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OBSERVATIONS ON

THE COMMUNICATION OF SCIENTIFIC AND TECHNICAL KNOWLEDGE

Report to Directorate-General XII
Of the European Commission

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NOTICE

The information, recommendations and analyses contained in this report are working guidelines presented by the author on his responsibility and do not implicate the European Commission or indicate its future actions.

[Author's note : Translation sometimes approximate. If you can, please refer to the original version]

Foreword

"The art of asking provoking questions is at least as important as that of providing clear answers [...], and the art of setting those questions to good use and keeping them alive is as important as the first two."
Jerome Bruner (1996)

This report is not really a report. Apart from a few exchanges to verify certain points of detail, no investigations have been carried out as a basis for the analysis presented here. This analysis is based on a classic question - *what needs to be done to increase "public understanding of science"?* - that leads directly to another question: since this issue has been raised with increasing insistence over many decades, and since considerable resources have been dedicated to the quest for an answer, *how is it that the question appears so often to be asked as if for the first time?*

The hypothesis is that only deep investigation of the second question (*what is the true nature of the problem?*) will provide the keys that will eventually enable us to provide a serious response to the first (*how are we going to achieve progress in this domain?*). Furthermore, this approach seems particularly vital in the case of the mass media. At present, their nature and their specific priorities seem to be quite difficult to integrate in a global approach to the dissemination of scientific culture, in which they nonetheless play what is considered to be a dominant role.

This study therefore concentrates on a phase that is often neglected: since it is evident that the question is not a new one, should we not begin by looking closely at some of the many reports and works already published on this subject? There is, of course, no question of drawing up some kind of impossible synthesis, but we need to explore whether these works have something to teach us about the issue, both by what they say and by what they do not say.

So, the aim of this report is not finally to proclaim any indisputable truth nor even to offer an exhaustive treatment of the subject; its purpose is to submit a few observations, interpretations and suggestions, all for debate, in order to open a forum whose vital necessity it is intended to stress.

Bertrand Labasse

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NB: Throughout this report, any masculine forms refer to both masculine and feminine. Also, the terms "scientific and technical culture", "public understanding of science", "public dissemination of scientific culture", each of which poses problems, are used according to context, without necessarily suggesting explicit distinctions. When used in isolation, the term "scientific culture" refers here to scientific, technological and medical knowledge. Undated references always refer to the last document cited for the author in question (op. cit.). Extracts and tables have been reproduced in accordance with French copyright law.

We should also like to emphasise that this study is based on an exploratory (and heuristic) approach and obviously does not pretend to provide a true and complete picture of the situation, which would require much more lengthy and in-depth research and greater resources. Apart from the over-representation at this stage of English and French source texts, it is obvious that research into overall trends necessarily leads to an obscuring of the particular features of each situation: what may be true in general is always false or simplistic in the particular. Each point made would require a thousand nuances and verifications in the field, which have no place here. In a desperate effort to allow easy reading, we have chosen to make extensive use of footnotes, but these are nothing more than a last resort. We accordingly accept full responsibility for our choices, approximations and omissions.

Summary: an inconceivable problem?

Truth comes out of error more easily than out of confusion. Francis Bacon

When it comes to drawing up an assessment of all the observations we have made here, it is difficult not to feel overcome by discouragement: many of the points we have noted have already been raised on several occasions by various authors. What is at issue here is not the originality of this study (which matters little) but its functional scope: if previous works, many of which have been more in-depth studies, have apparently served so little purpose, there is no reason to believe that this one will have any real impact on the surprising conceptual rigidity of most actors.

a. VISION MINUS VISIBILITY

At each stage of this overview, we have been faced with some interesting paradoxes and, in particular, some surprising areas of vagueness: fluidity of concepts and objectives, inadequacy or absence of models, reciprocal ignorance on the part of the actors, lack of clarity concerning priorities, gaps in empirical data, ignorance of vital parameters, etc. So the few issues we have explored seem all to converge in an essential finding:

> **The fundamental problem concerning the dissemination of scientific and technical knowledge lies, paradoxically, in the lack of knowledge of this issue and also in the lack of dissemination of this knowledge to the various actors.**

• The very subject on which action is being sought (***Processes;*** **Section 1**) remains fairly nebulous. Public understanding of science firstly implies, by definition, that information on science is somehow disseminated in society. Now the channels through which this dissemination passes have barely been identified (for example, people rarely think to include works of fiction, advertising, company documents, etc.), let alone assessed in terms of effect. It would obviously be very naive to try to establish an incontrovertible quantitative and qualitative nomenclature[126], but it seems just as absurd to attempt to take action on the basis of *a priori* opinions or impressions. A minimum of visibility, based on a structured approach, would make it possible not only to assess priorities more effectively but also to discover new lines of action.

[126] Several decades of research into information and communication sciences dealing with less broad-ranging problems (for example, the relationship between television and social violence or between publicity and elections) have amply demonstrated that it is virtually impossible to obtain "positive" knowledge in this field. This does not in any way exclude the possibility of achieving better empirical intelligibility and working models.

• Although it has been persistently pointed out in the literature, the diversity of the field and the stakes at play (***Objectives;*** **Section 2**) never seems to be taken into account in a pragmatic perspective. We have seen that this diversity is an inexhaustible source of misunderstandings[127], omissions (the human sciences) and strategic errors, including among the actors closest to scientific opinion. Of course, it is not a question of decreeing that one objective is better than another (unless such an opinion can be very strongly argued), but rather of making this diversity explicit and never losing sight of it. Furthermore, looking again at the question of methods, but this time from the point of view of objectives, would probably lead once again to contemplation of some valid and often neglected possibilities for action[128].

• The problems encountered in the field by both media practitioners and scientists alike (**Section 3**) derive quite naturally from all the above. If we really want to take the heat out of the artificial and superficial debate raging between them, then we need to provide them with some solid material that would help them to gain a proper understanding of the mechanisms and rationales at play. This would also enable scientists to play a more pertinent role in this process[129]. In addition, it takes only a moment's consideration to realise that if we ignore or deny the diversity and complexity of communication processes, we put ourselves in a position of powerlessness: there are some questions that concern specialist journalists, others connected with general journalists, others that come from scientists themselves, and still others that concern the owners and managers of newspapers or audiovisual media, not forgetting the authors of books, entertainers, film-makers, businessmen, etc. We shall never get anywhere if we simply lump them all together. We can moreover demonstrate that journalism as everyone might like it to be (journalists included) is faced with some absolute impossibilities linked to the very nature of journalism's function. A serious and fruitful point of departure might be, for example, to draw up a hierarchised list of all the criticisms levelled against the press and to examine each one to see if it is possible to remedy the problem within existing constraints.

• ***Training*** of the various actors (**Section 4**), which we should remember is deemed to be a priority by virtually everyone, cannot be taken lightly. The stakes are considerable, not just in terms of direct impact (scientists who are better informed, media practitioners who are more

[127] For example, do we want to promote a more favourable image of science or enable the public to take a more detached position?

[128] To take a particularly simple and relatively easy example: if it is felt that the burgeoning of the pseudo-sciences is a real problem, then it might be useful to talk to bookshops and librarians to draw their attention to the fact that these pseudo-sciences gain a lot of credibility from the fact that they are placed on the same shelves as scientific works (particularly in psychology, medicine and astronomy). It is obviously not a question of setting up some kind of thought police, but simply of helping these actors to be aware of the issue.

[129] Including through constructive criticism of errors in this area, with account being taken of the specific constraints. We believe - at the risk of offending a number of colleagues - that this kind of constructive criticism could be very useful. But we also believe that, if it were done well, it would initially lead to some tricky paradoxes.

competent, etc.), but also in terms of structural impact[130], which tends to be given less consideration but is just as important in the long term. At the moment, however, the question of specific content has yet to be answered. Torn between two poles (science and communication), courses run the risk of providing highly fragmented training, in which theory and practice are juxtaposed without necessarily coming together. By simply asking ourselves the basic question of who the trainers are to be, we get a glimpse of the problem - *good courses in science communication will never (except from in exceptional cases) be created simply by bringing together a scientist and a journalist to teach them.*

So it would not be so very easy to develop on a large scale courses whose student numbers are currently very small (assuming, that is, that the declarations of intent in this respect are actually followed by a real undertaking on the part of the public authorities). Moreover, the lack of data and models, which we have mentioned on several occasions, has a direct effect here: how do you teach a subject when it is still not quite clear what that subject is? The current state of "techniques of expression", drawn from practices that are very poorly formalised and virtually without any psycholinguistic value (*use short sentences, write in the active mood, etc.*), is much too poor for us to expect them to lead to any great improvement[131]. It takes much more than short sentences and simple vocabulary to create a good piece of popular writing. The high-level processes that come into play (argument, construction of meaning, cognitive adaptation, etc.) still need to be integrated in practice. So it would be extremely useful to promote the development of a carefully thought out didactic approach, both for introductory courses and for vocational training: What should be taught in an ideal world? What can actually be taught? Can this be improved upon? etc.

• From laboratory to ministry, via universities and research bodies, every ***scientific superstructure*** **(Section 5)** has an absolutely vital role to play in promoting activities to disseminate scientific culture. Yet it seems that, even when they are genuinely concerned about the issue, these bodies are not fully aware of their responsibilities in this area. Indeed, there is often a difference between declared intentions and the resources, both financial and mental, that are actually devoted to their realisation:

- encouragement for scientists and research teams to communicate their knowledge or research findings[132] is rarely backed by practical measures. Those who take the risk often have more to lose than to gain by it;
- communication initiatives seem to be very ad hoc, based on whatever ideas emerge and having no clear objectives. Also, the way in which they are implemented often reveals an

[130] For obvious reasons, training units (Berlin, Barcelona, London, etc) correspond to the main areas of research and expertise being developed in this field.

[131] We should point out that this problem also arises in the field of general journalism, though with fewer editorial difficulties. The traditional conflict between institutes of journalism, which are doing their best, and employers, who complain about the poor technical skills of their graduates, is a good indicator of this situation.

[132] Which is, of course, not the same thing, unless we omit to distinguish objectives...

astonishing lack of professionalism, particularly at the intermediate levels (universities, local groups, etc.). It might also be noted that, for its part, the journalistic community demonstrates a certain lack of coherence in expressing its expectations, indicating a lack of detachment that is no less astonishing;
- finally, superstructures at the highest levels seem rather cavalier in their role of general coordination and guidance. By failing to consider the complexity of this field, by not preparing the ground for serious, global, on-going reflection, by failing to undertake methodical research to identify missing data, they are promoting, top-down, a **culture of obviousness**, in which everyone is noisily looking for answers without being able to formulate the questions[133]. This could be proved by comparing the amount of money allocated to actions of whatever kind with that allocated to researching data and relevant models (we shall come back to this point again later).

• The question of ***audiences*** (**Section 6**) reveals more clearly than any other the extent of the technical and conceptual challenges that have to be met in order to develop the dissemination of scientific knowledge. On the one hand, trying unilaterally to disseminate complex knowledge to an audience on which so little information is available is perhaps not the best way of going about things. Despite their limitations, national and European statistics might be able to provide more audience data, which would be as vital to scientists as to media practitioners. On the other hand, consideration of the audience radically alters the nature of the question. If we replace the supply approach (which seems to have reached its limits) with a demand approach whose rules - in so far as they are known!- seem very different and perhaps unacceptable, we have to look at some basic questions that cannot be avoided if we want to stop going round in circles.

• The indistinct mass of ***local initiatives*** (**Section 7**) reveals both the great wealth of actions in the field and the way in which this wealth is being wasted. The inadequacy of collective experience-sharing manifests itself both in the lack of links between quite similar projects and the failure to take full advantage of the most original and best targeted initiatives. This means that a great deal of effort is expended on separately researching, devising and implementing individual actions whose scope could certainly be much greater if they were less isolated.

So it is not surprising that the conclusion reached by Quebec's Conseil de la Science et de la Technologie might be as valid for the rest of the world as it is for Quebec[134]:

> In practice, therefore, it would seem that government programmes have, to a certain extent, helped to increase a supply of popular science products that are aimed at a very vague and ill-defined audience, based on a term - scientific and technological culture - that has become a kind of "passe-partout" and is very general and confused, reflected in vague objectives

[133] This approach is not uncommon in many human activities and socio-political spheres, but it is less expected in learned circles, which pride themselves on their methodological attitude.
[134] Which is, of course, not to say that we share all its assumptions (any more than we expect its authors to share our point of view).

> (informing, educating or entertaining). The time has come to review, even if only partially, the management philosophy behind these programmes.

b. THE PATH TOWARDS SPECIFIC UNDERSTANDING AND EXPERTISE

The picture we have portrayed thus far could, if we stopped there, give rise to a highly distorted image of the situation. The impression that one might draw from it is that all the actors in the system are remarkably cavalier, if not stupid. However, this is absolutely not the case. The reality is much more complex than that.

Certainly, these actors (scientists, media practitioners and also university, scientific and political decision-makers[135], etc.) often seem to think they have sufficient knowledge of the issue to form a firm opinion and act accordingly. However, reasons for this surprisingly contemptuous attitude[136] run much deeper than pure ignorance: if we look at it from an epistemological angle[137], it might even be considered perfectly normal.

To understand it, it is worth coming back to the fundamental point raised by the Pradal report more than twenty-five years ago with respect to training in popularisation:

> Finally they ask us: "But who is going to teach?" It is not a serious question. Every discipline of thought, be it scientific or otherwise, goes through a stage of "intimate" development, that is, it has been the brain-child of a few people from other, existing fields. Then, little by little, these people become specialists in their new field and develop it [...] at the moment, popularisation is going through a creation phase. If it is to enter an operational phase, it needs to be structured..."

Although Pradal does not appear to be referring to it, his reflections immediately bring to mind the analysis of the construction of an academic discipline offered by Kuhn (1970).

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[135] It should be pointed out in this respect that national decision-makers are often aware of the inadequacies of available knowledge and commission studies on specific issues. It is very rare for this kind of specific, isolated study to provide any real enlightenment, however, and rarer still for their findings to have any practical effect: most of them are quickly forgotten, and many are no longer available.

[136] This could be proved by simply wandering through a university campus, asking any researcher you might meet to answer two questions: what do they think of, for example, current research into the phosphorylation of proteins (or superconductivity at critical high temperature, etc) and what do they think of science communication. One might imagine that the vast majority of researchers would indignantly refuse to pass an opinion on the first subject, pointing out that it does not come within their area of expertise, but that most would have no hesitation in discoursing at length on the latter, which we have nonetheless seen to be remarkably complex.

[137] The word ***epistemological*** is obviously being used have in a very broad sense that is more empirical than philosophical.

Indeed, Kuhn's model, although it refers only to the evolution of "hard" sciences, seems remarkably pertinent[138], casting light, by analogy, on the case we are discussing here.

It should be remembered that, according to this historical and sociological approach, a field truly begins to advance only when those who are involved in it are able to refer to a recognised body of knowledge, a "paradigm". Until they have such a reference base[139], observers "*are unable to assume a shared body of knowledge [...] and feel obliged to create everything from scratch*"[140]. This starting point plays a vital methodological role:

> The pre-paradigm period, in particular, is regularly marked by frequent and deep debates over legitimate methods, problems and standards of solution. (ibidem)

However, these debates usually go in circles and cannot move forward:

> In the absence of a paradigm [...] all of the facts that could possibly pertain to the development of a given science are likely to seem equally relevant. [...] Furthermore, in the absence of a reason for seeking some particular form of more recondite information, early fact-gathering is usually restricted to the wealth of data that lie ready to hand. (ibidem)

The analysis of situations (and therefore the search for good solutions) can therefore only be a "*buzzing, festering confusion*" (ibidem). In addition to their theoretical value, that is, the intelligibility they can bring to a given field, paradigms have powerful structuring effects: they define what can, until a new order is established, be deemed to be accepted knowledge (which then makes it possible, among other things, to produce teaching manuals), they hierarchise the problems to be solved, and they enable a community to claim an identity and specific expertise. One of the obvious differences between the sciences of the Renaissance and their current descendants lies in the fact that a reasonable non-specialist would now hesitate to produce new theories, in physics for example, out of nothing, because he or she would be aware of the enormous amount of accumulated knowledge in the field. Although Kuhn is essentially interested in fundamental approaches, it is clear that this sum of knowledge also defines competences in the applied fields; if patients listen to their doctors and businessmen listen to engineers, it is because they recognise them as having specific expertise, based on knowledge that they themselves do not have.

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[138] "providing a means of articulating structures of thought with social structures" (Vinck, 1992).

[139] As Kuhn himself says, the word "paradigm" as he uses it may have various meanings: referring both to a reference scientific theory (for example, Copernicus' heliocentric model, Newton's law of gravity, etc.) and to "***all the beliefs, accepted values and techniques which are shared by members of a given group***". In our case (where it would be absurd to hope for global, positive, functional theories), the second meaning is obviously predominant. We also need to remember that the notion originated in the field of experimental sciences, though Kuhn feels that its heuristic value extends well beyond that, particularly as regards the constitution of a community of specialists: "***the nature of this passage to maturity would be worth studying more fully than it has been in this book, particularly for those who are interested in contemporary social sciences***".

[140] Kuhn here takes the example of the pre-Newtonian viewpoint.

So a (tentative) analogy with the problem of the dissemination of scientific and technical knowledge is very tempting:

> Although the popularisation of science and technology has become an area of study over the past thirty years, it has not been established as an academic discipline, with a specific body of knowledge, its own rules, theories and traditions. (Leitão & Albagli, in Martínez & Flores, eds., 1997)

The effects can be seen both in the uncertainty about the relative importance of the theoretical and practical questions to be solved and in the problem of the content to be taught, the redundance of some pieces of work (particularly case studies in which fact-gathering "*is restricted to data that lie ready to hand*"), the failure to capitalise on knowledge and, above all, the fact that these works tend not to be used outside the small circle of researchers specialising in this field.

It is therefore not surprising that a university president, a minister or a scientist will be content to reach a hasty judgement, without being aware that he or she is ignoring this whole body of analysis, which might be very rich but is too scattered to represent an essential reference. Similarly, it is difficult to reproach an establishment for appointing communication officers who are not particularly competent, when it is impossible to define competence in this sphere. Finally, the same question arises in the field, in the difficult relationships between scientists and communicators or museum curators (not to mention journalists): whilst scientists can depend upon their solid competence, their interlocutors have hardly any arguments to support their views.

If we look again at the Pradal report - the oldest of our selection - we can see that things have changed beyond measure over the past twenty-five years. Firstly, many of the structures Pradal dreamed about (specialised training, a central service to guide journalists towards competent scientists, etc.) have now been set in place and, secondly, a community of specialists has actually begun to emerge. One of the most revealing signs is the introduction of a major international conference (1989, 1991, 1994, 1996, 1998, etc.), plus many occasional conferences, and the emergence of learned journals such as *Public Understanding of Science* (launched in 1992) and *Science Communication* (that has emerged out of the journal *Knowledge*), not to mention the growing number of books being published and research teams working on this subject. The domain of science communication cannot, therefore, or can no longer be, perceived as a marginal sector. Yet it has to be said that the formation of this scientific community seems to have been of little benefit to public strategies[141] to promote science communication, and less still to the actors in the field: the works exist, but how many of the actors and decision-makers most closely involved bother to consult them? Or, to take a more concrete example, how many of the universities who claim to be concerned about these issues - that is, virtually all of them - have subscribed to the journals we have just mentioned?

[141] Although its members have very often participated in the works of discussion committees.

We have not come across a single communications officer or head of establishment who is even aware of their existence.

As Gregory and Miller say, it is difficult not to feel

> ... frustration at the sloth with which the results of this work seem to be informing policies and practices in the public understanding of science, and at the frequency with which commentators in what is in essence an interdisciplinary field ignore [...] the work of those in other disciplines. (op. cit.)

It would appear that this situation can be explained in epistemological terms. Indeed, these works have not reached a phase of collective construction whereby explicit note is taken of generally recognised advances (we can see here a reflection of the sociological dimension of Kuhn's paradigm). Yet there is undoubtedly a degree of basic consensus, often rather simple but nonetheless solid and supported by empirical observation. For example, the fact that a science communication problem cannot be tackled without account being taken of the multiplicity of objectives involved, the fact that popularisation is not simply a question of translating into popular language, or the fact that the friction between scientists and media practitioners derives mainly from the conflict between contrasting systems of priority and legitimacy. Lewenstein (1992) also notes that

> Like science itself, the study of public understanding of science is fragmented. [...] Because of this fragmentation, it has been unclear whether the many separate fields with an interest in the public understanding of science - including both practitioners and researchers in the areas of journalism, museums, science education, and science studies - could come to any consensus.

Now, various representatives of these fields, brought together when the American Association for the Advancement of Science set up its committee on the public understanding of science and technology,

> ... came to remarkably similar conclusions. Those conclusions can be summarized by a single statement: Whether one is concerned about production or research, about television or museums, about literacy or critical thinking, new ideas in this field will come only when we take the perspective of the audience. [...] To understand what information is important, to understand what techniques work, we need first to understand the audience. (ibid)

However, basic notions of this kind still have to be justified in learned works (even though everyone is reaching the same conclusions) and, above all, to be tirelessly explained to scientists, both humble and prestigious, often without convincing them. To have any real effect, research on science communication really needs to be consolidated, synthesised[142] and

[142] Some very good syntheses have begun to appear over the past few years: for example - to cite the most recent (and one of the best) - Gregory and Miller's ***Communicating Science***, which is much quoted in this report. Mention might also be made of the fact that COPUS in the UK has

even popularised. But, of course, you can really only popularise something that is recognised as being "knowledge".

Another problem is linked to how this research - whose purpose is to understand - might answer the questions of those who are wanting to take action. Would a scientist or decision-maker who took it upon himself systematically to read the abundant literature now available actually be in a better position to take concrete action? Yes, to a degree, but perhaps not so much as to justify the time spent: the majority of existing works do not appear to be intended for any practical or "applied" purpose. Worse still, analyses based on a strictly scientific approach could be absolutely paralysing for a practitioner who really wanted to take them into account: at present, many of them are not only incompatible with the real constraints of popularisation but even contradict each other (as we have already seen in connection with, in particular, the issue of the personalisation of research work).

> Too often, too, the activist is unaware that anyone has tried to reflect on what has been done, while the researcher is interested only in recording and criticizing. (Gregory & Miller, op. cit.)

The fact that academic analysis is incapable of offering workable solutions is clearly a major problem, which might explain its lack of an audience in the practical field. Out of pure curiosity, for example, we spent a few days looking at all the messages relating to science posted on the Internet by one of the world's largest news agencies: from an "academic" viewpoint, a good third of them seemed very open to criticism for one reason or another, but from a journalistic viewpoint, we felt the style of many of them was quite natural for the medium (although some of them could, and should, have been edited).

The abyss between the analysis and the practice of popularisation is especially evident when we compare learned works, some of which are rather dry and heavy, with practical guidelines, which are more often than not disconcertingly naive. Where is the middle line? The whole problem of training content comes up again, and it is by no means simple: social science researchers are faced with a complexity that defies any reductionism, whilst practitioners desperately need some workable concepts, solid models and reliable data. This partly explains why, as we have mentioned on many occasions, there are still no answers, even vague ones, to so many "naive" but vital questions. This is particularly true of all the questions that require concerted effort to be invested in some pioneering classification work - work that would be long and tedious and might even be risky (because it would be readily open to criticism). The fact that these shadowy areas still exist also has something to do with the lack of effort on the

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launched the first attempt to "popularise" certain advances in this field. However, it is vital that these efforts to create coherence by means of reference syntheses concerning specific issues be continued. The issues concerned might be, for example, the teaching of science communication (content, techniques, etc), the status of science in advertising, relations in the field between scientists and journalists, scientists and museum curators, etc.

part of the public authorities to improve the coordination and funding of research in this area and to publicise it.

One of the main challenges is to increase the contribution that specialists make to helping actors in the field. Yet neither journalists and other media practitioners nor scientists seem, for the most part, open to this kind of work. In short, these two groups actually have two characteristics in common: they are sceptical by nature and they have more faith in clear figures than in the analyses and intellectual constructs of the social sciences.

One could, for example, go on and on raising the question of the differences in motives and objectives without ever getting a response. If we really want to give this observation meaning, we have to offer "something concrete". That would actually be quite easy, if we used the rather rough and ready but nonetheless powerful tool of large-scale quantitative studies: listing the various possible objectives of scientific information (humanistic, economic, civic, etc.) and asking a thousand scientists and the same number of journalists, businessmen, cultural leaders, university press officers, etc., in several countries to classify these objectives by order of importance in their eyes. The difference in their positions would immediately become "concrete" and have to be recognised. Many other points evoked at an essentially qualitative level would benefit from being looked at more closely in quantitative terms: the influence of the various sources of young people's interest in science (including works of fiction, in both written and audio-visual form), the real effect of communication training sessions on researchers' subsequent practices and attitudes, etc.

It would also be interesting - still by way of example - to extend, systemise and improve the dissemination of various pieces of research, also very concrete, on the forces at work in the communication of sciences, particularly the influence of press releases and book reviews on the choice of subjects covered by newspapers, and, vice versa, the influence of these articles on researchers' careers (and even on the citation of their works by their peers)[143]. However, if they are to be of any real significance, all of these measures would also require significant research resources and long-term follow-up. In the absence of an improbable, and not very desirable, scientific coherence (in which irrefutable paradigms would dictate the degree of urgency of the problems to be solved), works in this area depend almost exclusively upon researchers' personal interest and the amount of funding they manage to secure, with no real agreed agendas or programmes of any magnitude. The first and best question the public authorities could ask the research community is not "*what are we to do?*" but "*what do we need to know or understand and how do we go about it?*". Indeed, there is nothing we need

[143] Analysing science articles published in seven major daily newspapers, de Semir et al (1998) note not only that more than 13% were drawn from four scientific journals (***BMJ, Nature, Science, The Lancet***) but also that 86% of these had been the subject of a press release. The reverse effect is even more remarkable and could encourage researchers to take an interest in communication: according to Philips et al (1991), articles from the ***New England Journal of Medicine*** that gave rise to articles in ***The New York Times*** were (although of equal significance) later cited 72.8% more often in scientific literature than other research articles published in the ***NEJM***.

more than an explicit synthesis - however rough it might be - of the questions that need to be answered and the problems that need to be solved, of which we have outlined just a few examples here.

Whatever the case, many of these points are still obscure not because we do not know about them but because any significant progress would require lengthy, in-depth, multi-centred research. So we have hundreds of partial, parallel works - on, for example, media coverage of such and such a piece of scientific information - instead of a smaller amount of more thorough research that might serve as a useful reference.

The question of the problems to be solved might be more easily answered if it were also asked of media practitioners, and journalists in particular - assuming they were willing and able to give a serious response. This is doubtful, however, since practice seems to be as averse to theory as theory is to practice. We need only observe what is said during journalists' meetings and discussions to see that, here too, the "*buzzing, festering confusion*" of thought sometimes goes round and round in circles, with the same questions being raised again and again without even the beginning of a clearly thought-out response being reached[144]. Furthermore, the profound contempt of the media that is clearly perceptible in the remarks made by some scientists and human science researchers has an immediate backlash, convincing practitioners that, at this level, they have little to gain from any rapprochement. Since it is quite simply impossible to force journalism to change from the outside (unless somebody is ready to take

[144] There are obviously individual exceptions to this "***lack of theoretical framework***" (Jacobi & Schiele, op. cit.), but it is certainly a general rule. The vast majority of journalists show very little interest in the idea of approaching questions of this kind with a minimum of method and detachment. Apart from the legitimate defiance fed by a number of highly directive and very ill-informed analyses of the subject they claim to be covering, this lack of interest derives partly from the professional constraints of the job, which take up most of the time, energy and attention of those who perform it. But one might also hypothesise that this disillusionment comes from a deeper source: it seems to us that journalism is a-theoretical by definition and not because of lack of respect. If one had to take account of the infinite complexity of any item of news before covering it, journalists would be... researchers, and there would be no more newspapers. Even though the press often calls on "experts" (with whom, as we have already noted, it has somewhat uneasy relationships), its basic tenet is that it is possible to examine any situation, to understand it and cover it in a format and period of time that are compatible with the technical and economic framework of the job. So it is natural that the same approach, pragmatic but reductive, is instinctively taken when journalism tackles its own professional sphere. Finally, the specific transience of journalism (one edition goes out-of-date as soon as the next appears) does not encourage reflection over time: conference proceedings are rarely published and collective documents are rare. These sweeping comments do not do justice to the efforts that a few journalists or groups of journalists have made to look deeper, but they do help to explain the resistance of a "culture of obviousness". Indeed, journalism is a field in which self-knowledge is barely increasing (let us not even mention paradigms!). As a subject to be learned, teaching is based primarily on practical exercises, leading to "***a disjuncture between the teaching of journalism to adults and the teaching of other professional and academic subjects to adults***" (Allen & Miller, 1997). As a profession, this limitation is paralysing; "***a craft that sees no need to change perceives little need for research. [...] One thing that distinguishes a professional from a craftsperson is knowledge of theory, the underlying principles that make the craft work***". (Meyer, 1996).

over its funding)[145], the scientific community can only try to encourage reflection and ask for dialogue.

But it takes two to have a dialogue, which means you have to make an effort to understand the person you are talking to, especially if you are the one who has asked for the dialogue in the first place. So it is very important to consider how genuine dialogue could be instigated and the conditions that would be required to ensure that it was on-going and fruitful. Here again, it seems vital that the problems being faced and the models that explain them be carefully analysed in advance if we are to move beyond the phase of small talk and bickering:

> Journalists, if they offer any theory at all, invariably offer operational theories: they describe how and why they do what they do. (Most often, though, they say they just do what they do.) [...] Scientists, however, and some science communication researchers, offer normative theories: they want to tell the journalists how it should be. Because normative theories are very deeply rooted in cultural and social values, and because these values are very different in the scientific and journalistic communities, the differing perspectives of the two communities have led to considerable friction between them. (Gregory & Miller, op. cit.)

Indeed, there are many works on journalism but very little research for journalism, which is very different (Labasse, 1997b). Hence the spectacular breach between (external) theories[146] and empirical approaches, which we have already mentioned in connection with training.

Bodies responsible for evaluating and funding research are directly involved: as we have already said, instead of wondering what journalism can do for them, it might perhaps be worth their while to wonder what they can do for journalism. This change of perspective might, for example, help to encourage social science researchers to work more closely with practitioners, and lead to the emergence and funding of research/action initiatives within journalists' associations or unions, even if, in the short term, such works would not come up to academic standards.

The question of how to enable journalists to take a sufficiently detached position so as to take a good look at their practices, when the pace and imperatives of their professional activities do not allow it[147], is of greater significance than one might imagine (and not only in the case of

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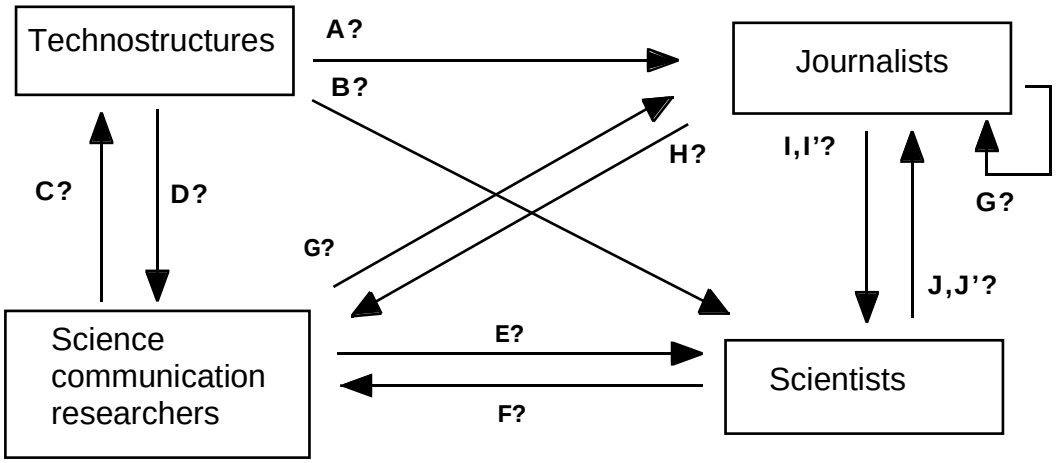
[145] And, of course, restrict a few civil liberties. We might well laugh at Pradal's wish that "***the profession of scientific journalism be regulated and controlled***", but the same wish appears in a barely concealed form in many of the documents we have acquired: it seems to be very difficult for people to understand that the wish to impose the norms of the scientific world outside that world leads to an impasse.

[146] One should not, however, generalise the idea that academic research is indifferent to the viewpoints and concerns of practitioners. Although this may still be the case in some countries, such as France, it seems to be much less so in others, as is reflected in the introduction to the synthesis edited by Jon Turney: "***Any comments on the result would be very welcome, especially if they relate to topics which practitioners feel merit more attention from researchers***". Also, many particularly pertinent works are being produced by former practitioners who have moved into research and teaching.

[147] To use the - zoologically questionable - metaphor of an editor in chief in the science press: "***a***

science). It might also be useful to consider the funding of applied research in schools of journalism and, once again, the coherence of public concerns and the resources allocated: if informing the public is as important as, for example, the man-machine interface, then it would be coherent to provide equivalent funding for it[148].

Table 7: A partial development of the initial question



A - How can the media be encouraged to provide better (?) coverage of scientific information?
B - How can scientists be encouraged to communicate?
C - How can scientific superstructures be helped to realise the complexity of the problem and the attention it deserves?
D - How can we obtain data and models that make it possible to devise coherent, sustainable strategies?
E - How can scientists be encouraged to pay more attention to the knowledge available?
F - How can guidelines that are of use to scientists be researched and drawn up?
G - How can journalists be helped to take a more detached view of their practices?
H - How can account be taken of the diversity of journalism as a field and its imperatives?
I - How can scientists be enabled to understand journalists better?
I' - How can relevant information be obtained more easily and more quickly?
J - How can journalists, and particularly general journalists, be enabled to understand research better?
J' - How can scientists be encouraged to provide relevant feedback when published information is clearly inadequate?

Flowchart restricted to journalism; it should also be noted that the public, whose prime importance we have stressed throughout, has been omitted for the purposes of simplification, as have science communicators.

cow does not drink milk" (personal communication). In other words, a journalist has to produce copy to earn his living. It is up to other commentators, whose pace of work is less restricting, to analyse journalists' output if they so wish. But, of course, this "***intellectual patter***" (personal communication from another journalist) is very likely to be ignored by journalists, even assuming they read it in the first place.

[148] Since real advances in many industrial spheres actually often come from the industry itself (for example, the graphic computer interfaces developed by Rank Xerox, then Apple and Microsoft), whereas one might expect little of "research" by information enterprises, which is, comparatively, virtually non-existent (unless market surveys - where they exist - are deemed to be research). However, computer interfaces are seen from an academic viewpoint as a significant issue (corresponding to an applied discipline, which defines problems on the basis of paradigms), whereas journalism is manifestly not. "***The mass media are something about which one can also have an opinion even if all one has done is glance at the morning paper***." (Gregory & Miller, op. cit.). At the end of the day, perhaps the scientific community is getting what it deserves.

The question of reference knowledge (paradigms) naturally concerns all the other practitioners involved in the processes of disseminating scientific knowledge. This is certainly true for museum curators, but also for the communication officers appointed by establishments and bodies. This latter function, in particular, seems to be very much ignored in the literature. We have no reason to believe that these communicators have all the knowledge and models they need, not only to enable them to perform their role effectively but also to ensure that their expertise is acknowledged and respected by the scientists they encounter. As long as the relationship between scientists and their partners (institutional communicators, journalists, exhibition designers, etc.) is seen as a top-down relationship between the holder of fundamental knowledge and inconsequential, frivolous "artists", things are unlikely to change.

So, the epistemological immaturity of the field of science communication is helping to paralyse it at all levels: from the designing of overall public strategies to attitudes and practices in the field. Without more research, and particularly applied research, without the systematic dissemination of the findings of this research, without lengthy and methodical reflection that brings the various actors together on this basis, any wish to develop public understanding of science can lead only to a constantly reinvented "tinkering".

> It is to be hoped that this research might develop in the same way as the importance of popularisation, despite the marginality of its cultural status. It should enlighten the decision-makers and actors involved in initiatives to permit the - certainly relative but nonetheless decisive - appropriation of knowledge. Indeed, democracy cannot indulge in the luxury of allowing an undertaking to be given up simply because it is difficult. (Jeanneret, op. cit.)

We can currently estimate[149] very roughly - though a study on this issue would also be necessary - that about 99% of appropriations allocated to the dissemination of scientific culture is absorbed by concrete actions, determined on the basis of unknown criteria, and that barely 1% - or perhaps a lot less - is spent on the collective understanding of this issue (on its paradigmatic "construction").

However, the analogy with Kuhn's model, although it seems to clarify the current situation and the problems involved, is not a recipe that would enable us to control the process of the construction of knowledge in this field by naively trying to force the process. Paradigms - or something similar to them - cannot be decreed or commanded at will[150]. This is even more true

[149] A very rough estimate based on the situation in France, but we doubt very much that the situation is very different in other countries. In the case of formal education, which is nonetheless taken much more seriously than informal education (and therefore benefits from much more applied research), the Ehlers report (op. cit.) states that: "***Currently, the U.S. spends approximately $300 billion a year on education and less than $30 million, 0.01 percent of the overall education budget, on education research. At a time when technology promises to revolutionize both teaching and learning, this minuscule investment suggests a feeble long-term commitment to improving our educational system***".

[150] See, on the other hand, the numerous possibilities offered by scientific networks, whose various modes, effects and functions are described by Vinck (op. cit.).

in the case of a problem which clearly extends beyond the simple question of sciences and techniques[151] and which, even if it is reduced to that level, involves some very different actors, not only in terms of level of analysis (science communication researchers, decision-makers, practitioners, etc.) but also in terms of professional background and attitude (scientists, cultural leaders and museum curators, journalists, etc.).

Yet, despite this formidable heterogeneity, it seems possible to move towards a better common understanding, towards a working understanding. Moreover, the need to establish some intelligibility and coherence is becoming more and more evident - either explicitly or implicitly - and urgent in the case of science communication:

- It is essential that the training process be accompanied by research into science communication. (Galluzzi, op. cit.)

- No satisfactory solution has as yet emerged, because researchers are not sufficiently aware of these problems. We believe that research bodies have a decisive role to play in this area. To ensure that this crucial question does not remain unanswered, the [Ministry of Research and Education] should conduct discussions with all the bodies involved. (Kunth, op. cit. on the involvement of scientists in communication)

- Governments should modify their approach and management philosophy concerning programmes to support the dissemination of scientific and technological culture:
— concentrating their attention and efforts on a small number of concrete problems concerning the development of scientific and technological culture among the people of Quebec, which need to be solved as a priority;
— thereafter, establishing an action plan based on a prior understanding of areas that need to be influenced or constraints that need to be removed, and targeting clearly identified groups or individuals with the potential to have a significant impact on solving the problem in question;
— actively involving the various partners who have an interest in seeing a particular problem solved;
— allocating a proportion of its budget reserved for scientific and technological culture to this purpose. (Berlinguet, op. cit.)

- It seems appropriate to recommend that the best possible group of experts be asked to draw up a Science Dissemination Plan that would be adopted and funded by governments and public and private institutions. (CCSC, 1999)

- OECD should:
— address the issue of public attitudes and awareness and monitor its integration into national science policies;

[151] "Research on popular science communication will endure only to the extent that it illuminates generic processes important to mediated communication of all types of information. To claim that our work informs only our understanding of the public communication of ***science***, I suggest, marginalizes what we do and are capable of contributing." (Dunwoody, 1992).

> — encourage the collection and dissemination, at national level, of studies and internationally comparable survey data on public attitudes and awareness and on career choices in science and engineering, and serve as a clearing house for such information;
> — facilitate exchange of information on activities to promote the public awareness of science and technology, on government policies to encourage and support such activities, and on the evaluation of their effectiveness; and
> — publicise and, to the extent appropriate, support international efforts related to public attitudes and awareness of science and technology, such as the proposed global science television channel and the global capacity-building programme of ICSU. (OECD, op. cit. [152])

However, the most pragmatic approach of which we are aware is that of NASA's "*Research/Roadmap for the Communication of Science and Technology in the 21st Century*" project, which is part of a methodical policy that NASA has been following for several years (Horack & Treise, 1998). It has, in particular, led to the funding of a systematic study of research into science communication (Weigold, 1998) and has provided some funds - relatively modest, it has to be said - to finance work by outside researchers.

> Some of the topics that have been covered by calls for research proposals have been[153]:
> *The PIO/scientist interaction
> *The PIO/media interaction
> [we'd really like to see one or both of these assessed using game theory analysis]
> *Research using the uses/gratifications model to understand audience interest in science
> *Research using a cognitive approach to understanding audience interest in science.

The project charter also details some objectives that might seem very ambitious to specialists in the area but which pose some very good questions from a pragmatic perspective:

> All research results from the Working Group are available to the general public, and there are no proprietary findings. Specifically, the EWG is chartered to provide the following:
> 1. Customer feedback on "state of the practice" science communications, and discussion of how science communications processes might be improved to further science in the national interest. Specific areas of interest might include:
> (a) Identification of how specifically the broad range of customers receive their technical information.
> (b) Identification of how customers use the information that they receive.
> (c) Identification of areas of the science communications processes that are not perceived by the customer to be value-added.
> (d) Identification of differing needs among customers of scientific knowledge.
> (e) Identification of key technologies and communications vehicles that will help science generating organizations advance and communicate scientific knowledge and understanding.

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[152] Curiously, the same requirement is not extended to governments, whom the writers of the report simply call on to take action: "***Governments should support effective strategies for the dissemination of information on science and technology, for instance by building and networking more interactive science centres and museums, establishing structural links between these institutions and schools and universities, and supporting volunteers working in the field of science popularisation..."***

[153] Memorandum circulated on the PCST electronic list. Rick Borchelt, 12/02/1999.

2. Develop a report of "best practices" in science communications. Where is it being done well now? What are some of the innovative approaches to communicating scientific knowledge?
3. Develop several case studies in science communications today, for the purpose of illustrating concrete examples of positive and negative aspects of science communications.
4. Develop a new on-line research journal in science communications, designed for the publication of academic research into how science information is communicated.
5. Develop and deliver a final report, containing the findings of the research and articulating the road map for science communications in the 21st century.

More generally, this project (which is being led by NASA scientists, communicators, teachers/researchers in journalism and communications, etc.) provides a very interesting, though limited, example of what an applied research programme in this field could be like[154].

On a broad scale, a global approach would obviously imply a more long-term commitment and more solid resources. It would mean working more upstream (on prior research into "good" questions and priority problems), more downstream (on dissemination to actors in the field and their involvement in the process of formulating knowledge) and more transversally, surveying initiatives, developing quantitative studies, bringing together differing points of view, etc.
In any event, we should not, in this area, hope for any more rapid or profound developments than methodological and budgetary commitments might enable us reasonably to expect. The underlying problem is undoubtedly a complex one, but its major features are very simple.

[154] One might also note the concern to make the findings of such work accessible to the widest possible audience.

Conclusion

Very many actors are involved in the social dissemination of scientific and technical knowledge, and this dissemination is dependent upon all their practices and attitudes. It would however be useless simply to ask them to change their behaviour.

On the other hand, it is within the power of local, national and international leaders in the worlds of politics and science to create the conditions for genuine quantitative and qualitative development of this area, treating it with seriousness, rigour and pragmatism, and it is their direct responsibility to do so:

- not placing piecemeal solutions before real understanding of the problems;

- ensuring coherence between official declarations about the importance of the post-school dissemination of scientific knowledge and political and budgetary commitment in this domain[155];

- guaranteeing visibility and the necessary resources for a methodical, sustainable strategy, notably:

  - by promoting and financing targeted research programmes and, in particular, "applied" research (quantitative, empirical, taxonomic, technical, didactic, etc.) of sufficient scope;

  - by systematically assessing the originality, scope and practical contribution of proposed research projects, as well as their correspondence with the reality of the processes of disseminating knowledge;

  - by promoting comparison of the various approaches[156], particularly by encouraging practitioners to provide a methodical, carefully constructed explanation of the constraints and rationales to which they refer;

- and, more generally, encouraging the collective construction and deepening of knowledge, models and know-how and ensuring that they are disseminated as widely as possible, via translation and publication and on line.

In this perspective, the European Community is in a better position than any to play a key role of instigator and coordinator.

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[155] Particularly, by specifying the strategies being implemented and the proportion of the education and research budget being allocated to these areas, compared with others.

[156] This descriptive and comparative work might, of course, initially lead to the emergence of some very powerful tensions between the various communities of actors, but this stage is essential when latent lack of understanding is a fundamental problem.

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