Science, Power and the Development of Culture: Great Scientific Advances Transforming Our Future

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Knowledge and power have always been aligned in our societies from the very beginning. Thus, the relations of science with power, and of culture with the economy, have to be viewed as a permanent reconstruction of the interactions between individuals, institutions and societal structures. The importance of science in the past two centuries has been central to our perception of present society: but what will be the pratice of tomorrow? Looking at great scientific achievements of the recent past we may have hope; however the search cannot be discontinued or discouraged.

Knowledge, science and power

Knowledge-based activities arose even before the first human societies acquired the capacity to use fire. But the command of fire brought certainly the attitude of dominance over nature which has been with us ever since. The needs to survive (and thus to make relevant collective choices in a frequently hostile environment) and to strengthen the cohesion of their own groups motivated the early humans to develop their systems of communication into languages and to improve their technical and other cognitive skills and capacities. In fact, as Fernand Braudel so deftly asserted, the whole thick-

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ness of the history of mankind is the result of thechnique[1].

What are the relations between knowledge and power?

The deployment of power involves always the institutions of a body of knowledge, which emerges as the source of its own legitimation and cultural identity; concurrently, the rules that govern the operation of this body of knowledge induce a set of power relations in the group of its practitioners[2].

Therefore, we can say that knowledge and power function as mirrors of each other in human societies, to the extent that the conditions for their respective enactement spring from mutual coexistence. In all epochs and communities, both knowledge or power sets its indelible mark upon the other.

The overwhelming impact of the transformations brought about by the industrial revolution showed that a considerable body of scientific and technological knowledge plays a central rôle in the performance of modern economies. The conduction of scientific and technological research activities is now seen to be crucial to the generation of tecnological innovations, and also to the construction of meanings, values and representations that enable the diffusion of innovations in society.

Hence, we must distinguish between "power" and the "power of science" on one hand, and between "power in science" and "scientific power", on the other.

Power is the possibility to act, or to exert influence, i.e. to enforce authority. Political power is directed towards winning and keeping power.

The power of science (meaning by this expression the command by science of the interaction between science and society) is directly related to its influence on the matters that are of relevance to soci-

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[1]Fernand Braudel - in "Les Structures du Quotidien, Civilization Materielle, Economie et Capitalisme XV- XVIII siècle", Armand Colin, Paris 1979.

[2]Michel Foucalt - in "Resumés de Cours", quoted by M.M. Carrilho, Itinerários da Racionalidade, Dom Quixote, Lisboa, 1989.

ety. Thus, the power of science is not dictated by the "intrinsic strength" of science and technology but rather by the perception of its importance for the consolidation and survival of the system of power. The status of eminent scientists and the "proximity" to power of scientific advice are, thus, indicators of the social value of science and tools of its invigoration.

Power in science (which means the command of power relations inside the body of science and technology) serves the important objective of securing the standards and competence of the scientific establishment. Of course, the capacities to act, influence and enforce authority, being specific attributes, (i.e. they materialize in the context of a definite sub-system: the scientific and technological one) imply sometimes a degree of immunity of research laboratories and science centres to the vices of the other existing institutions in society. But that is also frequently not the case.

Finally, let us consider scientific power, the goal of good souls and minds, which so many connote with "enlightened" power. Here, we must recollect that science and technology is just one of the domains of knowledge (a rather expanding and pervasive one in contemporary societies) that embody our culture. The employment of power, to be viable, needs thus to appropriate relevant scientific knowledge. But that doesn't imply that decision-making is developing into a scientific process, nor that other cognitive aspects pertaining to the issues should be shadowed. Science doesn't have the monopoly of meanings in our culture. What we must strive, consistently, is at securing sounder and more pertinent scientific bases in each decision-making process.

The making of present decisions genuinely characterizes us and the times we live in. In the past, when the future was supposed to be pre-determind (or written) the search for meanings through oral tradition or history was complemented with the recourse to divination - a way of mobilizing the unknown to minimize the consequences of uncertainty. In our century, the growing weight of science and technology in society led mankind to view the future as a construction, as the embodiment of present decisions. Decisions have thus to be

"evaluated" in relation to their own time horizon.

In the 1960's, a universal model for science and technology (S&T) was accepted, which corresponded to an instrumental concept of S&T in relation to social and economic development. Nowadays, however, we know that it is not possible to isolate research activities from the social context in which they are conducted; this is reflected by the growing "scientification" of the cultures of contemporary societies as well as by the increasing social involvement of S&T, of individual scientists and researchers and of their organizations. A new need has been created: the need to make sure that public funds spent on S&T research and development are used in a societal beneficial way -- evaluation performing primarily the role of mediator in this process.

In fact, the growing role of immaterial factors in our society contributed to clarify the differences between the values at the heart of the scientific pratice -- the search of proof -- and those underlying the administration of science -- the search of utility. From the tension between these values, from the continuous process of reconciliation between these two activities, emerges the motivation for generating elements that enable more rational (and therefore better) choices.

Science, culture and the economy

We must understand what is meant when we use the expression "immaterial" factors or components of society. In the first place, we have to recognize that all human societies are "economies", i.e. modes of organizing people and their surrounding environment in systems with enough coherence to use a background flow of matter and energy to sustain, maintain and reproduce this coherence.

These systems, which exhibit the features of what Ilya Prigogine calls "dissipative structures", have the following properties: (i) they survive in an open system; (ii) they maintain themselves through irreversible dissipation of matter and energy; and, (iii) their cohesion and information content are finite.

An economy can thus be viewed as a system which is stabilized by a flow of matter and energy. Its viability is linked to the capacity to find ways to keep the flow at an adequate rate. This capacity - which derives from the mode of organization - is consequently connected to the information content of the economy.

Therefore, it is necessary to introduce in the economic analysis a new dimension - to span the immaterial components - in addition to the existing physical (or energy) dimensions (which span the material components).

It is easy to understand why economic science only recently started to worry about the central rôle of immaterial investment and technological innovation in the evolution of society. For millenia, the development of human beings was dominated by the need to absorb increasing amounts of material goods and energy, either the form of food, shelter and artifacts or of labour and power.

Thereofre, the availability of material and energy sources had been the limiting factor of economic development until recent times.

The growth of the material component in our societies has been so prevalent as to obscure the immaterial component. In fact, the immaterial component has until recently been treated as an invariant.

We can say that the past evolution of mankind has been governed by the empire of the material component. Human transactions have thus had until recently the overall characteristics of exchange transactions. Exchange of goods and services has been at the basis of economic activity.

However, the emergence of whole industrial sectors centred on information technologies and the growing weight of immaterial investment in society (R&D, software, education and training, marketing, design...) has shown that the very nature of the economy is changing.

We see that the rising importance of immaterial factors in our societies tends, on one hand, to influence the accumulation of wealth by the creation of new vectors for its appropriation; on the other hand, furthermore, a powerful new amplificatrion factor of differen-

tiation is being introduced by adding, to the essential element of scarcity characterizing material resources, another constraint -- incomprehension (or the lack of intellectual capacity).

This explains the predominant importance that culture -- the system of values and perceptions, i.e., of preferences that derive from the collection of societal meanings -- fulfils in present times.

Culture serves, finally, as a guide of choices for the actions in everyday life which may (in some cases) affect powerfully the future.

Scientific achievements of our century

We have stressed the interactive nature of the relations between science, power and culture and the importance of scientific culture (for better choices) in society.

Deriving from this description we observe that the essence and logic of power (and even of scientific power) lies outside the domains of science; power maintains an ambivalent relationship with science, allowing sufficient power of science for its own legitimation purposes and inducing necessary power in science to be able to supervise on competence issues. Of course, this complex of interactions evolves in time and is subject to constraints and conflicts. But the critical choices are, ultimately, an attribute of governance.

What is, then, the decisive influence that scientific advances have in the transformation of society?

First, and foremost, in the provision of conceptual frameworks that may enable moe adequate perspectives and procedures to understand and tackle contemporary issues; second, in the creation of new meanings which entail a wider and more diverse range in societal choices; and last, but not least, in the generation of new technology that affects the way of life in society and on our planet.

Scientific advances can thus lead: (i) to new disciplines of scientific knowledge (e.g. quantum mechanics); (ii) to transformations in the information content and immaterial components (e.g. taylorism); and (iii) to changes and new events pertaining to the material components of society (e.g. electrification).

In this last decade of the XX century and looking back at what has been achieved, we can classify in the first group advances such as:

the introudction of fractals, and
thd study of complex behaviour;

in the second group:

the discovery of the molecules of life, and
the understanding of the physics of computing and communication;

finally, in the thrid group:

the discerning of the fundamental structure of matter, and
the formulation of plate tectonics.

Which (or which conjunction) of these advances will be more essential in shaping our future depends on the level of scientific culture of our societies - for the more pervasive effects are always induced by the most fundamental insights.

Making choices entails heavy consequences. But, in order to live, one has to choose incessantly, searching the meaning of becoming.

So, we also must peer into the future -- attempting to master the contingency of evolution -- an attitude that can be traced back to the construction of the great Greek epic poems. Or, as the great Antonio Vieira stated so eloquently in his portentous History of the Future three hundred years ago: "to assess hope, one must measure the future."

References

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