Publicizing Science! To What Purpose?

(Revisiting the notion of public communication of science and technology)

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Without an informed public,
scientists will not only be no longer supported financially,
they will be actively persecuted.
Asimov, 1984

A[1] common lament in the realm of science and technology culture (SL and PCST[2]) is the scant regard for publicizing science and technology. Similarly decried is the chronic lack of knowledge of science and technology by a high proportion of the general public, who are said to be *de facto* deprived of the right to speak on issues concerning them since they cannot grasp the real impact on society of the spinoffs from science and technology development. PCST actors reiterate that the real challenge is to maintain our individual and collective capacity for intervention in a knowledge society that is ever more complex to decipher and master. A constant theme in France, as elsewhere, is the plea to recognize and value the publicizing of science and technology (S&T), to acknowledge its need and support the means its mission requires.

This discourse has taken various forms. An example from the late 1950s, followed by a rerun of the mobilization movement in the 1980s, and its current revival today, allows me to show that the successive reformulations of the publicization project all draw on a stable core of meanings. Secondly, I concluded from a synopsis of surveys conducted in the United States and Europe on the development of science and technology culture that despite the considerable means and resources received, the anticipated collective increase in science and technology culture from this mobilization has yet be demonstrated. And thirdly, this brings me to query the true function of publicization, and fourthly, its origins. It seems clear to me that the notion of publicization poses a problem, that it must definitely be re-examined, and perhaps even revisited.

Shake-up in Science and Technology Culture

Beginning in the 1960s-1970s, sparked by a disenchantment with Progress, people began questioning the relationship between science and society (and this questioning continues unabated). It would crystallize around the conditions and means of accessing and sharing scientific knowledge, and how to bring science and society closer together.

Palais de la Découverte, February 26, 1958

The *réunion-débat* ("meeting-debate") chaired by François le Lionnais, then President of the Association des écrivains scientifiques de France (AESF – Science Writers Association of France), held at the Palais de la Découverte on February 26, 1958, was exemplary in its choice of the topics (cited *in extenso* below) and the arguments advanced during the discussion[3].

First the themes:

A. – *Qu'entend-on par "Vulgarisation Scientifique [lire : publicisation] ?"*
(What does "Scientific Popularization" mean [read: Publicization])? »
B. – *La vulgarisation scientifique est-elle une œuvre d'intérêt national ?*
(Is science popularization an effort of national interest?)
C. – *Les grand problèmes théoriques. (The major theoretical problems):*

1) Diversité des publics et des formes de la vulgarisation scientifique. Des analphabètes aux grands savants, en passant par les enfants, le public de la grande presse, les cadres administratifs et techniques, le Parlement et le Gouvernement.
Diversity of the public(s) and forms of science popularization. From non-literates to the great thinkers, via children, the general public and big media, administrative and technical bodies, Parliament and Government.)
2) Les relations entre les savants, les vulgarisateurs [lire : communicateurs scientifiques, animateurs, médiateurs…] et les informateurs. Respect de la vérité et nécessité de la rapidité. Le problème du sensationnalisme. Le problème de l'anonymat médical. Le "rewriting". Nécessité d'une double conversion mentale : chez les savants d'une part, chez les journalistes et les vulgarisateurs d'autre part.
Relationships among the learned, the popularizers [read: science communicators, animators, media specialists….] and informers. Respect for the truth and need for speed. The problem of sensationalism. The problem of medical anonymity. Rewriting. Need for a double mental conversion: among the learned on the one hand, and among journalists and popularizers on the other.
3) Vulgarisation scientifique et enseignement des sciences.
Science popularization and science teaching.
4) Vulgarisation scientifique ou culture scientifique [lire : CST] ?
Science popularization or science culture [read:SL]?
5) Le rôle des moyens audio-visuels, les bandes illustrées. La vulgarisation scientifique par les musées et les expositions. Les conférences. La radio. La télévision. [L'Internet aujourd'hui]
The role of audio-visual, comic strips. Science popularization by museums and exhibitions. Conferences. Radio. Television. [The Internet today].
6) La lutte contre les fausses sciences et l'occultisme.
The fight against the false sciences and the occult.
7) Valeur de la science-fiction
The value of science fiction

D. – *Les moyens pratiques. [Practical means]*

1) Comment augmenter le crédit et améliorer l'influence de la vulgarisation scientifique en France. Liaison avec les pouvoirs publics et les puissances de diffusion. Organisation d'enquêtes et de sondages d'opinion, etc.
How to increase credit and improve the influence of science popularization in France. Liaison with public authorities and the means of dissemination. Organizing surveys and opinion polls, etc.
2) L'amélioration de la vulgarisation scientifique en qualité. La "vulgarisation originale" et la "vulgarisation de la vulgarisation". Objectivité naïve et objectivité scientifique, etc.
Improving quality science popularization. "Original popularization" and "popularization of popularization". Naïve objectivity and scientific objectivity, etc.
3) Le recrutement des informateurs et des vulgarisateurs scientifiques et la valorisation de leur profession. Création éventuelle d'un Centre de Formation Universitaire. Fondation éventuelle d'un prix national, etc.
Recruiting informers and science popularizers and valuing their profession. Possible creation of a University Training Centre. Possible founding of a national award, etc.
4) Un organisme officiel et un Statut de la vulgarisation scientifique sont-ils possibles ?
Is it possible to have an official organization and a Satute of Science Popularization?

By substituting "publicizing" or "publicization" for "science popularization", these themes, with a few minor adjustments such as the addition of the Internet to audio-visual means, could very well figure entirely on an AMCSTI meeting agenda, for example, since they are still just as topical. And the discussion report itself could easily pass for the debates of an expert panel meeting on the occasion of the Etats Généraux de la Culture Scientifique et Technique:

François Le Lionnais pleaded for the recognition of popularization which he felt is of national interest since it serves national independence by helping to develop science:

> … [T]here is no lack of tasks of national interest right now …. There is … atomic energy, ICBMs, housing problems …; isn't it somewhat childish here to want to include our problem – [popularization] – among these enormous problems? …. Well, I don't think so. Will you allow me to quickly express a syllogism: if we French wish to ensure our national independence (the problem occurs similarly in other countries in the same way) we won't do it, that's well-known, without adequate development of science, pure research, and applied research. (freely translated)

But he points out that the development of science demands high quality science teaching. Ours had to be reformed while keeping in mind that the pace of science development quickly renders it obsolete, and hence the need for popularization. More flexible and directly focused on current events, it will compensate for an inevitable delay:

…. Also recognized is … that a country can only have adequate science development if there is proper teaching, which, at least here at home, is referred to as educational reform; this has also been discussed and admitted …. Science advances quickly; … faster than teaching does … ; whatever the educational reform, no matter how good, science will quickly move past it. So we need a complementary mechanism. We need, if you'll pardon the awful expression, a "rattrapeur de vitesse" ("*a quick catcher-up*"); where national education is concerned, we need a scientific popularization that provides the speed and flexibility necessary for teaching. …. (freely translated)

Jean-Louis Crémieux-Brilhac (Secretary General of the Comité Permanent pour l'Expansion de la Recherche Scientifique, Associate Director to the President of the Conseil) has denounced the lack of knowledge of the role of science in economic development, and saw popularization as the means to remedy this, while also fostering vocations in science:

…. It is quite extraordinary in a country, which is that of the *Encyclopédie*, of scientism and of scientific research policy, that a mere one percent of the population gives science and technology research this determinant value as the motor of economic progress. Undoubtedly, an ample reason in itself for developing science popularization is to consider that it has a role to play and a national importance. On the other hand, concerning the training of people, the development and improvement of the nation's level of science, we know that a major research policy is necessary. …. Popularization makes it easier to attract the researchers and scientists we need.…. (freely translated)

Henri Longchambon (President of the Conseil Supérieur de la Recherche Scientifique et du Progrès Technique) stressed the improvement of the quality of life that we owe to science:

… I therefore think it would be in the national interest … to have us … understand the practical value [of science], its impact on this raising of the quality of life that has to some extent become the test of the value of a social organization in all countries. ….(freely translated)

Louis François (Secretary General of the Commission Nationale Française for UNESCO), taking the same tack, emphasized the acceleration of progress, the adjustments it imposes on societies and the need to make the public aware:

May I be permitted to add two things. We see ever faster progress in science and technology that is transforming the world. But, at the same time, we observe how slow are the transformations in the political, economic and social structures. ... And, it is good that we show everyone these great developments in science and technology that impose profound changes on the political, economic and social structures of our diverse societies. They must absorb its problems by transforming themselves. (freely translated)

Paul Ostoya (Editor in Chief of "La Nature") recalled that science is too important to be purged of culture:

… [An] important role of science popularization consists of remedying this [the fragmenting of culture], by providing … the means to catch up in this field [science] and not to remain completely ignorant about something as important as the development of science, in a word, to remake a popular culture. (freely translated)

Finally, Louis Cros (Director of the Institut National Pédagogique, Director of the Ministry of Education's Office) remarked that the artisanal phase is over, and that the State should now be committed to:

[In response to a question from Mr. Le Lionnais on the status of popularization] …. I believe like yourselves, that the artisanal stage is behind us; obviously the public authorities must be concerned with giving the organs of science popularization the means justified by their important scientific and social mission. (freely translated)

May I state here that this would be heeded by the State, as we shall see later.

A permanent hardcore of meanings

I wanted to recall this debate, now nearly 50 years old, because it dealt with various questions that included: national independence being guaranteed by science and technology development, since it helps maintain the collective competitive capability; the teaching of science, since the PCST debate is never separate from the issue of teaching, they go hand in hand; the structural backwardness of the school, which is seen as too inflexible to react quickly to circumstantial fluctuations; the lack of knowledge of the beneficial effects of science and technology, which are vectors of economic progress; the promotion of research careers; improved living conditions; political, economic and social adjustments to irreversible changes; the "dignity of man" today; the responsibility and support of the State…

We find here, condensed into short statements, nearly all the key ideas[4] that today still underpin the consensus uniting all the actors in the PCST movement. Some terms have become generalized, others have been added, which would permit this discussion to figure very honourably in our contemporary debates, their statements being just as relevant today. These key ideas are rooted in a hardcore of meanings that I summarize as follows:

- Science and technology "great actors and catalysts in transforming the world, are at the centre of the system of production, of daily life and the reflection on the contemporary world"[5]; to maintain this dynamic they presuppose the perpetuation of values which, from scientific rationality and the concomitant mastery of skills, form the foundations on which our modern world is based. The contemporary expression of rationality happens through an assimilation of the modes of reasoning inherent to scientific thinking: this responsibility is first and foremost incumbent on schools, supported by S&T communication. The challenge is to transmit the values and abilities that build our society.

- Maintaining the collective economic capacity of the nation demands a rapid and flexible adaptation to change; this adaptation relies on a constantly renewed mastery of scientific knowledge and its areas of application. Raising the SL threshold helps maintain the nation's prosperity. The rapid adaptation to scientific, technological and industrial changes, key to

improving competitive capability, happens through the development of new competencies, based on understanding and mastery of the fundamental principles of science and technology. The challenge is to maintain, even increase, the margin of economic competitiveness.

- Advances in science (in biotechnology and genetic engineering today, hot topics that grab media attention, as physics was at the time of the *réunion-débat*) that revolutionize our understanding of the living world, challenging our very concept of life, and progressively deconstruct the complex system of ideas, concepts, and representations, slowly formulated and shaped by history, enabling us to perceive and think of ourselves as "human". The monument erected by science expresses one of the greatest achievements of the human mind. Science takes its place alongside the other components of culture like music, literature, and the fine arts. The challenge is participation in contemporary culture.

- The democratic resolution of environmental, societal and philosophic debates sparked by these upheavals demands everyone's enlightened commitment. Access to SL for the greatest number guarantees collective and individual integration into an increasingly complex society. Science and its achievements constantly revolutionizing the relationship to the world and society require that everyone be able to act with understanding in making ethical, strategic, ecological and technological choices that prescribe the future or, that they at least understand the implications, to be acknowledged as full citizens. The challenge is democratic empowerment.

Up to now, these four key-dimensions have formed the cornerstone of all efforts to publicly communicate science and technology. They have made it possible to develop and carry out projects; to fully or partially orient the actions of those engaged in these projects; channeled the content strategies and choices; and guided the ways to treat, present and develop them. By invoking the Enlightenment and the popularization of science in the second half of the 19th century, the preamble to this conference strongly recalls the well-known but oft' neglected fact that the "public presentation" of science is not recent. On the contrary, it has a long and storied history which the contemporary desire to publicize science is part of. It is in the course of this history that the dimensions I've just referred to emerged and took shape. They are worth mentioning, if briefly.

Two sides of the same history

The question of knowing who in the social community will also reconcile the scholarly and secular discourses by reformulating for everyone what has been said in the language of a few, arose at the end of the 17th century, at the time when "sages" were busy inventing their own language in order to converse amongst themselves through specialized journals[6]. Fontenelle, with the publication of *Entretiens sur la pluralité des mondes* (1686) [Bernard De Fontenelle, *A Plurality of Worlds*, translated by John Glanville, 1688] adopts the role of lawyer for the community of sages, for whom he is the mediator and interpreter with the cultivated public. For all intents and purposes, what would become the "public presentation" of science developed in its general form as a collective project in the mid-18th century. It coincided with the development of positive scientific thinking and the Salons[7]. The field of application expanded during the century, the number of publications burgeoned as they became ever more popular, and the cabinets of curiosities that had appeared at the end of the 16th century[8] progressively transformed: the

collections had to be both "seen" and "understood". Their inherent and singular knowledge had to be revealed at the time and place where their self-defining objects were being contained. Thus other places and practices to publicly communicate science came into being. It should be remembered that this movement to reveal knowledge to the public was part of a wider movement that wrested science away from occultism, astrology and alchemy, and especially away from the "mysterious". The announcement that the Rings of Saturn had been discovered by Huygens in 1656 was circulated by means of a indecipherable anagram, accessible only to the initiated. The 18th century sages resorted to secrecy, first amongst themselves and later with the general public. They opted for the multiplier effect to spread knowledge in the vernacular language. Thus, the idea that science is universal, but also practical and useful, gained ground. However, dissemination of knowledge also took place to demonstrate the power of reason and hence that of man over nature. And the Salons supported, publicized and legitimized this movement affirming the independence of reason. The 18th century was "infused with faith in the unity and immutability of reason. Reason is one and the same for any thinking subject, for any nation, era and culture. From all of the variations of religious dogma, the maxims and moral convictions, ideas and theoretical judgments, there emerges a firm and immutable content, a consistency, and its unity and consistency are the expression of the true essence of reason"[9]. No terrain is prohibited from it. And most of all, what is different from the great metaphysical systems of the 17th century that still adhered to the realm of revealed "eternal truths", the reason of the Enlightenment was "the original and primitive power that leads us to discover truth, to establish and ensure its presence. This operation of ensuring the truth is the germ and vital condition of all genuine certitude"[10]. Reason is liberty in action – made manifest through the exercise of the critical spirit – opposed to blind submission to authority and the guarantor of tolerance against dogmatisms. This is the meaning of Kant's *sapere aude*[11]. The Enlightenment entails a going beyond, a voluntary tearing away from one's condition. It entails implementing a true secular process of transcendence to attain the Universal. And this ideal of perfectibility, of progression, of going-forward, represented in the scientific project, is expressed tangibly by Progress, the promise of betterment for everyone.

In the 19th century, the pace of scientific progress accelerated as work became better organized. The self-employed "amateurs" of the 18th century, few in number, and often using rudimentary tools, were replaced by "professionals" trained by regular teaching of science, provided by a network of specialized institutions that possessed libraries, collections and laboratories. Better organized, by means of specialization, a prototype for the division of labour, and better equipped, research then progressed rapidly. The disciplines expanded their own language – formalization, symbolization, quantification – emphasizing the enclosure of their own knowledge. To this was added the growing importance of industrial spinoffs, which explains why the application of scientific knowledge to agriculture, industry and transportation in the 19th century progressively transformed economic life, ultimately leading to the emergence of big industry. These social transformations were depicted in such revues as *L'Echo du Monde Savant* and *La Science Illustrée* which were the forerunners of true popularization magazines, vigorously defending the cause of progress. In disseminating science to a larger audience of all classes of society, they perceived the conditions of a potential universal instruction and well-being which are the hallmarks of progress. In short, a broad movement of dissemination wherein Auguste Comte, the accomplished representative of scientism of that era, saw the means of a universal education to achieve a positivist philosophy. This 19th century thrust, characterized by the "affirmation of the

social necessity of science"[12] continued into the early 20th century and up till the 1960s (when the *reunion-débat* took place at the Palais de la Découverte).

Two ruptures occurred in the 1960s and 70s. The first was characterized by a growing independence of popularization, a coming into its own. This bolstered its legitimacy. Popularizers, until then merely auxiliary to the scientific community, 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 power that knowledge gives"[13]. While they made a huge contribution to the dissemination of the scientific thinking and spirit of the 19th and early 20th centuries, a "third man" had to be substituted who was neither scientist nor layman, 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. In hindsight, we now know that the denunciation of an ever-widening gap helped the media's movement toward a more independent role. The arrival of an intermediary, just when the scientific community and general public were quite distant, served to define the conditions of this media role, affirming the thrust for autonomy. The most obvious and spectacular manifestation was the redeployment of science museums reinvented as "Science Centers". The Exploratorium in San Francisco and the Ontario Science Centre in Toronto both opened in 1969 and served as reference points that have left their stamp on all museums that have opened since. They were the first to definitively make communication with their visitors the primary objective of their mission. (Using the same logic in another context, it goes without saying that the learning spinoffs from these media messages, measured by the expectations of the scientific and academic fields, would quickly be judged unsatisfactory. This didn't bother the media for whom the question of relating to the academic field was easily resolved by making entertainment the given *modus operandi*, each time seeking the largest possible audience – with the possible exception of school and university programs broadcast on some stations, but this is another debate.)

The second rupture was marked by an increasing awareness that Progress always brings problems and risks. In the 1960s – to be brief – came the stark realization of a progressive intrusion of science and technology, their ramifications on the smallest details of daily life, along with social transformations and particularly their impact on the organization of work. This intrusion was of course accompanied by accidents of dire consequence, such as the oil spill from the shipwrecked *Torrey Canyon* in 1967, and the accident at the *Three Mile Island* nuclear power plant in March 1979 (the explosion at a pesticide plant in Bhopal, India in 1984, Chernobyl in 1986, among others, and the list goes on…). Add to this, and denounced since 1962, are the persistent pollutants such as PCBs, dioxins, furans, DDT, and numerous pesticides present everywhere in the environment whose effects represent serious and insidious threats to public health (and the balance of ecosystems)[14]. Too many such incidents sparked a backlash against scientific development and the attendant notion of Progress. A systematic doubt progressively took hold in people's minds and became a fact of society. The public became cautious, mistrusting and critical. People questioned the Utopia of a society transformed by the rationality of the Enlightenment, represented by science and materialized through scientific Progress.

To this I must add that the 1970s marked the turning point of a Kondratieff cycle[15]. The *Trente Glorieuses*[16] came to an end and the ensuing economic constraint, amid a Utopic morosity

(among other factors), prodded the State to a new concern with publicizing science, which began to take shape in the 1980s.

The State gets involved

Starting in the early 1980s, the valuing of SL and PCST – more precisely the form this valuing took – was seen as a societal issue. Governments were on the right path and very quickly they made publicization their business. Up until then, while not uninterested, they had essentially left it up to the actors to speak out as needed. What Louis Cros had hoped for in 1958 (cf. supra) happened: the decade became one of State commitment.

"At the beginning of 1981", said Jean-Pierre Chevênement at the opening the Colloque national sur la Recherche et la Technologie in January 1982[17], "it was not apparent that a year later scientific research and technological development would be considered to be a national ambition"[18]. Preceded by 31 Regional Assises, sector-based study days, of broad national mobilization of research organizations, universities, companies, unions, professional organizations[19], and the announcement of numerous measures: "to create a large Ministry of Research uniting the disparate and fragmented means among various ministries", "to restore fundamental research", "build mobilizing programs, clarify and rationalize the relations between research and industry to reconquer the interior market and preserve our national independence", "cultivate the taste for research and ensure the scientific information of the French", and "to establish new European programs", the national conference was seeking a "crisis exit", marked by a "renewal" of research, an "opening of the world of research to the economic world", and to "society in its democratic expression"[20]. François Mitterrand's announcement of a policy "able to create *the intimate insertion of research and technology into our society, into its culture and into its choices*"[21] made it possible to tangibly envisage a culturation of science[22]. (Today, a simple rereading of the proposed objectives shows the extent to which this discourse is rooted in the same substrate of meanings that I evoked).

The very first CCSTI[23], just created in Grenoble, would include them. They generously proposed: the encounter and dialogue of scientific, industrial associative and cultural partners with the public; to develop the circulation and exchange of scientific information; to foster the initiative and coordination of scientific knowledge dissemination efforts and to highlight them; to promote awareness-raising and training of local actors in disseminating scientific knowledge; to develop actions favouring better irrigation of territory especially for the specific areas of the rural milieu; to participate in the development of a European and international dynamic[24]. The associations and groups (AMCSTI, APISP, ASTS. CIRASTI…) benefiting from increased support did not remain inactive[25]. The Cité des sciences et de l'industrie[26], a leading establishment for renewal, created in 1985, was given four converging missions: "elicit the meaning, provide reading material and understand the contemporary world and its trajectory, enable access to information and knowledge, and contribute to the evolution of individual and collective mentalities".

This will to acquire the tools and means to bring science and society closer together is not exclusive to France, far from it. The Bodmer Report published in 1985 in the United Kingdom deplored the poor level of understanding of science and encouraged scientists to communicate with the public. The *Committee for the Public Understanding of Science* (COPUS) was set up in

1986 (at the initiative of the *Royal Institution*, the *Royal Society* and the *British Association for the Advancement of Science*). Its mandate was to pursue greater visibility of PUS (PUSET -- for *Public Understanding of Science, Engineering and Technology*). It was very influential in enabling scientists to learn about the various forms of media, to deal with questions of public interest (*Media Fellowships, Media Training Workshops, Westminster Fellowships, Women's Institute Courses*), and to support PCST events (*Seed grants, Development grants, National Science Week grants*), etc.[27] In addition, COPUS contributed enormously in legitimizing the dissemination activities of the general public enterprises for researchers in the scientific fields. Beginning in 1994, the OST (*Office of Science and Technology*) pursued and broadened the objectives of COPUS. In pell-mell fashion, it sought: to demonstrate the relevance and importance of science and technology in daily life and business; to stimulate young peoples' interest to promote careers in these fields; to learn about scientific developments; to foster rapprochement and dialogue between scientists and the public on ethical, moral and social questions through these developments and their spinoffs; to raise the level of public knowledge for a more fruitful dialogue; and simultaneously to sensitize the scientific community to public concerns… In 1997 *Science Connections* surveyed 49 scientific organizations engaged in valuing and promoting PCST in the United Kingdom.

A couple of words on the United States. The same PUS objectives have been pursued in the United States by a plethora of organizations[28]. "However, given the local independence and spirit of initiative that characterizes American life, there was never a systematic attempt to coordinate, or even to catalogue, these activities. There is no national policy for public communication of science and technology, any more than there existed an information base or political will to create it[29]. This doesn't stop the federal government Ministries or the national agencies from actively promoting PCST[30]. I must also mention the AAAS (*American Association for the Advancement of Science*) (141,000 members and 300 affiliated organizations) which includes the promotion of PCST in its constituting act, and because it is present throughout the United States; and the ACS (*American Chemical Society*) which annually organizes National Chemistry Week with the participation of its 200 local sections. At the time of the appearance of Halley's Comet in 1985, the AAAS launched Project 2061. This, on the one hand, defined national PUS standards – in a country where the educational system is completely decentralized – and, on the other hand, aimed for their achievement by 2061, the date the Comet will reappear[31]… Europe, since 1993, the date when the Semaine Européenne de la Science et de la Technologie was launched, has followed suit.

I could continue at length but I think this suffices to remind us that PCST has long been the focus of a social project. All the countries[32] – to varying degrees of course – have subscribed to it. To raise the level of the public's scientific information, to revalue the sciences, involve the public in debates, and commit young people to pursue careers in science… That's the mandatory theme for all policies and measures adopted!

Today, 20 years later…

What did this mobilization yield? Certainly, of all such endeavours initiated in France, some remained relatively neglected: the popularization initiatives still have only marginal impact on the advancement of researchers' careers, and the science media professions don't lead to careers

with the same benefits as those for researchers and teachers. But the French situation is not necessarily typical. In Australia, for instance, the professionals of CSIRO (*Commonwealth Scientific and Industrial Research Organization*) are responsible for communicating the scientific aspects of their work to the public. And the United Kingdom has a well-established science communication profession. In any case, in terms of what's offered, there is more equipment, there are more projects, those involved have become professional, and budgets, grosso modo, have been maintained.

However, there seems to be a need to revitalize the enthusiasm! Roger-Gérard Schwartzenberg[33], Minister of Research, declared at the launching of the Assises de la culture scientifique in November 2001: "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 science and technology culture" since "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 we bring science and society closer together, when nowadays they are tending to move farther from each other? How do we reduce this distance and how did it come about?"

The national plan for disseminating PCST, unveiled on February 25, 2004 by the minister delegate for Research and New Technologies, takes the same tack. The plan, like the Assises, observes that citizens are "curious" and have an "interest in science" but at the same time show a "certain scepticism" and "mistrust". They "lack reference points to understand the world around them". How, then, can we promote science vocations and direct "young people to science and technology career paths"? The issues must be "debated" and "reference points given". Since the "vital roles of science and technology in our society, and also in our daily lives, increasingly structured by innovation, demand an operative relay adapted to the general public. This entails disseminating information, reference points, keys to understanding the world for a diverse public". PCST must be recast by a new approach: concluded the minister, "we can broaden access to science culture… only if we renew and modernize the ways to transmit it and to make the general public aware of it"[34]. It is not only France that harbours the hope of a renewal of the science-society relationship. Tony Blair 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 judgment 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 in trying to achieve"[35].

It is striking to note just how much the arguments of past years recur today. Why act as if everything must be redone, to better propose the same thing … or virtually the same thing. Why the alibi of a recasting? The argument, as I've noted, is the knowledge gap between science and society, which, far from diminishing, continues to widen; that the efforts haven't proven fruitful enough, that there's a periodic need to revive interest, to relaunch a mobilization. And whether the real challenge isn't so much PUS itself as the cyclical appeal for a renewal of the science/society pact? But before examining this hypothesis, I must briefly present the results of various studies on the dissemination of PUS.

Evaluating science and technology culture

I had thought to deal with the evaluation of science and technology culture dissemination according to the usual breakdown for a study of cultural practices. The question would have been: "Who's interested in science?", "In what way? By reading (*Science et Avenir*, *La Recherche*, *Discover*, *Scientific American*…), by visiting science museums (*Palais de la Découverte*, *Cité des Sciences et de l'industrie*, *Muséum National d'Histoire Naturelle*), by participating in events (*Semaine des sciences*, *Université de tous les savoirs*, *journées portes ouvertes*…) ? "How often?", "For what purpose? To be trained, informed, cultivated, entertained?", "To what effect? To awaken interest, stimulate curiosity, participate in debates?", and so on. All of it nuanced, of course, by reference to socio-economic indicators and other pertinent variables[36]. Such an overly specific approach would have prevented me from isolating the overall trends. It seemed to me more relevant to outline the major features of a synopsis[37], on the one hand, to show what we learned about public practice from these trends and what came out of this, and on the other hand, to examine both the effectiveness and scope of the actions undertaken, dictated by necessity.

The state of PUS

The simplest notion we can have of PUS is to define it as a knowledge of basic facts, elementary concepts, and a general understanding of the scientific effort[38]. 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 threshold deemed minimal, we consider that the individuals pegged as scientific non-literates lack certain skills required as citizens in a modern post-industrial society. The *National Science Board* (NSB) in the United States and the European Commission regularly conduct surveys of this kind to collect comparative data and analyze trends. The most recent one (NSB - 2004) revealed that U.S. respondents[39] on average correctly answered 8.2 questions out of 13 designed to measure the level of scientific knowledge, i.e., a success rate of 63%, compared to 7.8 for Europeans (60%). Compared with earlier surveys, this rate has remained constant in the United States since 1990. The NSB pointed out several changes: more people today know that antibiotics do not kill viruses (this result is attributed to media coverage of ailments causes by drug resistant bacteria); and for the first time more than 50% (53%) of U.S. respondents answered "true" to the statement that "human beings developed from early species of animals[40]" (69% in Europe), while the previous rate was 45%.

The answers received to the question "in your own words, what does studying something scientifically mean?" – a more abstract question than those dealing with specific information knowledge[41] – indicating a strong majority of U.S. respondents (two out of three in 2001) don't clearly grasp what "scientific process" means. Which implies that it is difficult for a large portion of the population to distinguish science from non-science[42]. The NSB suggests that this lack of knowledge could explain the rise in the pseudosciences: 60% believe in extrasensory perception, and 41% consider that astrology is "at least a little scientific" (in Europe, 53% consider astrology to be "fairly scientific").

PUS measurement also takes two other factors into account: attitude and interest. A positive attitude towards S&T, combined with a basic scientific knowledge, appears to determine an

individual's capacity to take part in the democratic discussion. The perfect inverse appears true too, with the expectation that raising the level of PUS for the public favours a positive attitude, enables citizens to understand science and technology issues, and encourages participation in discussion and decision-making since they are aware of the impact of S&T on society and the choices that inevitably ensue[43]. A higher proportion in the United States than in Europe considers this impact to be beneficial[44]. Thus 86% of U.S. respondents, as against 71% of Europeans, agree with the statement that "science and technology are making our lives healthier, easier and more comfortable", and respectively 72% compared to 50% of these feel that "the benefits of scientific research outweigh any harmful results"[45]. The NSB takes special care to emphasize that the proportion of Europeans who strongly disagree is higher than in the United States (in Europe one in four, compared to one in ten in the U.S.); that the percentage of U.S. respondents who consider the spinoffs to be mostly beneficial has remained above 70% since 1988. But the European percentage fell by 11% 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, while in the United States the link is weaker. In other words, unlike Americans who are naturally more inclined to see the good side of science, having a certain scientific knowledge serves to foster a positive attitude among Europeans. What is verified then is the initial statement that knowledge, a positive attitude and interest form a whole. Which brings me to interest.

A person may have a positive attitude without any real interest in S&T. Or he or she may have little interest yet feel well-informed, just as another may be quite interested yet feel poorly informed. One thing is certain though, confirmed by all the work: the primary factor in predicting interest – and PUS competency – is having learned science. A solid education in science and mathematics induces an ongoing learning. The second factor is to increase the amount of education, whatever the field of training.

Informal learning is not as structuring. The public that shows interest in science and technology is generally distributed in three categories: "attentive", "interested", and "residual" (this is Jon D. Miller's well-known typology: it measures in all cases the degree of voluntary exposure to scientific information). The "attentive public" refers to a public that is very interested, very well-informed and a regular reader of specialized journals and magazines; they visit museums and are interested in scientific cultural events. The "interested public", while calling itself "very interested", does not feel very well-informed. The proportion of "attentive public" is significantly lower than that of the "interested public". This is valid for all countries, which suggests that few actively seek out information, to understand the issues, or to participate in debates, even though they may say they are keenly interested. This is true even if both observe that an omnipresent science and technology revolutionizes the present and overdetermines the future. As for the "residual public", without actually being indifferent to science, they express very little interest. It happens occasionally when something catches their attention, so they only pick up a little news by chance. This partly explains why the residual public's information is so sparse and random. In this perspective, may I add that to the observer the public's knowledge appears to be a mosaic of decontextualized bits and pieces. This public voluntarily declares itself willing to know more about science and technology, but is constantly distracted by other things. Science and technology centres, for example, have thoroughly grasped the implications of this ambiguous relationship. They exploit it systematically, knowing that visitors generally gauge their visit by

the interest it sparked for them – the feeling of having learned something or not – and they judge the quality and impact of an exhibition or other activity by how stimulated they felt.

Finally, the recurring mobilizing themes, from one study to the next, are health (medical implications and research, new treatments, risk factors, biotechnology spinoffs…) and, in recent years, environmental questions (health and environmental questions being spontaneously linked in the public mind). The impact of scientific discoveries, inventions, innovations – from nuclear to space – that don't directly affect their daily lives, elicit little interest unless a news item appeals to public attention. It is interesting to note in passing that television is far and away the leading information source indicated in the United States and Europe. After TV, in order, are: the written press, radio, school or university, scientific journals and the Internet. However, between 1998 and 2000 the audience for TV information programs has continually declined, to stand at 37% in 1998, 31% in 2000 and 24 % in 2002.

From a review of major studies, Jon D. Miller concluded that the number of scientifically literate adults has doubled over the past 20 years[46] and is now close to 17% in the United States, the United Kingdom and France. He notes, however, that this level is "is still problematic for a democratic society that values citizen understanding of major national policies and participation in the resolution of important policy disputes[47]". Assuredly, there will always be a keen journalist intent on reminding TV viewers or readers that only 41% of European respondents consider as "true" the statement that: "electrons are smaller than atoms" (48% in the United States, 46% in France[48]), thereby reinforcing those already convinced that not enough is being done to alleviate science illiteracy, and we've got to beef up publicity efforts.

Revisiting the idea of science and technology culture

All of these surveys invariably reassert that the likelihood of contact with scientific culture, when it is not specifically encouraged at school, undertaken systematically in a spirit of self-learning or sparked by a chance encounter, essentially devolves from a higher level of 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 skills needed to help bring science and society closer together. Amid all this, I would like to point out that the artistic, literary and economic cultures, basically in the same boat, are also poorly shared. The S&T situation is neither unique nor new. I think it is readily illustrated by recalling the debate of the 1970s criticizing the dire lack of public introduction to economic culture. Largely demonstrated by studies that have nothing to envy of today's studies, they systematically denounced this lack and feared for the consequences.[49]. Surveys certainly seem to indicate that the media has a limited impact on the acquisition of new knowledge and the development of the scientific mindset. But there is a knowledge transfer nonetheless since, on the one hand, for all its deficiencies the media serves as an information source and, on the other, learning is a process: we don't learn in one shot, nor from just one medium. We learn by repeated hits, multiple stages, successive corrections, and from different sources. This goes for all learning. The public understands and retains despite the distortions, incomplete information and lack of training. These efforts therefore emphasize the role of schools and media. Schools are expected to provide a formal introduction to science, which it's hoped will engender a sustained interest, while media – understood in the broad sense – should abet this

interest by according more attention to the sciences and, for those showing less interest, increase points of potential contact so as to inform them, stimulate, involve and engage them. Consequently, achieving the true scientific and technical culture, while desirable and desired since it's considered essential for the enlightened participation of citizens in the debates of the day, hinges on training for some, and on everyone's exposure to random and diffuse information. Is this not the persistent push-pull that surveys measure?

How to escape the paradox of a periodic reassertion of the need to publicize science, each time with the attendant wait for the science and society pact to be concluded, and finally renewed, yet we have lingering doubts about the actions, their scope and effectiveness. We understand the intermittent need to revive interest in order to keep PCST on the agenda of immediate social concerns. But this is not what it's about when we hear solemn appeals for the need to regenerate the science/society alliance, the general mobilizations and measures that result. I think (or at least it's my working hypothesis) that these cyclical reactivations have little to do with the rapprochement they advocate, or at least, not in the way they're conceived.

Being in the forefront of society

To resolve this paradox, one must deal with the question of actions operating over a span of time rather than at specific moments. To know when, and especially how, PCST took centre stage in society. On this topic, the British and American work has shown four successive expansions in media coverage of science, each time coinciding with a transformation of the science/society relationship, and each time followed by a sharp decline in PCST coverage[50].

I will summarize them. The first expansion, which began in 1840[51] and reached its peak in 1875, was that of the social affirmation of science at the expense of religion. It was also that of professional research, with the amateur progressively giving way to the researcher. The press and the book were the main vectors of dissemination. During the second expansion, 1900-1925, science was institutionalized and gradually revealed its potential: scientific development, whose economic spinoffs quickly became evident, was quickly corralled to serve the national interest and has remained that way since. Radio was gaining popularity and began to include PCST (afterwards called popularization). The third expansion, 1940-1962, corresponded to the advent of pure R&D research with its step-by-step planning. The scientific model reigned. The Palais de la Découverte and CNRS in France, like the famous Vannevar Bush report, *Science, The Endless Frontier*, published in the United States at the end of the war (which spurred the American program of fundamental research concentrated in the large universities and funded by the State) focused on developing pure research, and advocated the same vision for the role of science in society. Television became a global phenomenon. The fourth expansion, beginning in 1975, sprang from the economic crisis, triggered by the energy crisis (1973), and marked by doubt and growing concerns. The anti-nuclear movement, first, and then environmental questions galvanized a radical critique. There was increasing privatization of research while at the same time the techno-sciences were coming into their own. The public relations discourse encroached upon that of journalism (scientific or other).

There are a lot of nuances in all this. But what this work highlights first is that contrary to what the solemn appeals suggest, science returns cyclically to the centre of the social debate. And

second, the times when PCST is in strong demand, when its social necessity is most insistent, are precisely when it is very active in fully exercising its role. This dual observation makes one wonder about the true function of PCST. Even more, this work shows that, grosso modo, the phases of expansion and compression seem to parallel the major economic cycles and the structural adjustments that accompany crisis, when the potential for science and technology innovation propels its revival. In this perspective, the PCST discourse serves a twofold purpose. On the one hand, it destabilizes the knowledge and skills that held sway up till then (a critical step in deconstructing the knowledge relationship) and, on the other, it highlights the emerging attributes (a positive step in establishing a new relationship). The invitation to share knowledge, to understand the science effort, to participate democratically… become the practical alibis. In other words, the social actors are periodically invited to change their role. But they must first anticipate their new character, and a scenario and a decor are then very useful. Two examples from the French context will allow me to illustrate that the effort of publicizing consists mostly of reconfiguring the representations of science (while deconstructing others still operating); to transform their relationship to the field of knowledge; to force, so to speak, the social actors to rethink how and in what way the sciences "make sense" for them. What's important is to internalize the new relationship, much more than to master a particular knowledge. Since potential is realized through *dispositio*, the way of imagining and thinking in a situation of appropriating, producing and using knowledge.

The Palais de la Découverte, inaugurated in 1937 in Paris, like most museums designed in this era, was structured around the idea of basic science. Its objective was – and still is – to recreate for visitors the moment of discovery by reproducing milestone experiments that demonstrate the advancement of knowledge. Jean Perrin gave the best synopsis of the project: "we first wanted to familiarize our visitors with the fundamental research that creates science, by repeating on a daily basis the great experiments that underpin this research, without lowering the level, and in a way that many could grasp. We wanted to introduce people to science culture along with the qualities of precision, critical probity and freedom of judgment that this culture develops and which is useful to everyone, no matter what their career"[52]. Discovery is the miraculous moment that rewards the researcher's long and patient work conducted over long years. Pierre and Marie Curie, among others, working with selfless passion, represented the perfection of this ideal. A single desire: to advance science and humanity. No restraint in application, innovation or results interfered with their quest. It was up to society to find the potential industrial and economic spinoffs, to make it useful for itself. This was not the researchers' responsibility. In this context, we might wonder how faithful are the experiments reconstituted by the Palais, just as we might question how valid are the deliberations of the Académie des sciences reported in 19th-century newspapers, and just as we nowadays question the media coverage of our scientific conferences. What was expected of public presentation of science was to evince the qualities set forth by Perrin, such as critical attention to detail, much more than any particular fact. What was sought was a certain way of being in the world, by forming a habitus, as Bourdieu would say, that predisposed the social actor to think (and to project) in a relationship of quest of knowledge and simultaneously to be part of a social relationship in quest of knowledge (since the two are inseparable). The notion of epistemological obstacle elaborated by Bachelard at this time was a good illustration of what this *dispositio* implies for the subject: a surpassing, something must be forgotten in order to achieve a condition of learning, and perhaps one day be able to discover. In

short, it demands a continual lay pursuit of transcendence that I've already evoked in respect to the Enlightenment.

So that's why the errors, the simplifications, the reductions, presented in any and every message, are secondary (which doesn't mean they are insignificant), just like the problems of understanding and resistance to discovery that occur during all learning. Bachelard writes that this resistance is overcome only with a honing of the apparatus of reasoning. He feels that knowledge is clear only afterwards, at the end of the inherent effort involved. "We know," he wrote, "*against* former knowledge, by destroying misleading knowledge, by overcoming something that, in the mind itself, is an obstacle to *spiritualization*"[53] (my emphasis). From then on we understand why the quest for knowledge is also an initiatory effort: to find "the truth in a true intellectual repentance … is to accept an abrupt change"[54], to reshape one's identity. But it is also to be able to project oneself through all time, to be dedicated solely to a quest whose outcome is uncertain, with selfless patience, as Perrin said. The scientists on display at the Palais de la Découverte, heirs of the spirit of the Enlightenment, represent reason dedicated to pure and disinterested research. Thus they played a role as frontline propagators, which they only relinquished to science journalists during World War II. The physical and abstract universe reigned. Discipline doubly emblematic through its formalization and its applications, notably in the conduct of war through invention of radar and fabrication of the atomic bomb, could no longer be decoded from common experience. There had to be someone to describe this formal universe and explain its impact. The audience for science in the public sphere had to be expanded because traditional knowledge and know-how proved inadequate to confront the new intellectual tasks[55].

This is the perspective in which the Palais de la Découverte took shape. On the one hand, it was a dissemination project designed to transpose the paradigms structuring the scientific community, and on the other, to show the conditions of access to the cultural legitimacy of an ascendant social fraction, namely the scientists and more particularly the physicists. (Since, as Duby points out "the dissemination of a type of culture takes place synchonistically with the formation of a social group"[56].) For France the founding of the Palais de la Découverte coincided with the beginning of the third phase of expansion (1940-1962). It is a marker of an ascendant mode of relationship to knowledge – that of disciplinary knowledge and fundamental sciences, briefly described earlier – just as the meeting of February 26, 1958 is a marker of the end of this expansion and the start of the destabilization of this same relationship to knowledge.

The second example is that of the *Sciences Centers*. The context has completely changed. No longer is science on stage, but rather its spinoffs. The recently opened Montreal Science Centre goes even further. Innovation alone holds centre stage, and science itself is only incidentally evoked, as a distant reference. While the Palais de la Découverte left it up to others to transpose the discoveries of science, as vector of progress and change, the reverse process is now taking place. Innovation has replaced fundamental research as the motor of change[57]. This shift in consensus on the role of science was reflected in the advent of *Science Centers* in the 1970s. The change was more profound than it first appeared. Why? Fundamental research valued and gave value to knowledge in itself , as something revealing the world's intelligibility through the unconstrained exercise of reason. Today the relationship has changed. It is less about understanding the world than transforming it. Maintaining economic development, bolstered by

an endless renewal of consumption, demands a constant input of new ideas and products on the market. In other words, innovation presupposes a systematic obsolescence as a productive force. Knowledge is subjugated to it. I'm not saying that there is no longer any fundamental research being done. That would be absurd; I am simply saying that a rule of necessity reigns: research takes place in contexts validated by potential uses[58]. More than ever, this knowledge is being produced collectively in a context of application. The process is transdisciplinary. Skills are committed to heterogeneous and diversified means of production, determined by social as much as financial accountability[59]. (To be related to the disenchantment with Progress accompanying the rise of the fourth phase[60].)

In less than 50 years the relationship between society and science has changed completely. The presentation of S&T to the public as done by the *Sciences Centers* not only reflects but also promotes and pomulgates. Instead of the image of researchers engaged in individual quests, highlighted by the Palais de la Découverte, we now have teams united around a project to which each contributes their knowledge and skills. The relationship to knowledge is no longer the same. In the first instance it represents a discursive space within which the knowing subject is there to think and act – knowledge is constitutive of the effort in which the researcher, as subject and social actor to this knowledge, is engaged. In the second case, illustrated by the *Science Centers*, knowledge, mobilized for a specific purpose, is dissociated from the subject's heuristic quest. Knowledge only happens through this mobilization. So it is a constant matter of seeking new information, upgrading knowledge, recycling… In this regard the successive recastings of school programs here in France, elsewhere in Europe, and in America leave no doubt: that schools too are being reshaped around a few key-ideas: to acquire skills, to constantly update this knowledge, to learn to resolve problems in a group, handle various communication situations, etc. In short, accommodate the collective resolution of problems by mobilizing the necessary skills, and mutually determine the strategies, the means, and the information required, immediately available or obtainable through research. A good illustration of the new relationship with contemporary knowledge is the *Science Learning Network (SLN Alliance)* of *Unisys Corporation* in the United States, which brings together *Science Centers* and schools so that that they function as data banks and resource centres for each other.[61].

Essentially, it seems to me that there's a cyclical recurrence of the discourse on the need to again publicize S&T, and this occurs simultaneously as new conditions of production are implemented – sparked by a succession of notable innovations – and demands a rapid acculturation by the social actors. The publicizing of science (all media together) then functions like a symbolic operator, an active benchmark, enabling them to think in a new role, justified by the acquisition of new abilities and skills, and a renunciation of the old, deemed obsolete. What could be more legitimate than a society-driven work accompanied by the desire to share knowledge (or "knowledges") and reforging the science/society pact (desirable in all respects)? But without forgetting nonetheless that these *desiderata* reactivate the core of meanings of all discourse on PCST, to better incorporate into a new context. With the British and American work as a backdrop, I noted that the relaunch of this publicization is triggered by two groups of external factors: economic growth and innovations. This work also suggests that the role of publicization has progressively come into its own, and now operates as an adjunct, a catalyst to economic development. (Which would explain the State's involvement beginning in the 1980s).

Before concluding, I would like to call your attention to an effect of this work of recomposition, the redistribution of the right to speak that attends each recomposition.

Social spaces and communication devices

What researchers and scientists say about their activities, how they conduct them, the results obtained, the desired spinoffs, all these certainly contribute to the transformation of what "makes sense" for the actors, and how the relationship of society and S&T is represented. But, in giving researchers and scientists the right to speak, who is it that puts science on display? To answer this question I return a final time to the famous *réunion-débat*.

The February 26th discussion made clear that the written word -- the press and magazines – largely dominates the popularization practices. However, what was then called audio-visual, before simply becoming today's media, already had a considerable influence on the evolution of disclosure practices. The potential of this media, especially the power of the image that it showed and crystallized, was not lost on those involved. They emphasized the visual memory of children, and how effective popularization could gain from it. They realized the necessity to adapt to the preponderance of the image, and clearly anticipated that they would have to allocate a place for it in their activities. After doing so, they fully grasped the structuring effect of media on cultural practices, and consequently the necessary adjustment to the popularizing practice. "[W]e must ask ourselves," concluded Crémieux-Brilhac, "if, in the 20th century, the most effective popularization, whatever its attributes, or how much we like the printed page, is not that of radio and television"[62].

We know what ensued. In the next 20 years, the media's ever-growing influence on the imaginary and cultural life would reinforce a process of media autonomy begun well before. The idea, advanced around the 1960s, of a "third man"[63], an intermediary between the creators of knowledge (highly specialized scientists, using esoteric and certainly effective language but known only to themselves) and the public (which had another language, other preoccupations, and other recreations), clearly reflected the growing independence of the media field, showing it to be the natural place that could reach out to the scientific community to ask for information, to receive and process the answers, and retransmit to the public. It was no longer a question of popularization but scientific mediation. Hence, the scientific field ceded the initiative of publicizing science to the media field. In other words, the focal point of the S&T discourse moved from the scientific field to the media field, just when "discovery" gave way to the applications and economic spinoffs it could anticipate. Suffice to recall how the technical and technology culture, with its know-how and its tricks of the trade, till then considered to be inferior to scientific culture (itself idealized by the apparent absence of constraints), suddenly gained enormous credibility. In this context, the independence of the media field offers a relatively free communication space where discourse can take place without being shackled by existing devices. The media therefore offered a potential for redeployment of the publicization discourse that it quickly became part of. I use these two examples to emphasize that publicizing S&T, in a push-pull with society, cannot consider itself independently of the roles of the actors involved in a dynamic of deterritorialization / reterritorialization, constantly at play. This dynamic opens up the communication spaces where the discourses and the publicizing practices are reconstituting, and it incorporates others – or, at least, adds them to the periphery. This

dynamic reinforces the roles of some actors and weakens others, which is why the science/society evolution during the various phases of expansion is accompanied by different and changing places to speak out from.

I will give you a second example of change or displacement. As I've already noted, between 1960 and 1980 the museology of science experienced a "cultural revolution", from which the Science Centers emerged. These establishments stood apart from the preceding generation by the primacy accorded the public (or "publics"), and their separating the research aspect from dissemination. The focus was on the communication relationship, much more than on a "screen of concepts" where visitors "project and discover their perceptions"[64]. Publicizing then opted for interactive devices, intended to be both recreational and didactic in order to captivate, fix and retain visitor attention. Changes in the process of disseminating S&T that formed the basis for the Cité des sciences et de l'industrie's dissemination project[65].

But the rise of interactivity only partially explains the profound movement of recomposition then taking place. The externalization of certain traditional museum activities was more radical, though rarely perceived as such, because it was taken for granted in terms of effectiveness and performance. Most museums up until then had part- or full-time resources, staff (researchers, technicians, graphic artists, display people …), and the infrastructures they required (laboratories, libraries, workshops…) to design, develop and produce, *intra muros*, the mock-ups, assemblies, installations and exhibitions they presented to the public. These realizations, specific to each institution, were almost always designed and developed according to the inherent needs and constraints of each project, and sometimes took several years to complete. In a way, these unique productions, virtually non-reproducible, were their own model. The museum network therefore showed a wide range of particularities, each with its own configuration. Each museum formulated its own objectives and working rules, and defined the terms and conditions of the relationships it wished to establish and maintain with its environment. In short, each element of the network was part of, and interacted with, an open milieu. This is why the network, understood as a system to highlight and disseminate science, imposed its rules, norms, expectations and finalities, which is to say its internal coherence, on an outside environment which had not yet produced its own.

With the arrival of the science centres, everything changed. First of all, a displacement of the pole of legitimacy, which Cameron (1971) reported in regard to the Ontario Science Centre:

> [At] the end of 1966, the government and several members of the Board of Directors decided that museums were no longer with it at all. The word 'museum' therefore became inacceptable. They felt the public no longer had any interest in a museum with collections and a research program, a conservation laboratory and a library. As well, after a few months, all qualified personnel in museology experience had left the institution. The planning and development then devolved to a group of museographists, to specialists in public services and a staff dispatched by the Ministry of Education, so there was no longer any museology expertise and the Centre could no longer be a museum in terms of its mandate[66].

Cameron notes, and rightly so, that the planning and development changed hands. This led the teams in charge, who were laypersons in the reference areas, to surround themselves with specialists but without, justifiably, binding them to their recommendations. This is now common practice in the museum world. Consequently, the management, coordination and control functions increased while the externalization, up until then occasional, but thenceforth more

flexible, would become generalized, thereby opening up a more or less closed market in the museum field of subcontracting services and expertise. This was equivalent to privatization since externalization implies a major redistribution of the establishment's own staff and resources. This privatization movement had a profound impact on the museum field. For example, the twofold and constant constraint of visitor attendance – the contemporary /benchmark of museum productivity – and, consequently the systematic renewal of museum offerings, imposed new functions (management, coordination, cost control, schedules…), a standardization of procedures (design protocols, development and production of exhibitions, educational activities, publications, commercial cultural products, etc.). The providers of specialized services also imposed their own logics, constraints, and standard. The result was the strong trend to uniformization that Crozon had already noted in 1981 upon return from a mission in the United States, Japan and Europe where he visited some 50 S&T museums. The museums "fully reference science and technology activity. This translates into a great unity of language, the same borrowings in scientific language, the same diagrams or curves, graphics or formulae, … the same subjects chosen in the same sciences (the inevitable pendulum of Foucault, or "the same chicks being hatched"…) leading us to observe that we only show what we know how to show"[67]. May I add that this trend has continued. Doing only what we know how to do, doesn't that guarantee efficiency and performance when we have to produce something quickly and frequently? The arrival of the science centres, as much through their instituted dissociation from the fields of reference, the search for ways to compensate this, the emphasis on the public, and so on, force a realignment of the museum project and an organizational transformation that prefigures the even more radical changes that a burgeoning neo-liberalism would impose on the next decade. The outcome was an alignment of the museum field – not yet completed – to fit the logic of the cultural industries[68] (an alignment that is characterized today by museum offerings focused around cultural products created for the consumer market), and in regard to my statement, one that desolidifies science networks and museum diffusion networks[69].

If today's question, especially at this conference, is "popularization" (or "publicizing"), and no longer the "mediation" of S&T, the "communication" of S&T, the "popularization" or even "vulgarization" of S&T, so many terms, each expressing a recent history of modalities (in the sense of convergent communication devices) of S&T socialization, it acknowledges the succession of social factors to reformulate the "public presentation" of S&Ts and their inherent spaces. While, in creating the Palais de la Découverte, scientists sought to establish a direct relationship between the producers of knowledge and the public[70], the arrival of media professionals and science centres, has desolidified this to the benefit of the public scientists. The science journalists' right to speak, like that of museum professionals, is today in turn threatened by the growing impact of public relations' specialists[71].

Conclusion

I have tried to show three distinct yet related aspects of publicizing science. All the reformulations of the "public presentation" of S&Ts have up to now reactivated the same hardcore of meanings although each time they are part of a different context. In a way, this is the most profound level, the most entrenched, and one which spontaneously attracts a large consensus. However, this consensus obscures the real work of recomposing society's relationship to S&T, to which publicizing actively contributes through the reconfiguration of the social

actors's relationship to knowledge. Finally, this recomposition is accompanied by a shift of communication spaces which includes a right to speak. And which brings me to two concluding remarks.

First, I feel I must return to the critique by Philippe Roqueplo[72] on the role of media. Roqueplo concludes that the media systematically reproduces the gap that it denounces. Rather than achieving the rapprochement that it lays claim to, it substitutes a "window dressing". Roqueplo maintains that the appropriation of scientific know-how basically depends on practice: scientific knowledge is first and foremost know-how. Consequently, "the experience recounted is not the effective experience". And for non-scientists who lack the practical aspect, the account of the experience does not represent reality, it remains on the level of discourse since they have no way to do it. This "window dressing" is activated through a seeming "show of content" of science provided for the science discourse and through the "show of authority that legitimizes this content and its integration". In short, a show about and on science, relegating and confining each to their role of scientist or non-scientist. At best, there will be representations of knowledge but no genuine appropriation. Roqueplo, true defender of a science that answers only to itself and symbolized by the Palais de la Découverte, theorized the science/society relationship that prevailed during the third expansion. It was suddenly impossible for him to conceive that media's main symbolic operation was on a level other than disseminating knowledge. He remained enclosed in a model where science and society are two distinct entities; as if there's a wide gap between science (and of course its researchers), on the one hand, and society, on the other, with the residual question being the extent of this *knowledge gap*. In his model the referential is knowledge produced uphill by scientists. This can only be degraded or weakened when media plays its hand (*deficit model*).

Second, at the other end of the spectrum, closer to us, Jean-Marc Lévy-Leblond[73] points out that "the level of ignorance of a specific area is nearly as high in the scientific community, most of whom work in other areas, as it is among lay people. So we're not dealing with a single large gap separating scientists and non-scientists, but a multitude of distinct gaps, separating specialists". Moreover, to defuse once and for all the question of science illiteracy, he recalls a survey conducted in a large circulation magazine revealing that while "30% of people believe the Sun goes round the Earth[74] …, 60% do not know who painted the Mona Lisa, 56% did not know when Charlemagne became Emperor, 35% could not name the city where the Parthenon is found". Not without humour he observes that such a survey conducted in England showed that more citizens were able to name a few of the Seven Dwarfs than could name a few current prime ministers! So much for that! The illiteracy in science and technology, pervasive worldworld, can only continue to worsen in future. Whatever the amount and range of knowledge mastered by whatever people in a given field (if the specialists can agree amongst themselves on the knowledge they consider essential), it can only be out of sync with other fields and out of touch with new knowledge produced in each area. The gap is structural. In the "science archipelago" the gaps can only widen between the scientists themselves, between scientists and non-scientists, and between non-scientists. Looked at this way, the question of science and technology culture is again stymied. Why? Because Lévy-Leblond starts from the same premises as Roqueplo, revisited by the surrounding relativism of the fourth expansion.

If culture can be defined as a complex of signs and meanings – including language – woven, combined, intertwined within devices for transmitting values and meanings[75], we understand that cultural practices convey meanings because they depict the society they are part of and return to[76]. Practices, representations and behaviours interact with matrices of relationships and meanings. We therefore understand that publicizing science, at a moment marked by a given society and its crystallized practices, anchors and consolidates shared meaning. It therefore behooves us to grasp the transformations in the practices of science publicization to try to apprehend the matrices of emerging relationships and meanings. We should not be deceived: it is the consolidation of meaning that produces the culture and not the reverse[77].

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[1] This article was first published in Pailliart, I. (éd.), (2005), La publicisation de la science, PUG, p. 11-51.

[2] The reference is to science culture, scientific and technical culture, science and technology culture, science literacy, or public understanding of science (PUS) as it is now generally referred to… To me these terms seem equivalent, and so I use them interchangeably. But it is sometimes useful to distinguish the means PCST (public communication of science and technology) from its purpose PUS (public understanding of science).

[3] Association des écrivains scientifiques de France, (1959), La vulgarisation scientifique – Réunion-débat, February 26, 1958, Paris, Palais de la Découverte. Other participants in the debate: Louis de Broglie, Secrétaire Perpétuel of the Académie des Sciences, Nobel Prize, Honorary President of the AESF, Jean Eparvier, Directeur Général-Adjoint of "France-Soir", Dr. Paul Milliez, Tenured Professor at the Faculté de Médecine de Paris, Member of the Science Committee at the RTF, Jacques Moreau, Editions Larousse, and Jean Rostand.

[4] For an overview, see: Schiele, B., Jacobi, D., (1988), "La vulgarisation scientifique – Thèmes de recherche", in Jacobi, D., Schiele, B., (éd.), Vulgariser la science, Seyssel, Champ Vallon, p. 12-46.

[5] Jantzen, R., (1996), La Cité des sciences et de l'industrie -1996-2006 - De la décennie de la floraison…, … vers la décennie de la raison, Paris, Cité des sciences et de l'industrie, p. 14.

[6] The Journal des sçavans appeared for the first time on January 5, 1665. In March of the same year *The Philosophical Transactions* was published in London in the form of a monthly revue. It should also be noted that the fledgling scientific community, by producing specialized revues, instigated a device that "at once assures the circulation and validation of information by forming a consensus dealing with scientific facts among members of the learned community". Kaufmann, A., (1993), "L'affaire de la mémoire de l'eau – pour une sociologie de la communication scientifique", Réseaux, 58, p. 79.

[7] Among others, to note the most important: Chambers published the *Dictionnaire universel des arts et des sciences* (*Encyclopedia*) in 1728, Abbey Pluche presented the *Spectacle de la Nature* in 1732, Voltaire published the *Eléments de philosophie de Newton* in 1738. Then, inspired by Chambers, Diderot and d'Alembert, surrounded by collaborators, issued the *Encyclopédie*.

[8] Mauriès, P., (2002), Les cabinets de curiosités, Paris, Gallimard.

[9] Cassirer, E., ([1932] 1997), La philosophie des Lumières, Paris, Fayard, p. 41.

[10] Cassirer, E., ([1932] 1997), op. cit., p. 47-48.

[11] Kant, E., (December 1784), "Qu'est-ce que les Lumières ?", Berlinische Monatsschrift.

[12] See: Eidelman, J, (1988), La création du Palais de la Découverte - Professionnalisation de la recherche et culture scientifique dans l'entre-deux guerres, Thesis, Université Paris V – René Descartes.

[13] Moles and Oulif, (1967) condensed the vision of this period: "A new function appears in society: that of *mediation*. The intermediary will be responsible for the *communication* of elements of thought among those that make them, in an abstract but necessary language for a highly coherent system, and those that may after information have right of regard on ensuing decisions, be they space policy or new theatre, decisions that too often are made by remote authorities, for whom only those said to be infallible oracles have access to the *dossier*". Moles, A. A., Oulif, J.-M., (1967), "Le troisième homme, vulgarisation scientifique et radio", Diogène, 58, p. 33. (freely translated)

[14] A primary work: Silent Spring. Carson, R., ([1962] 1987), Silent Spring, Boston, Houghton Mifflin Company.

[15] The oil price hike by OPEC is generally considered as the turning point.

[16] Fourastié, J., (1979), Les Trente Glorieuses, Paris, Fayard.

[17] Jean-Pierre Chevênement, Ministre d'Etat et Ministre de la Recherche et de la Technologie, launched the Etats généraux de la culture scientifique in 1981. (freely translated)

[18] Ministère de la Recherche et de la Technologie, (1982), Introductory speech by Jean-Pierre Chevênement, Paris, La Documentation française, p. 55. (freely translated)

[19] Ministère de la Recherche et de la Technologie, (1982), Préface by Jean-Pierre Chevênement, Paris, La Documentation française, p. 5. (freely translated)

[20] Ministère de la Recherche et de la Technologie, (1982), Speech by François Mitterrand, Paris, La Documentation française, p. 67-74, passim. (freely translated)

[21] In italics in the text. Ministère de la Recherche et de la Technologie, (1982), Speech by. François Mitterrand, op. cit., p. 69. (freely translated)

[22] According to the well-known expression by Jean-Marc Lévy-Leblond: "mettre la science en culture" ("putting science into culture").

[23] Today the network has 52 CCSTI. Twenty-nine are included in the Réunion des CCSTI, recognized by the State.

[24] Add to this PCST actions by the Ministry of Culture and Communication, the Ministry of Youth, the Ministry for National Education and Research.

[25] It may be useful to recall that, amid all the events at the 1982 conference, two laws were adopted: the Loi d'orientation et de programmation de la recherche et du développement technologique de la France {An Act respecting the orientation and programming of research and technology development in France] (no 82-610, July 15, 1982), the Loi sur l'enseignement supérieur - dite Loi Savary [An Act respecting higher teaching – called the Savary Act] - (no 84-52, January 26, 1984), which assigned several missions to higher teaching, among others the diffusion of knowledge and research results. A coordinating body, the MIDIST (Mission Interministérielle de Diffusion de l'Information Scientifique et Technique), oversaw the actions of the various ministries. I might also add that the Loi relative aux droits et libertés des communes, des départements et des régions [An Act respecting the rights and freedoms of commons, departments and regions] (no 82-213, March 2, 1982), that gave autonomy to regional and departmental councils, served to decentralize PCST activities. This helped the developing CCSTI by giving full play to their relay role. The empowerment of all aspects pertaining to PCST was affirmed by the Loi d'orientation pour l'aménagement du territoire pour le schéma des services collectifs de l'enseignement supérieur et de la recherche [An Act respecting orientation for development of territory for the plan of collective services for higher teaching and research] (dite

Loi Deffere [called the Deffere Act], no 95-115, February 4, 1995), notably for establishing contracts between the State and the regions, and the regions and the universities, etc.

[26] Jantzen, Réal, (1996), op. cit., p. 12. May I point out that Cité – created by decree no. 85-268 of February 18, 1985 – is one of the four great national PCST establishments. The other three are the Conservatoire national des arts et métiers (renovated and reopened in April 2000), the Muséum national d'histoire naturelle – which includes the Grande galerie de l'Evolution (remodelled and reopened in 1994), the Galerie de Minéralogie, the Comparative Anatomy and Paleontology galleries, the Jardin des Plantes, the Musée de l'Homme, the Parc zoologique de Vincennes, and other sites in France – whose amended status in 2001 assigned a third mission to receive the public at their sites – and the currently operating Palais de la découverte.

[27] For an evaluation 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.

[28] It would take a complete book to cover the American initiatives. For an overview (which must however be updated), see: Lewenstein, B., (1994), "Enquête sur les activités de communication publique de la science et de la technologie aux Etats-Unis", in Schiele, B., (éd.), Quand la science se fait culture - La culture scientifique dans le monde, Ste-Foy, MultiMondes, Lyon, Centre Jacques Cartier, p. 129-194. (Lewenstein, B., (1994), "A Survey of Public Communication of Science and Technology Activities in the United States" in Schiele, B., (Ed.), *When Science Becomes Culture*. Boucherville, Quebec, University of Ottawa Press, pp. 119-178.)

[29] Lewenstein, B., (1994), op. cit., p 129.

[30] Lewenstein's compilation, largely inspired by the FCCSET/CEHR PUNS report of 1993 (PUNS - Public Understanding of Science), lists the programs of the Ministries of Defence, Education, Energy, Environment, Health and Social Services, of NASA, the NSF (National Science Foundation), and the Smithsonian Institution.

[31] See: http://project2061.aaas.org; AAAS, (1993), Benchmarks for Science Literacy, New York, Oxford University Press; and Rutherford, F. J., Ahlgren, A., (1990), Science for all Americans, New York, Oxford University Press.

[32] For an overview of the development of CST in Germany, Australia, Austria, Belgium, Cameroon, Canada, Denmark, Spain, Finland, France, Greece, Italy, Japan, Mexico, Norway, The Netherlands, Portugal, United Kingdom, Sweden and Switzerland, see: Schiele, B., (1994), op. cit.

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

[34] 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 February 25, 2004 by Jean-Jacques Aillagon, Minister of Culture and Communication, www.culture.gouv.fr. A series of measures followed: to launch large public meetings and to mobilize the associations, create a foundation for science culture, mobilize the teachers and the scientific community, coordinate the institutions throughout the territory, develop tools for scientific culture.

[35] Science Matters : http://www.number-10.gov.uk/output/Page1715.asp.

[36] The well-known work by Donnat on *Les français face à la culture*, and *Les pratiques culturelles des Français* give an idea of what I had in mind. Donnat, O., (1994), Les français face à la culture, Paris, Editions La Découverte; - (1998), Les pratiques culturelles des Français, Paris, La documentation Française.

[37] This synopsis comes from the compilation by: Miller, J. D., (1991), "Attitudes Toward Science and Technology : The United States and International Comparisons", Science & Engineering Indicators, Washington, DC, Government Printing Office, p. 165-191 ; Miller, J. D., (1996), "Public Understanding of Science and Technology in OECD countries : a Comparative Analysis", communication, Symposium on Public Understanding of Science and Technology, Paris, OECD; Miller, J. D., Pardo, R., Niwa, F., (1997), Public Perceptions of Science and Technology – A comparative Study of the European Union, the United States, Japan and Canada, Bilbao, Fundación BBV; National Science Board, (1986), Science Indicators, Washington, DC, U.S., Government Printing Office ; National Science Board, (1988), Science and Engineering Indicators, Washington, DC, U.S., Government Printing Office; National Science Board, (1990), Science and Engineering Indicators, Washington, DC, U.S., Government Printing Office; National Science Board, (1992), Science and Engineering Indicators, Washington, DC, U.S., Government Printing Office; National Science Board, (1994), Science and Engineering Indicators, Washington, DC, U.S., Government Printing Office; National Science Board, (1996), Science and Engineering Indicators, Washington, DC, U.S., Government Printing Office; National Science Board, (2002), Science and Engineering Indicators, Washington, DC, U.S., Government Printing Office; National Science Board, (2004), Science and Engineering Indicators, Washington, DC, U.S., Government Printing Office; Commission des Communautés Européennes, (1989), Eurobaromètre No 31 - L'Opinion Publique dans la Communauté Européenne, Bruxelles, Direction générale de l'information et de la communication et de la culture; European Commission, (2001), Eurobarometer 55.2 - Europeans, science and technology, Research Directorate-General. The work in this area is as legion as it is repetitive: to be convinced of this, consult the directories of government publications (EC), the major associations (AAAS, AAM, ASTEC, NSF…) and the international organizations (OCDE, UNESCO…).

[38] The question of measuring STC receives so much attention from researchers that governments take note. Among the numerous works see: Durant, J., (1993), "What is Scientific Literacy", in Durant, J., Gregory, J., (Ed.), Science and Culture in Europe, London, Science Museum, p.129-137; Bauer, M., Schoon, I., (1993), "Mapping variety in public understanding of science", Public Understanding of Science, 2 (2) : 141-155, Laugkscsh, R. C., Spargo, P. E., (1996), "Construction of a paper-and-pencil *Test of Basic Scientific Literacy* based of selected literacy goals recommended by the American Association for the Advancement of Science", Public Understanding of Science, 5 (4) : 331-359; Jenkins, E. W., (1997), "Scientific and Technological Literacy for Citizenship: What can we learn from research and other evidence?", in Sjøberg, S., Kallerud, E., (éd.), Science, Technology and Citizenship - The Public Understanding of Science and Technology in Science Education and Research Policy, Oslo, NIFU - Norsk Institutt for studier av forskning og utdanning, p. 29-50; Miller, J. D., (1998), "The measurement of civic literacy", Public Understanding of Science, 7 (3) : 203-223; Miller, J. D., Pardo, R., (2000), "Civic Scientific Literacy and Attitude to Science and Technology: A Comparative Analysis of the European Union, the United States, Japan and Canada" in Dierkes, M., von Grote, C., (Ed.), Between Understanding and Trust – The Public, Science and Technology, Harwood Academic Publishers, p. 81-129.

[39] Unless otherwise indicated, the data is taken from: National Science Board, (2004), Science and Engineering Indicators -2004, http://www.nsf.gov/seb/srs/seind04/c7/c7h.htm.

[40] Freely translated in the French version of this paper.

[41] Questioned as part of a survey, 43% of U.S. respondents and 37% of Europeans answered correctly; and on their understanding of probabilities, 57% of U.S. respondents and 69% of Europeans got the right answer. The questions were as follows: "Now please think of this situation. Two scientists want to know if a certain drug is effective in treating high blood pressure. The first scientist wants to give the drug to 1000 people with high blood pressure and see how many experience lower blood pressure levels. The second scientist wants to give drug to 500 people with high blood pressure, and not give the drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure. Which is the better way to test this drug? Why is it better to test the drug this way?", "Now think about this situation. A doctor tells a couple that their 'genetic makeup' means they've got one in four chances of having a child with an inherited illness. Does this mean that if their first three children are healthy, the fourth will have the illness? Does this mean that each of the couple's children will have the same risk of suffering from the illness. Does this mean that if they have only three children, none will have the illness", NSB, (2004), op. cit., chap. 7, p. 17.

[42] In 1993, the United States Supreme Court established the standards (falsifiability, error rate, peer review, general acceptance) for admissibility of court experts (Daubert vs Merrell Dow Pharmaceuticals). Research carried out, based on 400 cases to determine if the judges clearly understood these standards showed that only a fraction had mastered the concepts of falsifiability and error rate. NSB, (2004), op. cit., chap. 7, p. 18.

[43] On this point, see: Miller, J. D., (1983), "Scientific Literacy: A conceptual and empirical review", Daedalus, 112 (2) : 29-48, passim.

[44] For a comparative analysis, see: Banchet, J., Schiele, B., (2003), "Comparaison de quelques enquêtes nationales et internationales sur la compréhension et la perception de la science par le public", in Schiele, B., Jantzen, R., (éd.), Les territoires de la culture scientifique, Lyon, Presses Universitaires de Lyon, Montréal, Les Presses de l'Université de Montréal, p. 95-114. In the same work, see also: Miller, J. D., (2003), "Culture scientifique dans un monde de communication à large bande", p. 79-93.

[45] From: NSB, (2004), op. cit., chap. 7, p. 23.

[46] The plateau covered by the NSB spans some 10 years (1990-2001), which would have implied, if the trend is correct, that the increase noted by Miller would have happened before 1990.

[47] Miller, J. D., (2004), "Public understanding of, and attitudes toward scientific research: what we know and what we need to know", Public Understanding of Science, 13 (3), p. 273.

[48] For the United States: National Science Board, (2002), Science and Engineering Indicators - 2002, National Science Foundation, NSB-02-1, for France: Eurobaromètre 55.2 http://europa.eu.int/comm/public_opinion/archives/eb/ebs_154_en.pdf.

[49] To have an idea of earlier issues, see, among others: Lacout, A., (1976), "Représentation économiques et formations d'adultes", Pour, 49, p. 45-63 ; Albertini, J.-M., et al., (1974), L'initiation économique des adultes, ATP, no 4 des sciences humaines, CNRS; Verges, P., (1976), Les formes de connaissances économiques - Eléments pour une analyse des raisonnements et connaissances pratiques, thèse d'état, Université de Lyon II. On another level, but noting a decline, consult: Bloom, A., (1987), The Closing of the American Mind, New York, Simon and Schuster.

[50] Unfortunately, it was not possible for me to give all the references I would have liked as part of this conference. However, I would like to mention the best known: Hinton, D. A., (1979), Popular Science in England, Bath, Université de Bath, Thèse; LaFollette, M. C., (1991), Making

Science Our Own, Public Images of Science, 1910-1955, Chicago, University of Chicago; Bauer, M., Durant, J., Ragnarsdottir, A., Rudolfstottir, A., (1995), Science and Technology in the British Press, 1996-1990, London, The Science Museum.

[51] I take the delineation proposed by Bauer (1998). Bauer, M., (1998), "'La longue durée' of popular science, 1830 – present", in La promotion de la culture scientifique et technique : ses acteurs et leurs logiques, Paris : Université Paris 7 – Denis Diderot.

[52] Quoted by : Rose, A. J., (1967), "Le Palais de la Découverte", Museum, (20)3, p. 206.

[53] Bachelard, G., ([1938] 1970), La formation de l'esprit scientifique, Paris, Vrin, p. 14. [Formation of the Scientific Spirit, Clinamen Press (2001)]

[54] Bachelard, G., ([1938] 1970), op. cit., p. 14.

[55] Meadows, Jack, (1986), "Histoire succincte de la vulgarisation", Impact : science et société, 144, p. 395-401, passim.

[56] Duby, G., (1967), "La formation des modèles culturels dans la société féodale", in David, M., et al., (Ed.), Conference Proceedings, May 7 to 9, 1966, Paris, Mouton.

[57] Castells, M., (1996), The Network Society, Cambridge, Blackwell.

[58] An indicator of this trend in the museum field: museums increasingly develop their research according to the exhibition projects, while not so long ago, it was the reverse.

[59] Limoges, C., (1995), L'université entre la gestion du passé et l'invention de l'avenir, Symposium de la Commission de planification, Québec, ronéotypé, p 8-10, passim.

[60] See: House of Lords, Select Committee on Science and Technology, Third Report, Science and Society, February 23, 2000. This report observes that a crisis of confidence today characterizes the relationship between science and society. For the Lords, this critical situation demands the application of correctives which satisfy the public's demand for the transparency from scientific and government authorities. Very pragmatic, they declare: "public hostility to a product or process may drive industrial investment in production or research overseas", p. 1.12. I recall in passing that the NSB survey of 2004 refers to this critical relationship.

[61] Helfrich, P. M., (2000), Building On-Ramps to the Information Superhighway: Designing, Implementing, and Using Local Museum Infrastructure, in Schiele, B., Koster, E., (éd.), Science Centers for this Century, Ste-Foy, MultiMondes, p. 87-123.

[62] Secrétaire Général du Comité Permanent pour l'Expansion de la Recherche Scientifique, Directeur-Adjoint à la Présidence du Conseil. Association des écrivains scientifiques de France, (1959), La vulgarisation scientifique – Réunion-débat, 26 février 1958, Paris, Palais de la Découverte, p. 35.

[63] The primary article is of course that of Moles and Oulif (1968), op. cit.

[64] Moles, A. A., (1967), Sociodynamique de la culture, La Haye, Mouton, p. 28.

[65] See: Decrosse, A., Landry, J., Natali, J.-P., (1987), "Les expositions permanentes de la Cité des sciences et de l'industrie de la Villette, Explora", Museum, 155, p. 176-191; for a critical perspective, Chapter 4 – Les silences de la muséologie – in Schiele, B., (2001), Le Musée de Sciences, Paris, L'Harmattan.

[66] Cameron, D., ([1971] 1992), "Le musée : un temple ou un forum", in Desvallées, A., (éd.), Vagues – une anthologie de la nouvelle muséologie, Savigny-le-Temple, M.N.E.S., Vol. 1, p. 78, (from: "The Museum, a Temple or the Forum", Curator, XIV (1), p. 11-24).

[67] Crozon, M., (1981), "A quoi servent les musées ?", in Groupe de liaison pour l'action culturelle scientifique, (éd.), La science au musée : sur les musées des sciences et des techniques, Paris, Groupe de liaison pour l'action culturelle scientifique, p. 81. Cameron (1997), describing the

contemporary evolution of museums, writes: "Should it surprise us if museums are becoming indistinguishable from shopping malls, or that collections are being viewed less as a public trust and more as fluid assets to be sold to offset deficits? Should museums profiting from each other through fees and charges for services, or public exhibition galleries closed to the public for a wedding reception come as a shock? No. Consider this line of argument. The museum is competing in a free market for its customers' entertainment dollars not their minds. Il is offering products, not ideas". Cameron, D., (1997), "Closing the Shutters on 'The Window on the World' : Museums and the Future", in Côté, M., Ferera, L., (Ed.), Perspectives nouvelles en muséologie / New trends in Museum Practice, Québec, Musée de la Civilisation, p. 172.

[68] Works on the cultural industries have developed significantly over the past 20 years, one might say at a pace where they were restructuring the market of symbolic goods. The effects of these industries on STC are considerable, especially in annexing of the museum field. See: Miège, B., (2000), Les industries du contenu face à l'ordre informationnel, Grenoble, Presses Universitaires de Grenoble, and Miège, B., (1989), The Capitalization of Cultural Production, New York, International General.

[69] On this point, see "Producteurs et consommateurs", in Bensaude-Vincent, B., (2000), L'opinion publique et la science – A chacun son ignorance, Paris, Institut d'édition Sanofi-Synthélabo.

[70] Eidelman, J., (1992), "La création du Palais de la Découverte : idéalisme corporatiste et matérialisme politique", in Schroeder-Gudehus, B. (éd.), La Société industrielle et ses musées : Demandes sociales et choix politiques – 1890-1990, Paris, Editions des archives contemporaines, p. 161-169.

[71] On the development of public relations vs. science journalism, see: Gregory, J., Bauer, M., (2003), "'PUS inc.': l'avenir de la communication de la science ", in Schiele, B., Jantzen, R., op. cit., p. 41-65 ; Göpfert, W., (2003), "Une vue déformée des sciences : de la faiblesse du journalisme et de la force de relations publiques", in Schiele, B., Jantzen, R., (2003), op. cit., p. 67-78.

[72] Roqueplo, P., (1974), Le partage du savoir, Paris, Seuil, passim.

[73] Lévy-Leblond, J.-M., (2002), "Science, culture et public : faux problèmes et vraie questions", Quaterni, 46, p. 95-103, passim.

[74] To return again for a moment to Terre et le Soleil, here is what Lévy-Leblond says about it: "à la question "lequel tourne autour de l'autre ?", je ne peux, en tant que physicien, offrir une réponse sans ambiguïté que si l'on me dit à quel système de référence elle est censée se rapporter. Car le Soleil, vu depuis la Terre, tourne bien autour d'elle ! Et affirmer le sérieux d'une telle réponse n'est pas argutie provocatrice : les calculs très sophistiqués des trajectoires suivies par nos sondes spatiales se font effectivement dans ce cadre où la Terre est (à bon droit) considérée comme immobile, cinq siècles après Copernic. (…). La description du mouvement peut se faire dans n'importe quel référentiel". ["to the question 'which turns around the other?', as a physicist, I can only offer an unambiguous answer if I'm told what the reference system is. Since the Sun, seen from Earth, turns around it! The seriousness of such an answer is not mere quibbling: very sophisticated calculations of trajectories followed by our space probes are made taking as framework that the Earth is (deservedly) considered to be immobile, five centuries after Copernicus …. The description of the movement can be within any reference".

[75] Harvey, D., ([1990] 1995), The Condition of Postmodernity, Cambridge MA, Oxford UK, Blackwell, p. 299. The quotation reads as follows: "[I]f we view culture as that complex of signs and significations (including language) that mesh into codes of transmission of social values and

meanings, then we can at least begin upon the task of unraveling its complexities under present-day conditions (…)".

[76] Linton, R., (1959), Le fondement culturel de la personnalité, Paris, Dunod.

[77] Castells, M., (2000), "Material for an exploratory theory of the network society", British Journal of Sociology, 51(1), p. 5-24, passim. Castells' core argument reads as follows : "[B]y meaning, I understand the symbolic identification by an actor of the purpose of her/his/their action. The consolidation of shared meaning through crystallization of practices in spatio-temporal configurations creates cultures, that is systems of values and beliefs informing codes of behaviour. There is no systematic systemic dominance in this matrix of relationships. There are all layers of social structure and social causation, folded into each other, distinguishable only in analytical terms. Thus, meaning is not produced in the cultural realm: it is the cultural realm that is produced by the consolidation of meaning" (p. 7).