scientific vocations and direct young people to scientific and technical paths? It's necessary to confront the issues and provide reference points, because the 'vital roles of S&T in our society, and also in our everyday lives--increasingly structured by innovation—demand an operative relay adapted to the public at large. This entails disseminating information, reference points, keys to understanding the world for a diverse public'[3]. PCST must be recast with a new approach: we can broaden access to scientific culture only if we renew and modernize the ways used to transmit it and to make the general public aware of it.

From the literature review undertaken in preparation for the Beijing PCST Working Symposium, we concluded that the 'doubt', 'scepticism' and 'distrust' were not residual; nor did they stem from a lack of awareness, or a knowledge gap between science and society. Consequently, we considered this mindset to be an aspect of the reality of contemporary societies. *Doubt, which is an element of the current social equation, must be taken into account.* Michel Claessens (Deputy Head, Information and Communication, Directorate-General of Research, European Commission) reiterated this view in presenting the results of the most recent survey by the European Commission: 'What is true is that people no longer have a naive view on science and technology. They do not see them as universal panaceas' (Claessens 2005). And Roland Jackson concluded his talk in the same vein:

> While economic dimensions are vital, I have a strong sense that we need to articulate much more clearly the social and environmental goals to which science and technology can contribute, which I expect would more readily generate public confidence and support. I also believe that

[3] See 'Plan national pour la diffusion de la culture scientifique et technique', http://www.recherche.gouv, fr/discours/2004/ dplancs.htm, and press conference of 25 February 2004 by Jean-Jacques Aillagon, Minister of Culture and Communication, www.culture.gouv.fr.

> scientists must come out of their laboratories, and technologists and engineers out of their workplaces to talk with and listen to the public about the reasons for what they are doing, the benefits, the possible concerns and the ethical implications. We need them to do this so that people are properly informed about the science and what scientists are doing, and so that scientists have a proper understanding of people's priorities, interests and concerns. This process needs to become part of the professional expectation of scientists, and suitably recognized, valued and rewarded. We are still some way from that point but, in the UK at least, there are clear moves in that direction.(Jackson 2005)

The gap in knowledge: measuring science literacy

The second conclusion we reached was that, far from narrowing, the knowledge gap between science and society continues to widen. This gap is growing because so much more knowledge is being generated, and even well-meaning people can't keep up. The size of the gap is not linked to the will of those involved or to the inadequacy of means of communication. It is instead due to the increasing complexity of our society. In the sciences, this increasing complexity is revealed by a fragmenting of disciplines and a specialization within those fragments that makes each specialist a stranger, a kind of layperson, for another. So it's not a gap between scientists and non-scientists, but a multitude of gaps between laypeople, between scientists, between specialists. Our society isn't characterized by an enormous hiatus between those who possess knowledge and those who don't, but rather by a multitude of fissures separating the specialists, the specialists within their specialities, and laypeople—each one alone on their own island.

This explosion of knowledge means we no longer have a shared culture of S&T, and this position is going to worsen in the future. Whatever the extent of the knowledge mastered by anyone in a given field (that's if the specialists can agree among themselves on what they consider to be essential), an individual can only be out of sync, out of touch, with other fields and with the new knowledge produced in those fields.

The gap is structural. In the 'science archipelago' [1], the knowledge gaps can only grow wider. *From this angle, the question of scientific culture, raised in terms of the gap between scientists and the public at large and often theorized under the term 'deficit model', is a false problem, leading to a dead end.*[2]

But just what, exactly, do these surveys measure? Are they measuring the right things? And what conclusions can we draw from them?

The simplest notion that many have of S&T communication is as knowledge of basic facts, elementary concepts, and a general understanding of the scientific effort.[3] Determining the science literacy of a population therefore means measuring (by survey, inquiry, etc.) the rate of correct answers to these three indicators. Below a certain minimal threshold, authorities consider that some individuals, designated as scientific illiterates, lack the competencies required as citizens in modern post-industrial society. This is the viewpoint adopted by the National Science Board (NSB) in the US and by the European Commission, which regularly conduct surveys of this kind to collect comparative data and analyse trends. The most recent US survey (NSB 2004) revealed that. out of 13 questions designed to measure the level of science literacy, Americans averaged 8.2 correct answers (63%), compared to 7.8 for Europeans (60%).[4]

Compared with earlier surveys, this rate has remained constant in the US since 1990. There have certainly been some changes, which the NSB points out: more people today know that antibiotics don't kill viruses (this result is attributed to media coverage of ailments caused by drug-resistant bacteria); and for the first time more than 50% of Americans (53%, up from a previous rate of 45%) answer 'tree' to

[1] The expression is from Jean-Marc Levy-Leblond.

[2] For a more in-depth discussion, see Schiele (2003, 2005).

[3] The question of assessing CST garners much more attention from researchers than it does interest from governments. Among the extensive works, see Durant (1993), Laugkscsh and Spargo (1996), Jenkins (1997), Miller (1998) and Miller and Pardo (2000).

[4] Unless otherwise indicated, the data is from NSB (2004).

the statement 'Human beings as we know them today developed from earlier species of animals' (69% in Europe). The results of the latest European survey (January-February 2005), compared to those of previous surveys (1992, 2001 and 2002), led Michel Claessens (see the next chapter) to observe that the level of scientific knowledge has increased substantially in many countries:

> Increases of over 15% are observed in Luxembourg, Belgium, Greece, the Netherlands and Germany; in the new Member States, the Czech Republic and Slovenia show a 10% increase in only three years. Sweden and Denmark achieved the highest rates of correct answers to the questionnaire's scientific knowledge quiz (13 questions). Results of the quiz show that for most statements a majority of citizens in the European Union answered correctly, which allows us to conclude that Europeans have a fairly good knowledge of scientific topics. The average of correct answers reaches 66% for the European Union, while that of wrong answers remains quite low at 21%(Claessens 2005).

This means that Europeans with an average correct answer rate of 66% have improved by 5 percentage points compared with earlier results and lead the US by 3 percentage points, using the NSB 2004 results.

Measurement in S&T communication also takes two other factors into account: attitude and interest. A positive attitude towards S&T, along with a certain basic scientific knowledge, appears to determine an individual's capacity to engage in democratic discussion. The inverse appears true, too, with the expectation that raising the level of S&T communication for the public favours a positive attitude, enables citizens to better understand scientific and technical issues and encourages participation in discussion and decision making, since citizens will be aware of the impact of S&T on society and the inevitable choices that ensue (Miller 1983). A higher proportion in the US than in Europe considers this impact to be beneficial. [1] Thus, 86% of Americans, as against 71% of Europeans, agree with the statement that 'Science and technology are making our lives healthier, easier, and more comfortable'; 72% and 50% of these, respectively,

[1] For a comparative analysis, see Banchet and Schiele (2003) and Miller (2003).

feel that 'The benefits of scientific research outweigh any harmful results' (NSB 2004: 73). The NSB takes considerable care to emphasize that the proportion of Europeans who staunchly disagree is higher than in the US (one in four in Europe, compared to one in ten in the US), and that the percentage of Americans who consider the outcomes to be mostly beneficial has remained above 70% since 1988 while the European percentage fell significantly between 1992 and 2001.

In this regard, the NSB suggests that the probability of showing a positive attitude increases as a function of correct answers to the knowledge test, but that the link is weaker in the US. In other words, unlike among Americans who are naturally more inclined to see the good side of science, having a certain level of scientific knowledge fosters a positive attitude among Europeans – a point far from being verified (Claessens 2005). What is verified, in the NSB's view, is the initial statement that knowledge, a positive attitude and interest make up a whole, which in mm suggests that a person can indeed have a positive attitude to S&T without any real interest in it. One person may have little interest but feel well informed, just as another may show considerable interest but feel poorly informed. One thing is certain, however, and confirmed by all the work: the main contributor to a prolonged interest--and a 'competence' in S&T communication--is training in science. A solid education in science and mathematics spurs sustained learning. The second factor is increased formal education, whatever the area of training. Informal learning doesn't have the same lasting effect.

A review of the principal studies conducted from 1990 to 2001 shows that the number of adults regarded as 'scientifically literate' has doubled over the past 20 years and is now close to 17% in the US, the UK and France'[1] However, this level 'is still problematic for a democratic society that values citizen understanding of major national policies and participation in the resolution of important policy disputes' (Miller 2004) .

[1] The NSB data covers a dozen years (1990-2001), which, if this trend is verified, implies that the increase occurred before 1990 (Miller 2004).

Assuredly, there will always be at least one keen journalist intent on reminding viewers or readers that only 41% of European respondents consider the statement 'Electrons are smaller than atoms' to be tree (48% in the US[2]), thereby reinforcing the views of those already convinced that we aren't doing enough to alleviate scientific illiteracy, and have to beef up the publicity effort.

All these surveys invariably reassert that the probability of contact with science culture, when it is not specifically encouraged at school, undertaken systematically in a spirit of self-learning or sparked by a chance encounter, increases with schooling, in science as in other fields. While tacitly pleading for greater publicizing of science among the public, these surveys consistently show that only a minority, namely those with the most schooling, develop the desired interest or competencies needed to help bring science and society closer together. Moreover, they show that the artistic, literary and economic cultures, which are basically in the same boat, are also poorly shared. The survey results certainly seem to indicate that the media has a limited impact on the acquisition of new knowledge and the development of a scientific mindset.

But there's a knowledge transfer, nonetheless: on the one hand, for all its deficiencies, the media is an information source; on the other hand, learning is a process. We don't learn in one shot, or from just one medium; we learn by repeated hits, in multiple stages, through successive corrections, and from different sources. This applies to all learning. The public is able to understand and retain despite distortions, incomplete information and lack of training. Therefore, these efforts emphasize the role of schools and the media. Schools are expected to provide a formal introduction to science, which it's hoped will engender a sustained interest, while the media – taken in the large sense – should abet this interest by according more attention to the sciences, and, for those showing less interest, increasing points of potential contact so as to inform, stimulate, involve and engage them. Consequently, achieving this genuine scientific and technical culture, though hoped for and desired

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2 For the US, NSB (2002); for France, Eurobaromètre 55.2. http://europa.eu.inffcomnVpublic_opinion/archivetdeb/ ebs_154_en.pdf.

because it's considered essential for the enlightened participation of citizens in relevant debate, hinges on training for some and on everyone's exposure to random and diffuse information. Is this not the tension being measured by the surveys?[1]

The question then becomes: What is the value of these surveys? Are they measuring a superficial understanding of simple science facts, or are they able to give an account of a citizen's ability to operate in an increasingly scientific world? Are they adequately measuring the gap between contemporary science and society? Are they really assessing how science and scientific knowledge are integrated into social life and daily activities?

The need to foster local action

How do we escape the paradox of a periodic reassertion of the need to publicize the sciences, with the accompanying wait for the impact on science and society, when we have lingering doubts about the actions, their scope and their effectiveness? *The Beijing PCST Working Symposium's third angle of approach was to foster local actions, focused on concrete social situations, with a view to responding to clearly identified problems.*

Does this mean objective information is secondary? No! But in situations of informal S&T communication such information doesn't dissociate, so to speak, the destined usage from its social context. In this perspective, the comment by David Dickson (Founding Director, Science and Development Network) about 'facts' during his talk at the symposium takes on a whole other dimension:

> My basic premise is that substantial and effective dialogue will only take place when those on both sides have a sound understanding of the relevant factual evidence; indeed evidence-based decision-making is an ideal that we should aspire to at every level of society, from local

[1] For a critical review, see Pardo and Calvo (2004).

communities to the top levels of government. And if the relevant factual evidence is absent--which often, sadly, turns out to be the case--then it is surely the role of the science communicator to fill the gap. In other words, they need to make up the relevant 'knowledge deficit' (Dickson 2005).

The need to target long-term actions

S&T communication efforts consist mostly in reconfiguring the representations of the social actors (while simultaneously deconstructing still other operative ones); transforming their relationship to knowledge; engaging, so to speak, the social actors to rethink how and in what way the sciences--and certain knowledge in particular situations—'make sense' for them. If science literacy can be defined as a complex of signs and meanings (including language) woven, alloyed, intertwined in the devices for transmitting values and meaning (Harvey 1995), we understand that science communication practices move within matrices of relationships and interact with shared meanings. These practices must take such interactions into account, since they are instrumental in deconstructing the old knowledge and establishing the new.

In a way, appropriating the knowledge also means acknowledging its potential to transform the sense, which in turn generates its structuring. It's sharing a new sense or meaning while mastering specific knowledge that really matters. For let's not be deceived--it's consolidating the sense that produces the culture, and not the reverse (Castells 2000). That's why the errors, simplifications and reductions inherent in all kinds of messages are ultimately secondary (which doesn't mean they're insignificant), as are all the difficulties of understanding encountered in learning--and nature's own resistances to disclosure, too. By successively refocusing representations and correcting errors, knowledge is appropriated and new competencies acquired. *Science communication needs to target long-term actions —those that take into account the social relationships and shared meanings*.

Conclusion

The Beijing PCST Working Symposium consolidated new directions for PCST. To be effective, efforts need to recognize that society has a higher level of doubt and a lower level of acceptance of science. PCST efforts must accept that science literacy is something that will always be limited, even to those directly involved through formal education or occupation. Rather, for science to be truly relevant to society, people need to be engaged in discussions about science at both local and personal levels. This engagement needs to be long term if science is to be a useful part of people's lives, and recognized intuitively within their decision-making processes and message interpretation.

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