Cultures of Science 2018, 1(1): 15–23

Cultures of scientific culture

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Abstract

The sciencescape has been completely transformed in just over 30 years. Science exerts such impact on today's society as to have completely remodelled it. The ways of appropriating knowledge, individual and collective, in terms of parcelling disciplines, the burgeoning knowledge produced by each of them, and the demultiplication of information sources, can no longer be thought of in terms of the model that prevailed up to now. To imagine another model, one must try to understand what has changed.

Key words

Culture, scientific culture, communication, science, technology, knowledge, skills

1. Introduction

The history of the complex science–society relationship may be simplified by stating that this history is primarily a growing integration through time, to the point where today's society develops only in parallel with science and technology. The notion of economic and social progress is now so intimately associated with developments in science and technology that the two factors tend to merge.[1]

2. The science–society dynamic

Add to this history a progressive awareness of the increasing impact of science and technology on society. Originally peripheral, with a limited effect on the social dynamic, over time they have induced a profound transformation—one that we grasp through their advancements and applications and that has upturned the familiar structure of existence and stunningly revolutionized the associated representations. Science and technology are so pervasive in our daily lives that their descriptive words and ideas pervade our thought. They 'invent and present a major portion of the objects, concepts, analogies and logical formulations we use to address our economic, political and intellectual tasks' (Moscovici, 2002, p. 22).

In this paper, I wish to explore the evolution of growing interactions between science and society from the perspective of the strategies and means of communication adopted to bring science to the general public and to foster the appropriation of knowledge.

For over 30 years, individual and collective appropriation of scientific knowledge has been perceived as a social necessity. Why is this? Because adapting populations to a perpetually renewing social and technical

environment means a constant acquisition of new skills; and keeping those skills up to date in turn demands an ongoing collective capacity for innovation, which is seen as the engine of economic and social development (Castells, 1996). While the notion of progress has long been linked to scientific and technical progress, the two are inextricably bound to that of economic development. And the necessity to regularly upgrade skills, to maintain collective performance, is but the counterpart 'of the process of change', as so aptly stated by Schumpeter, 'that constantly revolutionizes the economic structures from within by endlessly destroying its aging elements and continually creating new ones' (Schumpeter, quoted by Salomon, 1999, p. 44).

This means constant social mobilization. And governments, anticipating the expected positive spin-offs, have redoubled their efforts to develop and promote science literacy. This political will has served to underpin and shape successive strategies in public communication of science and technology (PCST) for more than 30 years. This is worth keeping in mind as we try to determine their evolution over that period.

3. PCST in the 19th and 20th centuries

But a nod to history is useful in understanding this recent dynamic. From the time that the scientific effort as we now know it began to emerge, it adopted means of dissemination for its own expansion and perpetuation—a reminder that producing and publicizing knowledge have always been pursued. Science from the start sought to be open, and the discoveries of alchemy, intended for a limited circle of initiates, were transmitted in the form of coded documents, written in Latin. Ways were found to share and elucidate learnings, the communicators choosing a vernacular that could be widely received. The 18th-century sages opted for an exchange of knowledge and the inherent increase of knowledge that it made possible. They renounced secrecy, first among themselves and then for the general public. In short, the development of science owes much to this choice of transparency adopted from the beginning. In this respect, the book plays an instrumental role.

Communication among researchers (that is, communication to produce new knowledge) distinguished itself from communication to disseminate knowledge from the time that mathematization and formalization entailed a self-enclosure. The notion of mediation to maintain contact with the general public originates from this dissociation. If the idea of mediation itself *ipso facto* involves a self-enclosure of the scientific field, it equally demonstrates a necessary willingness to socialize science (that is, to place it within social discourse), without which, being no longer part of public consciousness, it would deny its underlying principle of universality.

The public communication of science, as we understand it today—long referred to as 'vulgarization' or 'popularization'—appeared in the 19th century. In the first half of the 19th century, the pace of scientific progress accelerated and progressed thanks to better work organization. The 18th-century amateurs, few in number, working on their own and often with rudimentary tools, gave way to 'professionals' trained by standard science instruction dispensed by a network of specialized institutions endowed with libraries, collections and laboratories.[2] Research then became better organized, with specialization, a genuine model of division of labour and better equipment, and it progressed rapidly. Practical spin-offs also gained in importance. From the early 19th century forward, the application of scientific knowledge to agriculture, industry and transportation progressively transformed economic life, fostering the emergence of big industry and, as we propose, generating a massive flow of information geared to scientifically educating the

general public (Carle and Guédon, 1988). Following this, the great world fairs, such as the Great Exhibition (London, 1851), added to the growing recognition of productions of the human mind (Forest and Schroeder-Gudehus, 1988). It was in this context, specific to the 19th century, that 'popularization' truly blossomed: 'not only did works touting scientific ideals flourish, but so did the writers who dedicated their prime efforts to it' (Meadows, 1986, p. 396).[3]

Research was notably fundamental during this period, guided by the desire to know in order to know. Pushing the limits of the unknown was paramount. To that end, disinterested sages working in their own laboratories sought to understand and reveal basic laws governing the natural world. In so doing, they hoped to reveal the unity hidden beneath the world's apparent complexity. Their objective was to make it intelligible and to present it within a unified vision. Did not Darwin, in propounding the theory of evolution, reduce the diversity of the life force to a few basic processes? It is worth noting in passing that, in the spirit of the Enlightenment, Darwin aimed *The Origin of Species* at scientists and the general public alike.

This idea of fundamental research would persist until the 20th century. The dominant mode of dissemination then, exemplified in magazines, newspapers, science museums and so on, highlighted scientific knowledge within the logic of educating the population. This of course meant discovering the world revealed by science. But most of all it persuaded the population to espouse the idea that a quest for knowledge in itself gains its whole worth and merit through that quest itself.

The communication model of the era was a template of the master–student relationship: the scientists, or those who spoke or wrote on their behalf, often simultaneously played the roles of master and mediator with the public. They spoke to a public, deemed ignorant, that must be taught the rudiments of scientific concepts in order to bolster their minds and extricate them from their condition. Those with knowledge spoke to those without. It was an encyclopedic approach: the accession of scientific knowledge was perceived as the accumulating of parcels of purportedly essential knowledge, the assimilation of which was mandatory for anyone claiming to be science literate.

However, the spin-offs from disinterested scientific research ended up accumulating with ever-gathering force, clearly demonstrating the radical, transformative power of science and technology, and were increasingly present daily in an environment being constantly recast. As a result, once science's power to transform became evident, science itself was quickly put to the service of economic and social development. It has been that way ever since, reversing the previous logic. From then on, the aim was to know in order to innovate, and no longer to seek knowledge for knowledge's sake, while leaving to others the task of finding applications inherent in that knowledge. Today it is imperative to innovate and to search only when knowledge leads to innovation. This new thrust characterizes post-industrial society. The turning point, inverting the polarity, happened around the 1970s.

4. In search of a new PCST model for the 21st century

In the 1970s, there were considerable efforts to raise the general public's level of science literacy to one closer to that of scientists, to convince it of the positive spin-offs of research, and to involve it dynamically in the considerable changes resulting from science (Bodmer, 1985).[4] Indeed—and here is the upshot, I think—the result of all these efforts is a public much better informed but not necessarily more convinced, certainly less convinced, at any rate, than at the beginning of the 20th century, when advances in knowledge were still associated with enhanced

well-being. This observation led the Select Committee of the House of Lords to summarize the conclusions of its work in a stunning statement: 'Society's relationship with science is in a critical phase' (House of Lords, 2000).[5]

No longer is it possible to ignore the intricate complexity of problems that stride alongside the upheavals of daily life jolted by changes in the affairs of the world effected by science and technology. Everything occurs as if the combined effect of promotional campaigns, of developing and raising the level of the public's science literacy to adapt to those changes, was accompanied by a shower of uncertainty and doubt. The Select Committee of the House of Lords, based on various inquiries, observed at the turn of the 21st century that '[p]ublic interest in science in this country [the UK] is currently high', but that '[t]here is however, an apparent crisis of trust. While people appear to have an appetite for popular science, the paradox is that this is accompanied by increasing skepticism about the pronouncements of scientists on science-related policy issues of all types' (House of Lords, 2000).

That observation was not new. Already, in 1985 (p. 99), Michel Godet, anticipating the conclusions of the committee, had written in a broader perspective:

> The technical and economic change being more rapid than social change [means that the] social structures and reaction to new realities are increasingly inadequate. The crisis is but the reflection of the inadequacy of our structures, and the technological change only [serves to] exacerbate this contradiction between the forces of inertia and the forces of change.

In the same vein, 15 years earlier, in 1970 (p. 366), Jean-Jacques Salomon had stated:

> Science and technology are our destiny, in the same way that politics is the destiny of science and technology: we can learn to have it serve us better, we cannot choose to escape it.

In other words, today, 40 years later, it is the idea of a certain progress that is questioned in our coming world: a future that is no longer designed without the structuring input of technology and science, no more than it can escape a questioning about them.

But let us go back a few years to better grasp the sequence of circumstances that spurred this questioning. In the early 1960s, two ruptures would occur. The first was characterized by an accelerated movement of autonomization of PCST. This affirmed its legitimacy. The popularizers, until then auxiliary to the scientific community, demanded to be its exclusive mediators with the general public. They justified this demand by denouncing scientists, who were thenceforth deemed unsuited to communicating with the public, deciphering its expectations or sharing with it the 'immense power that knowledge bestows' (Moles and Oulif, 1967, p. 33). While scientists had certainly contributed in a major way to purveying scientific thought in the 19th and early 20th centuries, they had to be replaced by a 'third man', neither scientist nor layperson, who would serve as intermediary between the scientific community and the general public. The two were brought closer together, thus narrowing the gap between scientific and ordinary knowledge. This approach is exemplary because it constructs and condenses a representation that is diffuse, yet portends the role of media. In hindsight, we now know that denouncing an ever-widening gulf also helped incite the autonomization of media. The arrival of an intermediary sealed this autonomization. It kept the scientific community and the general public reasonably distant from one another, while defining the conditions of their presence via a media portrayal.

Research on the dissemination of science in the United States reached the same conclusion:

> By the early 1960s, four major groups had responded to the post-war demand for popular science, each for its own reasons. Each group—the commercial publishers, the scientific

> organizations, the science writers, and the government agencies—defined 'public understanding of science' in slightly different ways to serve their own needs (Lewenstein, 1992, p. 62).

In short, it was during these years that the notion of the *deficit model* came in, bolstered by the movement of media autonomization. The deficit model presupposes a *knowledge gap* between scientists and non-scientists. The most famous proponent of this vision, still popular, is of course Charles Percy Snow (1974). It appears in many contemporary works, such as the Eurobarometer opinion surveys that assess science literacy among the public.

The second rupture is the observation, mentioned above, that with progress come hazards and risks. Oil spills, such as the one resulting from the wreck of the *Torrey Canyon* in 1967, followed by a disastrous release of industrial chemicals at Seveso in 1976, the Three Mile Island nuclear accident in 1979, the Bhopal gas tragedy in 1984, Chernobyl in 1986 and other disasters remain in the forefront of people's minds. Add to this the risks associated with persistent pollutants decried since 1962 (Carson, 1987), such as PCBs, dioxins, furans, DDT and numerous pesticides prevalent in the environment, the effects of which represent serious and insidious threats to people's health (and the balance of ecosystems). Too many and repeated accidents spurred a questioning of the notion of progress, and this systematic doubt in people's minds has become a fact of society. As the report of the House of Lords (2000, p. 1) states: 'Today, fear of such risks is a major feature of public attitudes toward technology across the industrialised world.' The public has become cautious, mistrusting and critical. Gone is the force of conviction for a Utopian society transformed by the reason of the Enlightenment, represented in scientific and technological progress, and tangibly manifesting in economic development.

The flip side of this is our perception of another dimension to consider, more diffuse, but more profound. Because it became apparent during those years that a greater integration of science and society went beyond undesirable collateral effects, the model of scientific rationality now addresses all spheres of human activity. We have come to understand that 'it is the scientific life that in postindustrial societies structures all actions of social life, from school to university, from professional training to all cultural parameters and productions, from the management of industrial enterprises to those of political institutions' (Salomon, 1999, p. 10). This makes it more readily possible to subsume the complexity of the science–society relationship in a simple problem of communication between scientists and the public—that is, as if the task were but to resolve an incompetency in this regard.

In sum, today's public recognizes the benefits of science and technology development (improved lifestyles, better working conditions, better medicine and so on), but with a pragmatic proviso: it also acknowledges the inherent risks. This has made it more difficult to teach the public the 'truths' of science or to define the public as incompetent, with no voice in the matter, especially since the advocated choices or decisions could adversely affect it sooner or later (Bauer et al., 2007). Another way to describe this examination of the role of PCST is to say that, if society is transformed by its constant interaction with science, that transformation itself redefines its relationship with science. Suddenly, the current conception of knowledge and ignorance must be revised. And PCST strategies must adapt, because in so far as the symbolic conditions of operativity of the deficit model prevail, the accompanying justifications no longer apply.

But there is more. What we believed amid the vestiges of a heretofore incomplete science, turned out in fact to be vestiges in the throes of disappearing as they endured the

ongoing process of integration of knowledge—the real trend of scientific development. We now know that science is more like an archipelago than the ideal island once dreamt of. Will the disciplines continue to fragment into increasingly autonomous specialties as knowledge proceeds? Such an evolution leads to a paradoxical observation: the effort to reduce the diversity of the world to a few fundamental laws, to simplify the world, so to speak, became one with its complexification. Today we live in a world that is more difficult to decipher, since it is attuned to a multitude of different outlooks.

The effort to disclose and reveal culminated in a parcelling of knowledge. And thus:

> [T]he level of ignorance in a particular field is just about as high in the scientific community, where most of them work in other areas, as among lay persons. So we aren't dealing with just one major gap separating scientists from non-scientists, but a multitude of particular hiatuses separating specialists' (Lévy-Leblond, 2002, p. 96).

As a result, scientific ignorance is doubtless the best shared subject in the world. And it will only continue to increase in the future. Regardless of the extent and scope of knowledge mastered by anyone in a given area (in so far as specialists can agree among themselves on what's considered essential), this knowledge is always out of sync with other areas and even with new knowledge in its own area. The accumulation of knowledge thenceforth prevents anyone from boasting of purported mastery in their own area, which even more quickly encloses specialties within themselves, with imaginable consequences. The gap is structural. In the 'archipelago of science', the hiatus between scientists themselves and non-scientists can only widen. This situation is such that when a researcher is invited to pronounce on a question outside his discipline, his opinion becomes but one among others, and that of a layperson is worth just as much. This leads Michel Claessens to observe that '[the] models and work of researchers are sometimes so remote from the real world that they are not necessarily the best placed to deal with distinctly complex and multiform problems', and to conclude that 'notably for this reason, science cannot claim to directly influence politics' (Claessens, 2010, p. 45).

Thus the Utopia of a would-be encyclopedic PCST designed to fill the gap between researchers and laypeople leads nowhere. Confronted with an accumulation of knowledge in increasingly 'air-tight' areas in respect to each other, and faced with increasing specialization as well as the ever-accelerating 'obsolescence' of knowledge, the actualization of anyone's knowledge can only be contemplated in terms of the professional preoccupations of the moment. Thus, it is the individual trajectory that prevails, which implies that people's relationships to knowledge will be very different from one individual to another. Moreover, those relationships will vary in keeping with the wavering concerns of the moment, whether broaching a general question of culture or a specific topic.

Moreover, on another level, the evolution of the organization of work in postindustrial society also reinforces the importance of the individual trajectory in establishing a relation to knowledge. By highlighting the flexibility of the individual, the new organization of work equally transforms the relationship to knowledge and how it is acquired. Hence, 'the idealized new self' is 'an individual constantly learning new skills, changing his or her "knowledge basis"' (Sennett, 2006, p. 44). And, when the quest for innovation is central to the economic effort, how can anyone escape this, since their knowledge is accorded value only in terms of its usefulness, and when it becomes useful?

The development of the internet and the reformulation of the accompanying modes of mediation also converge to reinforce this trend. Cyberculture is primarily characterized

by a communicational immanence engendered by the internet, based on the three great properties of the web: surfing that shatters the constraints of space and time on traditional modes of writing; hypertext that enables 'a generalized looping of knowledge within itself' (Weissberg, 1999; Pélissier, 2002, *passim*); and fewer interactions, now 'permanent and retroactive' (*id.*) between the producers and users of information 'with any point of the communication network' (*id.*). This cyberculture leads simultaneously to the emergence of new actors and marginalizes the traditional forms of mediation of scientific knowledge. The diversification of means of communication brings new actors to the scene, from various horizons—from scientists totally invested in their work to passionate amateurs—engaged in producing and dispensing new scientists. This results in fewer sources and a challenge to the habitual modes of scientific mediation, so there are now more actors than ever engaged in producing science news, and scientists and mediators make up but a small number of them.

So the sharply defined borders between scientists and laypeople today tend to become rather blurred. And, whether or not it was intentional for traditional public-oriented science mediation to fragment into target audiences, the new communication format tends to essentially put specific interest groups in contact, to elicit such groups, and to very obviously try to be part of them, which radically changes the deal.[6] This aspect is of prime importance, in that information searching draws on widely ranging search engines while the media is diversifying (portals, e-zines, forums, personal home pages, chat groups, address lists, blogs) in pace with an equally diversifying internet attuned to the interests of these groups. It follows that specialized information aimed at professionals in a particular field is also accessible to the general public, or at least to an interested public. Thus, a hodgepodge of information co-exists pell-mell: promotional material, publicity, advertising, marketing, services, reports, public information, guides, directories. First, and notably, what is disseminated to certain audiences is very quickly accessible to everyone. Second, amid all the material produced for and circulating on the net, it is increasingly difficult to discern the information strategies among those touting and promoting organizations. Third, in this system of generalized communication and exchanges, based on exacerbated competition between organizations, it is impossible to be certain that the information has been validated by internal review mechanisms or by peer reviews and to control the sources.

5. Conclusion

I have tried to highlight some aspects of the present situation that I see as significant. As I have tried to show, the individual trajectory seems to me a path to be explored more fully because it will no longer be possible in future to conceive of the dissemination of science in encyclopedic mode—if, perchance, anyone ever seriously believed that acquiring science literacy was but the sum of elements of knowledge deemed essential and indispensable. Today, no one can master the corpus of knowledge produced in his or her own field. Everyone navigates alone in the labyrinth of knowledge according to professional preoccupations, personal interests, specific constraints or concerns of the moment. Mediation now plays out at the interface of individual expectations and access to timely information. The results will of course differ from one individual to another, as from one context to another.

But mediation cannot limit itself to being a mere contact point or contact facilitator to the desired knowledge. Unlike the outmoded conception of PCST as an exercise dispensing would-be neutral truths to a so-called lay audience, only an approach that fosters a confrontation of ideas between actors engaged

in a reflection yields a critical appropriation of knowledge in a world governed by complexity. The mediation must therefore be conceived as the creation of a discussion space, where arguments propped up by a commonality of knowledge are advanced and debated. And, indeed, this is what happens with the *consensus conferences* that engage the actors in a process of negotiation (Horst, 2008) and with the *science cafés* that put scientists in contact with the public without interposing a mediator (Riise, 2008). It is the discussion itself which, in the science cafés, then defines the mediation, communication and information spaces, and the science museums become forums of discussion on matters in which science raises genuine problems for society. In this kind of a dynamic, the knowledge relationship alters. It becomes deliberative; that is, a critical outlook emerges. And, ultimately, it is through the confrontation of such outlooks that a collective consent is forged.

Notes

[1] This article synthesizes, for the first time for a Chinese audience, a number of views already expressed in other contexts.

[2] Alexander von Humbolt (1769–1859) invented the modern university in Germany.

[3] See also Raichwarg and Jacques (1991).

[4] In this part, I borrow from Schiele (2005).

[5] The first paragraph of the report, titled 'A crisis of trust', reads as follows: Society's relationship with science is in a critical phase. By 'science' we mean the biological and physical sciences and their technological applications. On the one hand, there has never been a time when the issues involving sciences were more exciting, the public more interested, or the opportunities more apparent. On the other hand, public confidence in scientific advice to Government has been rocked by a series of events culminating in the BSE fiasco; and many people are deeply uneasy about the huge opportunities presented by areas of science including biotechnology and information technology, which seem to be advancing far ahead of their awareness and assent. In turn, public unease, mistrust and occasional outright hostility are breeding a climate of deep anxiety among scientists themselves. (House of Lords, 2000).

[6] In this perspective, it is understood that one of the preoccupations of science mediators, just as for scientists and all specialized interest groups, is to ensure the validity of the information exchanged on the internet.

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