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CONSTRUCTIVIST PROGRAM FOR INTEGRATED ASSESSMENT OF SCIENCE AND TECHNOLOGY

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Abstract

The article criticizes the standard objectivistic conceptions of science and technology. These are based upon some philosophical prejudices. The constructivist understanding of science, technology and society relations overcomes these prejudices when implements an interdisciplinary reorientation of research and teaching.

Keywords: culture of risk, objectivistic approach, constructivist reorientation, analytical methodology, social assessment of science and technology.

It is evident that the most serious problems of our times are closely tied to the development of contemporary technoscience, in part as a direct consequence of that development, in part indirectly, as a consequence of neglect of research to ameliorate the social and environmental effects of technological innovations. Nuclear power and weapons plant accidents; chemical industry accidents ranging from manufacturing to transportation incidents; the continuing contamination of the natural environment and the vital global resources of air and water; the accumulation of toxic wastes without safe means of disposing of them; the deterioration of the ozone layer; the generation of climate change by increasing atmospheric temperature; starvation, poverty, and permanent crisis in the so-called Third World: all of these form part of a long list of ecological and social crises of our *culture of risk.*

This is certainly not the first time in history that this situation has occurred. For millenia technological change, either internally generated or imposed from without, has provoked crises in cultures that have led to their transformation, or their eradication. What is distinctive about the current situation is that the risks seem never to have been so great, nor the possibilities so unpredictable. The potential for transformation latent in contemporary technoscience implicates not only the outward forms of human life, the existing social and institutional configurations, and our cosmovisions. Contemporary technoscience also contains the potential for radically refashioning human nature itself, as well as the very nature of the planet on which we live.

Although it has been extraordinarily late in coming, public opinion in some societies is beginning to demonstrate an appreciation for the problems that the indiscriminate application of new technologies poses for nature and for society. With this awareness has come a consciousness of the urgency with which solutions need to be implemented and of the necessity for new approaches if these solutions are to be discovered. Even among politicians there is a growing recognition of the political significance of the social transformations currently being caused by technoscientific developments. Judging by recent events in Europe, it may not be too bold to say that the major international political issues have now decisively shifted from the conduct of the Cold War, now officially over, to global ecological problems, such as transnational pollution and climate change, and global economic problems, both increasingly perceived as tied to technology policies.

With growing public recognition of these technoscience-related problems, different societies are rushing off in different directions attempting to resolve them, either by funding technoscientific research on technoscience-caused problems, or by changing social and political institutions so as to give the public some voice in the directions of scientific research and technological innovation. However, the most common approach in modern societies to the solutions of technoscientific social and environmental problems is to apply to them scientific knowledge of nature and society.

In short, the common approach being taken today is to apply technoscience-based solutions to technoscience-based problems. But if the ultimate ground of these problems lies, in significant part, in our conceptions of scientific knowledge and adequate technological intervention, then this approach can hardly be successful. And this is indeed the case, for modern *developed* societies, in coping with the alarming risks created by new technologies, tend to employ outdated technical and political assessment and intervention mechanisms incorporating the conceptions of science, technology, nature and human society upon which our technoscientific culture and its risks are based.

The Historical Construction of Technoscience

A brief historical account helps explain the various ways that our culture of risk has been anchored in technoscientific conceptions and cosmovisions. Ever since humans developed their most particular technical capability, language, each culture has represented, interpreted, and legitimated its own technical systems in some idiosyncratic linguistic form, as an aspect of its own cosmovision. As a matter of fact, conceptions of the origin, structure, and purpose of nature and society characteristic of each culture, are closely tied to technologies available in that culture. In ancient cultures we can find already explicit notions of a relationship between techniques of production and social organization, on the one hand, and symbolic forms of representation and cosmovision, on the other. With the introduction of writing by court scribes and priests, some 5000 years ago, there was a revolutionary transformation of techniques of representation, one that gave rise to a coordinate revolution in forms of social organizations. Thus, the technical innovation, writing, underlay the rise of large cities, class-structured societies, and centralized empires.

Among the great cosmovisions of that era, that of ancient Babylonian culture is of special interest because of its influence on subsequent Greek, Jewish, and Christian cosmovisions. The Babylonian myths constituted a hierarchical and hegemonic cosmovision that legitimated the social order implicit in state organization and the parallel expansion of the power of the ruling class. The order of nature, like the order of society, was imposed from above, in an authoritarian manner, commonly on the gods and on the heavenly bodies that governed the city societies, and on the human population of those societies, all dependent on the personalized, superhuman will of a patron god. The divine will was, in this vision, the source of legitimation for forms of social organization as well as for techniques of production that together perpetuated monarchical authority.

In the sixth century BC, a new cosmovision manifested itself, one that was to become characteristic of Western culture from then on, namely, the theoretical cosmovision of Greek philosophy. In this vision, the individual figures of ancient gods were replaced by abstract entities, and divine actions were replaced by theoretical principles. The biological approach, deriving largely from Aristotle's philosophizing, eventually dominated the language in which this cosmovision was articulated. The concept of nature or *physis*, for example, was defined so as to stand in contrast to the concept of artifice and artisanal technique. Where a natural object possesses an internal principle determining the course of its development, artifacts are intrinsically inert, the product of external actions, possessing no 'natures' of their own. Consequently, technical knowledge cannot be considered part of the science of nature, not even theories of technique, such as ancient mechanics.

However obvious the distinction between the natural and the artificial may seem, it has been biased from the beginning in a way that isolates the sphere of the technical action from the sphere of the natural. The biological tropes in which the Greek cosmovision were articulated, privileged certain types of techniques as natural, namely, those *soft* techniques associated with traditional agriculture. Opposed to these were the *hard* techniques of the artisans. This distinction was not so much theoretical as political, reflecting the power-base of the aristocratic landholders who were legitimated in their possession of power by both Plato and Aristotle. Craft techniques, on the other hand, were linked to urban democratic politics to which these philosophers were opposed and so they excluded craftsmen from political participation. Thus, in spite of formal differences between the philosophies of Plato and Aristotle, both formulated theory-centered cosmovisions which, like the mythological cosmovisions of their predecessors, legitimated particular arrangements of production techniques, social organization, and the distribution of political power.

In the Middle Ages, the theory-centered organic cosmovisions of the Classical Greek philosophers were combined with later mythic and religious cosmovisions, resulting in a teleological cosmovision that was replaced by the world-view associated with modern science. This world-view conceived of nature as a machine, thus uniting the *soft* techniques of agriculture and the *hard* techniques of the artisans-mechanics. The new philosophers were philosopher-engineers, among them Galileo and Descartes, who opposed the distinction of the natural and the artificial by identifying the scope of the science of mathematized physics with the domain of nature, identifying theoretical mechanics with natural science. Artifacts no longer stood opposed to nature, no longer were devices for tricking or coercing nature into doing our bidding (like Aristotle had said), they were now expressions of 'laws of nature'. The result was a technomechanical vision of the cosmos, of nature, and of human society.

This modern cosmovision not only anchors the social and political institutionalization of engineering practice and technological innovation, it also promotes and legitimizes the extrapolation to all areas of inquiry of the experimental procedures characteristic of mechanical knowledge production. Modern nature philosophy, articulated so clearly by Francis Bacon, encourages just such a program of technological generalization, aiming at a uniform scientific practice keyed to a mechanical experimental methodology for knowledge generation. Scientific research, on this view, takes as its object only that which advances human control of nature in a mechanical way. Scientific research here becomes a form of technological production. Furthermore, it is precisely the union of theorizing with technological production that gave rise to the technoscientific revolution of the second half of the nineteenth century, in which mechanical motifs in the early modern cosmovision were supplanted by chemical, energetic, electromagnetic, and nuclear physical motifs.

The nature modern cosmovision moved from a *cold* mechanical universe to a *warm* universe interpreted in terms of thermodynamics, electrodynamics, quantum physics, et cetera. As before, theories tied to technologies under the metaphor of control were extrapolated even to the theories of cosmic processes that were outside the realm of technoscientific intervention and manipulation. Nature and society were presented as governed by *laws* which, in reality, only represented the extension to both of ideas of operational control of devices and processes characteristic of technological intervention. This ideology of technology as control, and for control, was sublimated into an ostensible ideology-free theory of the cosmos. At the same time, embedding technology in such a sanitized view of theoretical science perfectly matched claims of authentic progress that were corollaries of theoretical science and the stories that it embedded in the modern cosmovision about the origin, development, nature, and destinies of nature, society, and culture.

Even this brief reconstruction of technoscience testifies to the increasing importance, over the last hundred years especially, of *hard* technomechanical action based on deliberate control and manipulation of processes accomplished with the help of whatever artifacts or means will achieve the projected end. It also testifies to the successful mystification that has accompanied making technomechanical action the paradigm for all human action, the rationale for which is the putative universality of the theoretical knowledge on which pretendedly technomechanical action is based, along with the unity of nature. To a considerable extent, many of the current problems attributable to technoscientific development derive from the increasing application of *hard* forms of intervention to domains traditionally considered *soft*, or natural. Agriculture, cattle ranching, and traditional medicine are all examples of such originally *soft* techniques that are now firmly within the grasp of technoscience. The result is that all of them have been subjected to intense efforts at conditioning and at directing characteristic processes in order to achieve some optimum end, where both *optimal* and *end* are defined in terms of parameters of such branches of technoscience as biotechnology, genetic engineering, molecular biology, et cetera.

The generalization to all areas of nature, society, and individual human action of methods characteristic of *hard* technology, has not only had important negative consequences for the European culture that gave rise to technoscience. By a kind of cultural colonialism, this same phenomenon has also been exported to other cultures which, ironically, have had their greatest successes precisely with those *soft* techniques now threatened by the imported technoscience. Many Third World problems derive from this cultural colonization, which is commonly imposed on these societies as a condition for participating in world political and economic affairs. Needless to say, its imposition, sometimes assimilated in quite brutal forms, is utterly indifferent to the autonomous expression and continuing development of autochtonic cultural traditions, values, and institutions.

The Standard Objectivistic Conceptions of Science and Technology

The standard conceptions of science and technology are based upon characteristically philosophical prejudices that reduce knowledge to assertive linguistic forms and conceive of science as objectivistic theoretical representation. The identification of science mainly with theoretical knowledge, which is in turn identified with a transhistorical, transcultural, Universal Reason, gives rise to an analytical treatment in terms of assertive discourse and logic, in which conceptual questions of a formal logical kind inevitably take first place. The same theoretical orientation that has led analytical philosophy of science into an academic dead-end is threatening to do the same to analytical approaches in the philosophy of technology.

Analytical methodology is not all that has been inherited from the standard philosophical conceptions of science and technology. Other influences are a short-sightedness toward history bordering on blindness, and an aversion to recognizing the relevance of social contexts, rendering impossible any praxis-based understanding, whether of science or of technology, that would explicitly be firmly rooted in historicity, in concrete social and environmental contexts, and in the complex factors motivating human activity. The exaltation of theory as alone rational, alone authentic knowledge has nurtured a thorough mystification of scientific research. It is this mystification that has made it possible to proclaim, and win wide assent to, the value-neutral character of scientific knowledge. This claim, in turn, has served to legitimate, as perfectly rational, avenues of scientific investigation that entail high risks. Even more surprising, however, has been the success of attempting to extend this claim to technology as well.

The claim of the value-neutrality of science and of technology is connected with another, less explicit, claim: that the science and technology studies too, are neutral in evaluative terms. That is, because of their theoretical and objective characters, neither of these are of any use in resolving normative questions or in deciding policies for action. Given that, as we are seriously told, there exists an unbridgeable gulf between theoretical and practical reason, it is useless to attempt to construct any bridge between theoretical understanding and concrete, practical decisions. But such a gulf exists only for one who treats scientific theories as though they had fallen from the sky, while a growing body of evidence, accumulated primarily by historians and sociologists of science and technology, along with some few philosophers, reveals that science, the same as technology, is always firmly anchored in practice and both, as any other value-laden practical enterprise, are social constructions.

But undoubtedly the most fateful consequences of the standard conceptions of science and technology derive from the philosophical combination that seeks to identify science with theoretical rationality, and technology with practical rationality, combined with the neutrality of both. Such a philosophy manages to justify scientific research and technological innovations as the result of the exercise of reason itself. However, if this was the case, it would be more appropriate to speak of rational strayings in view of the grave ecological and social crises and risks provoked by contemporary technoscience. If we wish to respond decisively to the many current problems and risks attributable directly or indirectly to technoscientific developments, then it is essential a profound revision in the understanding, not only of science and technology but also of nature, society and their interrelationships.

Constructivist Integration of Research and Assessment of Science and Technology

The Constructivist Program for Integrated Research and Assessment of Science and Technology (CPIRA) is an interdisciplinary program that seeks to interrelate the theoretical and the practical issues concerning technology and science, that usually follow quite different paths. More specifically, the aim is to interrelate in a fruitful way the empirical case studies, the theoretical research and the historical reconstructions, on the one side, with technology assessment, risk management, science policy and education in science and technology, on the other side. The interdisciplinary methodology of the program deals as much with the technological aspects of science as with the theoretical aspects of technology, as much with the theoretical results of research as with its operative procedures, as much with present developments as with historical origins, as much with the academic medium as with the social environment, as much with the artifacts and the material effects as with the cosmological derivations. Without renouncing either theoretical soundnes or competence in making value judgements, the program has as a first objective a systematic elaboration of the conceptual apparatus and of the general methodological, theoretical and historical framework, necessary for an accurate account of science and technology as practiced.

Among the tasks already referred to, that need to be accomplished is a radical revision of the standard conceptions of science and technology. As a first step, the CPIRA proposes a constructivist philosophy based on a radical reversal of the primacy of theory over practice and on the conception of technics, in the wide sense of operative knowledge, capacities and forms of action and social interaction, as the historical and methodologically primary form of knowledge, upon which all the other forms of knowledge – including theoretical knowledge – and the technological systems are constructed. Furthermore, the technological content, which is fundamentally context dependent, social-historical, and value-laden, takes primary place in science, not theories. Instead of technology being understood as applied science, scientific theories are understood as theorizing about technological effects and social processes, theorizing that then reciprocally influences the course of technological development.

The standard objectivistic conceptions of science have been transposed to parallel mystifications of nature and society. Nature is almost always conceived of as separate from society and from the activity of scientific inquiry itself, as an entity with its own properties and laws, which constitute the proper object of scientific investigation and are independent of them. Environmental problems, for example, on this view appear as functional problems within nature's own systems. A solution to these problems would thus follow from a scientific understanding of the natural processes serving these functions. Appropriate technological applications of this knowledge would allow us to correct and control malfunctions in relevant natural subsystems, forcing the processes we desire to occur. Nature thus appears as an independent object of theoretical contemplation ruled by ostensibly objective laws which, in reality, are expressions of a constellation of technological devices, processes, and techniques together with the form of their (social) institutionalization.

Our relationship with nature, then, is conceived as one in which nature stands over against theoretical contemplation, which is thus quite separate from nature. In such a context, nature can be subordinated to our objective technoscientific intervention because the two are separate. This situation transposes almost identically to our conception of society: as an independent structure for objective scientific investigation, and as suitable for manipulation based on the knowledge such investigation yields. In reality, however, the fundamental relationship between human beings and their environment, whether natural or social, is not a disengaged contemplative one, nor is it a passive theoretical relationship. Instead, this relationship is tied to engaged practices, especially to technical praxis and to human *metabolic* activity, sociological as well as physiological. What nature means in a given culture derives from the set of technologies available in that culture for interacting with the environment.

The constructivist interpretation of nature is based on the underlying technological relationships between people and the world they inhabit, not on theoretical representations of a world. Nature, no less than knowledge, society, and human beings themselves, can thus only be understood historically and *locally*: relative to an articulated context of human action. The relationship of humanity to its '*natural*' environment is not at all Platonic, but derives from humanity's metabolic activity, that is, from every kind of doing and undoing, transforming and reforming in which human beings engage, in short, from the totality of humanity's technological activity.

As with the relationship between human beings and nature, the actual relationship between nature and society get a constructivist understanding when it is interpreted operatively as a relationship between domains of action and interaction. More specifically, a constructivist understanding of the relationship between nature and society must be based on the technologies of interaction with the physical environment employed by people, together with the social technologies on which their organization and interactions are based. The relationships between nature and society, in the constructivist view, are understood as interactive relationships reflecting the existence of diverse technological systems wielded as much through various forms of social organization as by groups of individuals. Society, in turn, is understood along *soft* lines, as the whole complex of social interactions in place at a given time, not as a timeless social form locally realized. The dominance of certain technologies, a contingent not a necessary fact, profoundly influences the emergence of social patterns of organization. Reciprocally, patterns of social organization influence the direction of technological development.

The constructivist approach to the understanding of science, technology, nature and society that is the basis of the CPIRA, is specially appropriate to the social and democratic guidance of scientific and technological development. It can decisively help to understand technological change and to make clear that in order to overcome the problems of our present culture of risk and its fateful perspectives we need to call a halt to the technoscientific colonization of the whole of the technocultural varieties, and to re-introduce eventually in our ecological and social environment new types of soft intervention.

The CPIRA seeks as its ultimate objective to produce active change in at least two directions. On the one hand, there is the need of an interdisciplinary integration, as the only way to go beyond the one-dimensionality of the standard technoscientific model by developing theoretical and operative frameworks for new forms of comprehension, assessment and intervention. These new models can serve as a means of orientation for social and public action and as a platform for decision making in legal and ethical contexts. On the other hand, as important, or more important than theories, norms and decisions, is the need to develop alternatives from which to choose in making changes. To achieve this, the existence of individuals and groups capable of bringing about new forms of technological development is essential. In this context, one of the major objectives is to implement an interdisciplinary reorientation of research and education in science and technology, which has the capacity to overcome the negative consequences of the technoscientific conceptions and assessment of science and technology.

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