3th International Conference on Public Communication of Science and Technology
(PCST), Montreal,Canada,10-13 April,1994

SCIENCE AND TECHNOLOGY CULTURE: WHY DOES IT MATTER?

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Calls for better defined and more effective policies for the diffusion of scientific and technological [S&T] culture have multiplied in recent years. It seems to me that the first question that ought to be raised is: Why do we care at all?

It is certainly because the S&T culture, whatever it may mean, is seen as of primary *importance* and, second, because most analysts seem to agree to deplore its *low level*.

I suspect that for the sponsors of the present international colloquium, one of the aims in forwarding such a large debate is that perplexities remain concerning the ways to straighten a situation generally perceived as unsatisfactory. Indeed, through muddled or wishful thinking, we have come to a situation of confusion and disarray.

Let us first ask ourselves why we deem the S&T culture so important? It might help us a great deal in figuring out what it ought to be and how it might be promoted.

After all, we have never observed such lasting surges of interest for the diffusion of literary or musical cultures, or at least nowhere have we seen in the general press that we are threatened as a society by the poor extent of the diffusion of these cultural elements. It remains to be seen that lead articles in newspapers would deplore a general lack of understanding of the dodecaphonic system, and that the readers would agree that this is a major social problem.

It is clear that our sense of the importance and urgency of promoting a S&T culture in the population does not flow from purely "cultural" reasons, if by culture we mean the cultivation of the mind, the enjoyment of the creations of the mind, some sort of politeness of the mind, or a proper type of consumer activity.

In his famous plea for opening, or rather for re-opening communications between the "two cultures", C.P. Snow was mainly concerned with bridging the "gulf of mutual incomprehension" between the scientists and the literary intellectuals.[1] Though we may not be indifferent to that problematic, our main concern here is not a longing for the recovery of some lost and possibly illusory unity of our cultural experience, but rather the issue of a better diffusion of scientific culture among the larger population. Why is it so?

An easy answer is that if we care so much about S&T culture, it is because we now live in an S&T society. But again what do we mean when we use such a phrase? After all, we certainly also live more than ever before in a musical society, even though the music to which we are exposed most of the time may not be the kind of music we appreciate most. But we do not make such a fuss about music and other components of intellectual life. Why do we see the S&T culture as so vital? It is I think for three related sets of reasons:

- For *economic reasons* first: we may think that we need S&T to keep our rank as an industrial country, and that S&T are absolutely needed to prepare in an adequate manner the work force for more demanding jobs in a quickly evolving market in which knowledge is becoming the most critical commodity.

- Second, for *socio-political reasons*: at a time when main political decisions almost always aim at issues having S&T components, it is often claimed that democratic life requires from citizens an understanding of these components. It is seen as a matter of political morality, but also of pragmatic consideration: now that "public participation" in decision-making is recognized as a major issue, it is felt by many that unless the process involves a scientifically literate citizenry, either decisions will undemocratically be left to some private clubs of experts, or will be flawed because of pressures coming from ill-informed groups.

- Third, and finally, if we think that the diffusion of the S&T culture is so important, it also is because at a time of rising costs and increasing competition between diverse sociopolitical priorities, there is a general feeling that the scientific enterprise will be threatened unless it can count on *strong public support*. This, I think, is crucial if one wants to understand why the scientific community is so vocal about the S&T culture. This is one of the main reasons why the debate has shifted since the time of C.P. Snow's controversial lectures; it is no accident that at the turn of the 1970s, when counter-cultural movements multiplied and strong anti-scientific sentiments were widely voiced, programmes aiming at the so-called "public understanding of science" emerged and ranked high on the agenda of funding agencies, scientific organizations and their constituencies in Western countries.

These I think, the needs of the economy, the requisits of democracy and the interests of the scientific enterprise, are the reasons why the S&T culture is nowadays being constructed as a major social issue. This is not to say however that this description of motivations gives us an understanding of what S&T culture is, or ought to be.

How will the S&T culture make any difference? It depends of what we mean by S&T culture.

Indeed, it may be worthwhile to question the very idea that, regarding the three sets of issues I have just listed, it would be meaningful to consider the S&T culture as an unequivocal single entity. What needs to be done may call for different solutions; S&T culture may have more than one meaning.

If S&T culture is a culture at all, it may be in an ethnographic sense. Ethnographers see the culture of a people as embodying basic assumptions about the world, patterns of behavior, material artifacts, a distinctive organization of activities. We find something similar in the world of science and technology: groups of scientists share a common body of knowledge, participate in the same rites, use the same methods, and so on. Culture in that sense is a matter for actors in the field, for practitioners. The processes of disciplinary inculcation, of the constitution and transmission of the common culture of a discipline, in the wake of Thomas Kuhn's

famous book on *The Structure of Scientific Revolutions*, has now been studied in depth by sociologists of science.

In that sense, S&T culture, as disciplinary culture, is a matter of formal training. In that strong sense, only scientists, engineers and technicians are members of that culture or rather of one of the many cultures of science. Others, who are not practioners of the sciences, but want to learn *about* them, are so to speak cultural tourists, or at best, or worse, ethnographers. But we need to realize that an S&T culture in that strong anthropological sense, as knowledge, know-how and action, is distinctive precisely because it is specialized and severely bounded.

A competent scientist may know very little about the culture of other disciplines; scientific culture is mostly disciplinary culture. Or interdisciplinary in a rather limited sense. When we say that we want a scientifically literate citizenry, what do we mean? Certainly not that we expect the lay citizen to equally partake of the culture of all disciplines; even scientists cannot do that. It shows in details of daily life in what I have called earlier our S&T society. Take the videocassette recorder [VCR]. Even among us here, who may pretend to really understand the functioning of these machines; certainly not myself. Such a feat would require at the very least an understanding of the science and technology of frequency modulation, of electronics, of magnetic recording, of magnetic theory, of materials including sophisticated synthetic molecules, and of control theory. Some of us may have a general understanding of some of these elements; none of us would know how to manufacture a VCR.

Clearly this is not the sort of knowledge that we have in mind when we speak of disseminating an S&T culture, and it would not be reasonable to expect it even from a scientifically "literate" population. We expect it only from highly specialized experts, or rather from well organized groups of experts, partaking of a subculture in the anthropological sense.

That sort of culture is gained through formal training and practice. I think we easily see how that sort of learning through formal training is essential to meet the basic requirements for the solutions to our first set of problems: impulsing an innovative economy through the activities of employable and well trained citizens. Not all men and women need to be trained as scientists, but they all have to be

minimally literate in science, and that minimum may have to be set with modesty, if it is true that, as reported a while ago in *Time* magazine, some students in the ninth grade do not know how to read a ruler. In fact the enormous magnitude of the task is well emphasized in the very name of the American Association for the Advancement of Science program to make the US population scientifically literate: "Project 2061". Indeed it then appears realistic to think in terms of decades and not of years. This is a matter for schools and for continuing education, including professional training in the firms, a type of activity which is essential but that we are not yet mastering as well as in Canada some European countries, such as Germany. This is a matter of scientific and technical literacy; it does not cover however all that we have in mind when we speak of the S&T culture in science policy forums. Though they remain basic, and no doubt of the highest priority, the acquisition of literacy, and expertise through formal learning, do not automatically solve our two other sets of problems, as we shall see.

In his book on *The Economics of Industrial Innovation*[2] Christopher Freeman writes: "Public participation in the process of consumer-oriented innovation has very great implications for the education system as well as for the political system, the mass media and science journalism. […] The function of 'technology critic' is just as important as the function of 'literary critic' or 'art critic' and to some extent these should overlap. But such criticism will be far more effective when social scientists develop quite new techniques of technology assessment. […] Innovation is far too important to be left to scientists and technologists. It is also far too important to be left to economists or social scientists." What Freeman has in mind here are new processes of S&T assessment and decision-making involving some sort of public participation. The citizens will not all be scientists, and each scientist cannot be trained in each of the sciences relevant to meet the different problems that decision-makers face in our societies. And solutions to these problems, the decisions to be made, will not wait till everyone is competent to tackle these tricky issues. Basic training, basic scientific literacy will help. But some other ways of transmitting and discussing information will have to be found. This is what we have in mind -and not too clearly as we shall see- when we speak of the popularization of S&T as a form of dissemination of an S&T culture.

Commenting on the AAAS "Project 2061", Congressman George E. Brown Jr. wrote: "A democratic society may flounder unless all citizens understand the spirit, character, and values of the science that empowers so much of society."[3] Let us underline that here what is called for is not so much an understanding of the content of science as of its "spirit, character and values". This brings us I think to the fundamental ambiguity of the very notion of a popularization of science: it may mean as well making science more popular and the scientists with it and not necessarily making the people better educated in science. I suggest that, though both goals are perfectly respectable and can be pursued concurrently, one is often confused with the other.

Let me here take some examples from recent debates concerning biotechnology and the public perceptions of risks associated to them.

At a workshop organized a few years ago in Ottawa on agricultural biotechnology, a high civil servant from one of the provinces declared: "Perhaps the single most important factor that must be adressed by biotechnologists, governments, and industry, are the concerns and attitudes of the public related to any "new" technology. […] If we take the mystery out of biotechnology and keep the media and the public informed, then we can advance and use biotechnology to its full potential". And he added: "Public acceptance is directly proportional to public knowledge". I am afraid that there is no convincing empirical evidence for this last statement. Unless one understands knowledge as meaning the viewpoint of some of the experts. To popularize science in the sense of disseminating more widely scientific information does not necessarily entail making the issues more popular in the sense of generating more popular support for a given project.

Indeed, on these issues of S&T which are the object of difficult governmental decision-making, what we see are not only irrational attacks from poorly informed opponents against the rational behavior of the decision-makers and their experts. What we see rather are controversies between the experts themselves, uncertainties about risks, incomplete knowledge, conflicting educated guesses and the necessity of taking into account many other parameters than those that can be objectively agreed upon. And after all, it is not an irrational public which started

the controversies over genetic engineering, and in controversies over nuclear power, there were, and still are, experts on both sides.

If by popularization of science we mean presenting knowledge in such a way that the citizens would acquiesce to the authority of science, that is of some scientists actually, we are fighting a losing battle. The dissemination of knowledge may well make people less docile and more critical. Popularization of science is already a lost battle if it is seen as a substitute for controversies rather than as an ingredient in our collective learning process of managing such public controversies.[4]

The diffusion of S&T culture has indeed sometimes been conceived of more as a process of seduction than as of a process of education and social learning. For instance, to stay in the domain of biotechnology, the spokesman for a huge international corporation, which had built a substantial reputation for its programs for informing the public on biotechnology, declared a few years later: "…the prospects for success may not be so bright, and progress in educating lay people on such technical issues is a tricky matter to gauge." He added: "Communicating with the public is like talking to a passing parade, not a standing army. Besides, we're communicating with a great number of audiences – not just one". "We ought not to scare consumers […] by going into too much depth. They are interested in the value, quality, and safety of food, but don't care that much about the process […]. Let's avoid being bogged down about the processes." "The strategy of playing down biotechnology may also be helpful in dealing with farmers […]. Thus [our firm] now is trying to keep the words 'biotechnology' and 'foods' separated as much as possible".[5] And at the Ottawa workshop that I mentioned earlier, a participant said "we feel that because of the possible negative public perception of the term 'biotechnology' we should look at other terms such as 'practical biology' or 'applied biology' which seem less alarming." I suggest that when it comes to such poor subterfuges, to playing tricks with words, we may confidently diagnose that in some places something has got distorted in the program for disseminating the S&T culture.

To disseminate the S&T culture is not to convince people that there is nothing to worry about, and that decisions ought best to be left to experts. The S&T culture is no valium pill; let it be clear that not only fools but also educated people will make

trouble, and reasonably so, from time to time. After all, this is essential to the very notion of a "public". A crowd acts single-mindledly; a public is nothing if not a forum for debating ideas.

This is not to say that we should take at face value all those who speak in the name of the public interest; they do no more than to express a special, sectoral interpretation of the public interest, they are not delegates of the public – no more than the scientists – they have no mandate, and what they actually do is simply to express in public their interest, that is what they are interested in.

But rather than seeing controversies as signs or symptoms of failures, we should learn to see them as the normal exercise of democracy and as exceptional opportunities for public education, precisely because controversies create those rare moments when public attention – a scarce resource – is actually focussed on issues having some S&T components.

Under these real conditions that controversies provide, meaningful participation requires no doubt some minimal scientific literacy, but less in terms of actual specialized knowledge than of learning habits, ability to search and gather information, and to question presuppositions. It remains, no doubt, that not all the available information is readily accessible and that popularization iself has a role to play.

Much hope here rests upon the work of the written and electronic media, though they are sometimes far from showing the ability to meet the challenges in an adequate fashion. It is not only that the medias have a bias towards the dramatization of events. Some limitations also have to do with the very process of attempting to transmit knowledge through popularization. Popularized knowledge tends to be illustrative and metaphorical, not demonstrative as science is reputed to be. Popularized knowledge has essentially limited value as a substitute for formal learning. It generally tells little of science as a critical process, it functions as a culture of results rather than of problem-working, results moreover translated most of the time in a metaphorical fashion.[6] It may provide inducements to learning; it would be dangerous to see it as an effective substitute.

Learning is rarely achieved through passive consumption or pure entertainment. In that regard, much is to be said, I believe, in favor of hands-on experience, for the promotion of science clubs and amateur science, for the new types of learning environment provided in some S&T museums and science centers, and for some pragmatic initiatives in continuing education. Though rhetoric is far from absent in scientific practice, science has much to do with personal experience and action; science is not contemplation, it is in fact one of the most labour intensive social endeavours. We need to keep this in mind if we want to improve popularization of science, and make it more relevant to the citizens.

Finally, let me quickly comment on the third set of issues, that of S&T culture as a requirement for strong public support of the S&T social enterprise. In the article I mentioned earlier, Congressman Brown repeated an often voiced idea: "If the scientific community fails to develop a scientifically literate society, then it risks destroying the basis of support necessary to continue its existence".[7] This seems to be supported by history. The late Joseph Ben-David very convincingly documented how in the nineteenth century the development of what he called "scientistic movements" provided the necessary basis for social support of the scientific endeavour. As science becomes more and more costly and competes with other equally more expensive social priorities, support from the public seems to remain absolutely necessary to induce an adequate level of government spending for science.

Of course this is what scientists never stop saying, but they may have limited credibility because they have a vested interest in so saying.

But pollings of the "public opinion" seem to say the same. In Québec, as of January 1988, 71% of the population believed that it is very important for Canada to develop its own S&T capability and 63% thought that Canada ought to keep level with the most advanced S&T countries such as the USA and Japan.[8] In a congruent way, a recent report of the Royal Society of London exhibited a "considerable public *interest* in science" despite the fact that the "public *understanding* of science" is not so high.[9]

So where is the problem, since even an inadequatly informed public nevertheless shows high esteem for the scientific enterprise and seems convinced of its social

importance? It would seem that the diffusion of an S&T culture is of little relevance here. It would seem that the problem of our shameful rating in national R&D expenditures here rests only with governments and industry which would not realize what the public interest – in both senses of the term interest – is.

But it may also be that public opinion polls do not measure public opinion as a social force and are adequate only as measures of individual behavior as when the citizens act in a discrete and quasi-atomistic manner, for instance when they individually cast votes, or buy consumer products. Indeed, it has often been noted that these polls are rather unreliable measures of social movement, which moreover they regularly fail to forecast. Social movements and political pressure are not matters of atomized individual activity; they are matters of collective action, of mobilization. One may say that he values science, and not act upon it. Indeed, the isolated individual whose opinions are polled may be at a loss, even if he quite cares, to know how to act and change things. Moreover, he may highly value S&T, but also many other things: it is not costly to express opinions. But action always generates costs.

According to many actors, the popularization of science, understood as making science popular, has a role to play. I suggest however that, here again, the impact of the efforts towards popularization will remain of limited significance if they only aim at the isolated individual. To build an active public opinion is a matter of organization, or making people members of a collectivity. Here again, organized popularization of science, institutionalized continuing education may prove much more effective than individual media consumption of popularized results.

Let it be clear however that in making science popular there always is the pitfall of attempting to manipulate people. I am not thinking here of the celebration of science and its best servants, of making the excellent scientists popular heros: this seems to me perfectly fitting, legitimate and respectable; after all, we do the same in all realms of social life, and I see no reasons why scientists would not become role models as much as other benefactors of humankind such as pop singers or hockey players. What I am thinking of is rather the temptation to oversell science, the utterance of inflated claims as when some say that indigenous university research is the most essential fuel for industrial innovation, which simply is not

true. It seems to me that we walk perilously on a tight rope when we promise goods that we will be unable to deliver.[10] I am refering here to what Harvey Averch has called the "kitchen sink mode of argument": "The purpose of advocacy is winning, and to win, one may endorse, simultaneously, any and all propositions believed to have persuasive power, irrespective of whether one believes they have substantial merit. The 'kitchen sink' mode of argument is highly natural in S&T policy debate…".[11] Honesty may prove the safest road for the scientific community to gain and to maintain the support it needs. Again, the popularization of science, as making science popular, should remain true to the popularization of science as an education in science.

As we have seen, there are many valid reasons for attempting to promote the S&T culture. Indeed, there may be too many. The issue is riddled with ambiguities and there does not seem to be any quick and easy fix to any of the three sets of problems I have identified, the improvement of our economic performance, the democratizing of political decision-making, and insuring public support for the scientific enterprise. These are widely different sets of issues, they are not to be tackled the same way, and each calls for specific kinds of actions.

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1. C.P. Snow, *The Two Cultures: and a Second Look*. Cambridge, Cambridge University Pess, 1963.

2. London, Frances Pinter, 2nd edition, 1982; p. 201-202

3. George E. Brown jr., "Project 2061: A congressional view", *Science,* 28 July 1989, Vol. 245, p. 340.

4. On this, see: Camille Limoges and Pierre Doray, «Le débat public comme apprentissage social et comme régulation constituante: le cas de l'"environnementalisation"», in the *Proceedings* of this colloquium.

5. «Educating the public about biotechnology», *ASM News*, 1989, Vol. 55, No. 5, p. 295-296.

6. Daniel Jacobi and Bernard Schiele (eds..), *Vulgariser la science. Le procès de l'ignorance*. Paris, Champ Vallon, 1988.

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7. *Op. cit.*, p. 340.

8. Décima, *Étude des attitudes des Québécois et des Québécoises à l'égard de la science et de la technologie et évaluations de l'impact de la publicité.* Octobre 1988.

9. *The Public Understanding of Science*. Report of a Royal Society *ad hoc* Group endorsed by the Council of the Royal Society. London, The Royal Society, 1986; p. 15.

10. For a more balanced approach, see for instance Alvin M. Weinberg, «Criteria for Scientific Choice II: The Two Cultures», *in* Edward Shils (ed.), *Criteria for Scientific Development, Public Policy and National Goals*. MIT Press, 1968, p. 80-91; p. 91: "This is not to say that I object to the view of 'science as culture', a view which places science *per se* directly in competition with other activities of the society. It is merely that, in the short term, basic science viewed as an overhead charge on technology is a more practical way of justifying basic science than is basic science viewed as an analogue of art. Until and unless our society acquires the sophistication needed to appreciate basic science adequately, we can hardly expect to find in the admittedly lofty view of 'science as culture' a basis for support at the level which scientists believe to be proper and in the best interests both of society and of the scientists."

11. Harvey, A. Averch, *A Strategic Analysis of Science and Technology Policy*. The Johns Hopkins University Press, 1985, p. 6.