The Inverse Approach to Technologies

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Abstract — Mario Bunge remarks that technology is essentially connected with science and its method, otherwise it would be pure technique. But he also points out that it is not reduced to science because it incorporates other components. Bunge was especially concerned with investigating the connection between technology and science. Based on their characterization, these other components are explored—the inverse approach. This perspective allows a more detailed epistemological characterization of the technologies.

Résumé — Mario Bunge souligne que la technologie est fondamentalement liée à la science et à sa méthode, autrement il s'agirait d'une technique pure. Mais il souligne également qu'elle ne se réduit pas à la science, car elle intègre d'autres éléments. Bunge est particulièrement préoccupé par l'étude du lien entre technologie et science. Sur la base de leur caractérisation, ces autres éléments sont explorés — l'approche inverse. Cette perspective permet une caractérisation épistémologique plus approfondie des technologies.

Mario Bunge began as a scientist, continued as a philosopher of science and culminated as a scientific philosopher. He developed a comprehensive philosophy (scientific) system, explicitly displayed a semantics, an ontology, an epistemology, an ethics; in short, all branches of philosophy. The philosophy of technology is one of the most innovative and one of the first to do so. We will focus on this contribution.

On the one hand, he differentiates technique from mere technology and also from science. On the other hand, technology can be described as such only if it uses science and its method as supplies for the artifacts it creates. The connection of technology with science

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is an essential aspect, although it does not reduce it to science. This is the reason why he searched different paths for the links with science through concepts, components and methods.

But he did not exhaustively investigate the non-scientific aspects that characterize technology. We call emphasizing these aspects the inverse approach, and building on Bunge's foundations, we try to specify this other class of cognitive and non-cognitive components that collaborate to identify technologies.

In point II we present the standard view of technology that Bunge opposes, exemplifying it with John S. Mill; in III, the basic concepts of Bunge's technology; in IV we analyze the inverse approach through the non-scientific components of technology based on the design of markets; in V we examine the differences with the scientific method in consulting; finally, in VI we indicate some comments.

1] Technology Reduced to Science: John Stuart Mill

Bunge's conception consists of an implicit interpellation to the reduction of technology to scientific knowledge because it considers them different, although interconnected. John Stuart Mill is a remarkable example of this reductionism.

He distinguishes between science and art. Science is a set of true or false statements, which refer to phenomena, and endeavours to discover the law that governs them, that is, their causes. Art—technology at present terminology—are norms which are directed to action and instead of being true or false are accomplished or not accomplished, propose ends and the means to realize them. Thus, political economy or physics are sciences while economic policy or electronic engineering are arts.

Science is cultivated not only to understand how the world is but also to be able to realize our ends. Art is useless if not based on science; it is simple experience or common sense[2].

Scientists simplify to explain the world; they attend to only one type of cause—the economic, the physical, the psychological, the biological. The practical has to attend to multiple causes to achieve an end. Mill is very aware of this limitation when he proposes *homo*

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[2] Mill, « On the Definition of Political Economy, and on the Method of a Investigation Proper to It », 1967 [1844], p. 313.

economicus as an object of study of political economy, that is, the behaviors motivated exclusively by the desire of wealth[3]. He immediately points out that it would be absurd to consider that humanity behaves only in this way; the concrete man not only has economic motivations but also acts due to other reasons—psychological, moral, political.

Art is more complex than science because causes of different kinds intervene. This difference does not hide the essential relationship between the two: art is based on science, that is, a rule is based exclusively on a theorem of the science/s. The procedure to obtain a rule implies the following sequence: an end is selected; science considers it a phenomenon; it inquires into its causes; it obtains the combination of laws that would make it; returns it to art which examines whether the resources involved are within human reach; if so, formulates the corresponding rule or precept. In Mill's words,

> The art proposes to itself an end to be attained, defines the end, and hands it over to the science. The science receives it, considers it as a phenomenon or effect to be studied, and having investigated its causes and conditions, sends it back to art with a theorem of the combinations of circumstances […] The only one of the premises, therefore, which Art supplies, is the original major premise, which asserts that the attainment of the given end is desirable[4].

Technology is applied science; the combination of means to obtain an end is resolved exclusively within the field of science[5]. The determination of the ends is done by Teleology or the Doctrine of ends and expressed through normative sentences[6]. Technology from the cognitive point of view only adds to science the desirability of reaching certain ends. The underlying thesis is that technology is reduced to science; it means that technology is applied science—except in the specification of the end to be achieved.

This conception of technology is the most widespread, although not the only one, among contemporary philosophers, methodologists and technologists. Due to the reduction of technology to science, the

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[3] *Ibid.*, p. 324.

[4] Mill, *A System of Logic*, 1974 [1843], p. 944.

[5] Niiniluoto, « Ciencia frente a tecnología », 1997, p. 288, affirms that this is the standard conception. It extends from the Greeks to the contemporary epoch.

[6] Mill, *A System of Logic*, 1974 [1843], p. 949-50.

former does not have its own concepts, there is no novelty, it is a specular image of science; the difficulty lies in the feasibility of making the artifact or in possessing enough talent to combine scientific knowledge and obtain it.

His conception of technology is too narrow and does not adapt to the way in which practical problems are solved from physical to social engineering. Usually this position is relaxed by resorting to a hypothesis as solid as possible instead of a law—because it is not known or does not exist—without strictly demanding tests when they are not achieved; in any case technology does not provide methodological novelties.

2] Technology in Bunge

The notion of technology evolved throughout his extensive work, although he always maintained a core: the distinction between prescientific technique, technology and science. The second makes use of scientific knowledge and proceeds according to the scientific method; it differs from applied science because it has its own specific methods; it is also based on empirical principles that, if confirmed, are absorbed by science. He does not reduce technology to science.

The most important variations in his conception of technology, not necessarily incompatible, which sometimes intersect and overlap, were the following: a) for the goal pursued (utilitarian); b) for the kind of action (maximally rational); c) for the foundation of the rules (nomopragmatic statements); and finally, d) for the kinds of designs (based on science)[7]. We will limit ourselves to the last one; for us, the most solid and detailed.

Ontological analysis occupies a central place. The results of technological designs are artifacts that constitute a new level of reality[8], the artificial level, which is built with the aid of the natural level but different since it arises from the purposes of the human being—if this or other rational beings did not propose objectives, there would be no artifacts.

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[7] In Scarano, « Propuestas epistemológicas e Mario Bunge para comprender la tecnología », 2014, each of them is developed and evaluated.

[8] cf. Bunge, *Ontology II: A World of Systems*, 1979, p. 209-11.

He defines artificial as follows: "anything optional made or done with the help of learned knowledge and usable by others.[9]" Every artifact is an option or choice; this requirement excludes instinctive behaviors (for example, the construction of a nest). The condition that it is a product of learned knowledge, at least the first time it was executed, circumscribes the artificial exactly to the products of rational beings or their substitutes, such as robots. The characteristic utilizable by others alludes to the need for the artificial to exhibit a social value, whether actual or potential. It is a very broad definition that includes both technique and technology and other cultural manifestations[10].

The differences between both natural and artificial domains do not mean falling into the old antinomy by which the artifacts were outside the natural order, as it happened, for example, among the Greeks. Each of the elemental components of an artifact is subject to natural laws, that is, they can be analyzed from the regularities to which they "obey". Precisely, the virtue of the technologist is to use, through scientific knowledge, the natural laws to obtain artifacts. The connection is so intimate between artifact and nature that technology can contribute to the emergence of new regularities, so that

> Every artificial thing is a system with emergent properties, and possibly also emergent laws; and every artificial process is a change in such system. However, the elementary components of an artificial thing are natural things satisfying laws of nature; likewise the elementary components of an artificial process are natural[11].

2.1] Design and Planning

The objectives or purposes for which the artifacts were designed and produced are an essential aspect to understand them. The

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[9] Bunge, *Epistemology III (2): Life Science, Social Science and Technology*, 1985, p. 222.

[10] There seems to be a nuance between the wider characterization of Bunge, *Ontology II: A World of Systems*, 1979, and that of Bunge, *Epistemology III (2): Life Science, Social Science and Technology*, 1985, that restricts the qualification of artificial to human productions due to purposes but now based on learned knowledge. It seems very difficult to include certain forms of culture, for example, art in the latter.

[11] Bunge, *Epistemology III (2): Life Science, Social Science and Technology*, 1985, p. 225.

conceptual perspective that best captures the two components, nature and deliberate human intervention, is the notion of *design*. Design is the anticipated representation of a thing or process (possible or impossible); if the design is technological and not merely technical, the representation will be achieved through the intervention, at least partially, of scientific knowledge[12]. A design, especially in physical but rarely in social technologies, is composed of a collection of diagrams whether iconic or not, and a text. It includes a code that allows you to decode the diagram symbols, and the text can include formulas and diverse expressions. Instead of design, some prefer to use the term *synthesis* to suggest that, to obtain the artifact, there is both description and prescription.

The *function* is the ultimate goal of technological design; the supplies used to achieve it are only means to obtain functionality, that is, satisfactory utility or where possible, optimal: "the aim of technological design is to create *functional systems*, i.e. systems discharging effectively and efficiently certain functions useful to some people.[13]" The functionality requirement implies design restrictions: a) it must not violate natural laws; b) it must be realizable, that is, can be manufactured with current means; c) behave effectively and reliably; d) the cost of the design of the artifact must not exceed a certain number; and ideally, e) the expected benefits must be greater than the undesirable effects.

The *specification* of a design is the determination of these interrelated conditions that have a scientific, technical and social dimension. Usually the specifications of a design are expressed in a contract between the parties.

Once the design is generated, the next step is the *plan* to implement it. A plan or program is a succession of ideas that describe operations or actions on certain things that will be executed by rational beings or their substitutes with the purpose of causing specific changes in those things[14]. Planning is the inverse problem to the problem of forecasting. In the latter, with the help of laws, initial conditions and environmental stimuli, we can anticipate the state of the system at a future time. In the case of planning, with

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[12] Cf. *ibid.*

[13] *Ibid.*, p. 226.

[14] See *ibid.*, p. 228.

the knowledge of the laws and the initial and final states, we have to conclude the stimuli or the steps to follow to achieve the desired final state. In a simpler way, planning is an answer to the question of what the means to reach a goal are.

Once the design is produced according to its planning, we are faced with a man-artifact system; it must be operated to fulfill its functionality, and it will require adjustments, maintenance and, eventually, improvements.

2.2] The Scientific Study of the Artificial: Technology

According to the above, technology is the scientific study of the artificial. More explicitly, using the previous concepts, it is the field of knowledge that refers to the design of artifacts, their planning, operation, adjustment, maintenance and monitoring in light of scientific knowledge[15].

It includes a methodics that consists of criticisable and justifiable procedures, in particular: i) the scientific method; ii) techniques peculiar to technology, such as immunization and accounting; iii) the technological method:

> Recognition and formulation of a practical problem → Design—which is similar to solving a problem with some approximation → Construction of a scale model and a prototype → Test → Evaluation → Design review (reformulation of the problem).

The separation between science, especially between applied science and technology, on the one hand, and technique and technology, on the other, is not always clear cut. However, a field of knowledge that completely or partially lacks scientific basis or does not use the scientific or technological method clearly does not belong to the technological domain.

Science and technology are so similar that some confuse them, however, a deeper scrutiny distinguishes them. Thus, among technologists, terms that will rarely be mentioned or expressed by basic or applied scientists will frequently be heard: feasibility, tolerance, design, machinability, productivity, policy, plan. This terminological difference corresponds to a conceptual one, the difference of objects, means and goals. Science procures knowledge, technology

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[15] *Ibid.*, p. 231.

makes artifacts. They are intimately related, but they are not the same, nor is one reducible to the other.

3] The Inverse Approach of Technology

Bunge systematically studies the basic connection of technology with science and its method; in the same way, he points out that technology has other components that are not scientific or completely scientifiable. If the latter were not part of technology, it would be identical to science.

Thus, when he points to the adjustment and maintenance of artifacts as defining characteristics of technology, they can hardly be reduced to scientific knowledge. When he indicates that one of the basic constituents of the design is the proposal of the functionality that the artifact will fulfill—in other words, of its objective or purpose—for the most part or completely, they are evaluative, propositive or teleological states, but different from a scientific content.

Bunge mentions them, indicates the function they fulfill in technology, but little else. He is interested in the connection with science and it is the favorite place from which he argues. Conversely, based on his approach, we specify the complement, the non-scientific knowledge and components of technology. This is the reason why we call it the *inverse approach*. It is very interesting because these traits can more clearly classify technologies and help to understand the difference between science and technology.

Below we list, in a non-exhaustive way, components of technology, especially some non-scientific ones:

1. Theoretical knowledge
2. Scientific techniques
3. Expert knowledge
4. Common knowledge
5. Legal and normative
6. Philosophical
7. Ethical
8. Political
9. Interaction of subsystems other than the economic one
10. Budgetary and time constraints to execute the project

In items 1 and 2, there mainly appears the knowledge of basic or applied science whether concepts or theories; the same for the techniques[16] associated with the scientific method. Of course, we also find concepts and technological theories. Items 3 and 4 include prescientific knowledge whose nature and extent depend on each technology. Usually they constitute a sign of the latter; if they did not exist, it would only be science. Much of the know-how is constituted by these kinds of knowledge. Artifacts produced by man affect others, which implies normative issues of a legal nature (the bridge builder's civil responsibility) or an ethical one (to abstain from producing antipersonnel mines). These two items, together with 6 and 8, point out in a relevant way that, unlike science, the scope of validity of technology is not the universe but the human domain. A technology can be valid or not for purely political or philosophical issues, even if its scientific core (1 and 2 and even 3 and 4) is acceptable to all. In the case of the political dimension, it is evident in the acceptance/rejection of technologies linked to climate change. Discussions about abortion involve decisions beyond the cognitive core and touch upon issues of design validity in essentially ethical philosophical aspects. Technology is not a public good as basic science but a private good, and it governs the market; for this reason, the time of execution of the project and its cost are crucial at the moment of deciding a design beyond coherence and scientific goodness.

We exemplify the above components with a work by Alvin Roth on market design[17]. One of the basic problems of the economy is to study the allocation of resources. The general way of doing this is through the price system; however, there are markets in which the use of this system is ruled out on legal or ethical grounds. Consider, for example, the adjudication of residences for doctors or the allocation of organs for transplants. The theory of market design provides models that explain different situations of resource allocation and apply them to redesign markets so that they work more efficiently.

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[16] Here the term is used in the Bunge's sense, as "special methods" which collaborate to perform the steps of the scientific method in a problem, for example, statistical techniques, interviews, microscopy (cf. Bunge, *Philosophy of Science I: From Problem to Theory*, 1998 [1967], sect. 1.3).

[17] Roth, « The Economist as Engineer », 2002; see other examples in Scarano, « Economía teórica e ingeniería económica », 2018.

The problem consists of developing a mechanism to match residences to doctors who start their career in American hospitals, and a good residence is important because it influences their future career. In 1940 it suffered from important inefficiencies that were corrected in the early 1950s by means of the organization of a clearinghouse later denominated National Resident Matching Program (NRMP). Then, over the years, the medical profession underwent profound changes, some of which affected the medical labor market and led to a crisis of confidence in the NRMP in 1995. The mechanism, the matching algorithm, was successfully redesigned by Roth and Peranson in 1996 and then applied to other health markets and also to articulate law firms.

We present a very simple model for this problem. There are two disjoint finite sets F, for firms, and W, for workers. Each worker looks for a single job and each firm up to q_i workers. A matching is a subset of the Cartesian product of $F \times W$, such that each worker appears in a single ordered pair and each firm in no more than q_i pairs.

A matching can be defined by a function μ that has $F \cup W$ as domain and codomain such that $\mu(w) = f$ and $w \in \mu(f)$ if and only if (f, w) is a pair of the match; and if no pair contains w then the function does matching with itself.

A crucial step in obtaining subsequent results is to assume that the agents have complete and transitive preferences over the individuals of the other set to which they do not belong. Thus, for example, the w_i agent has the following preferences: $f_2 P f_1, f_1 P f_4$, ..., and the same for firms regarding workers.

Two definitions will be useful later. We say that μ is blocked for an individual k if $\mu(k)$ is unacceptable for k, and it is blocked for a pair of agents (f, w) if each one prefers any other agent to the one that accompanies it in the pair. A matching is stable if it is not blocked for an individual or for a pair. It was shown that the stable matching set in this model is never empty. Stability is a very important property, because if a mechanism is not stable the agent has incentives to avoid it. However, evidence shows that there are stable mechanisms that were abandoned by various institutions, that is, in practice; stability is not a sufficient condition. For example, an algorithm may not guarantee adequate representation of minorities and cause their rejection.

There are different kinds of algorithms that produce stable matchings. One would be to conceive a centralized clearinghouse that processes the preferences of F and W. Another would be to conceive it in a decentralized way with several steps where in each step the worker applies and is accepted (does not apply anymore) or rejected by the firm until the process is exhausted. A different one is the one that works structurally in the same way, but the firms initiate the process.

Some interesting theorems are:

> THEOREM 1 The set of matchings is never empty[18].
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> THEOREM 2 The deferred acceptance algorithm with workers that apply to firms produces a stable match "optimal for the worker". There is a stable parallel algorithm that produces an "optimal for the firm" in which the one that proposes is the firm. The stable optimal matching for one side of the market is the least preferred stable matching for the other side of the market[19].
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> THEOREM 3 The same applicants are matched and the same positions are filled in every stable matching. In addition, a firm that did not fill all of its positions in a stable matching will be matched to the same applicants in each stable matching[20].

This stylized matching model is the core of the theory; let us see some aspects when applying it in a hospital.

1. *Artifact*: Adjudication of residences for doctors.
2. *Theoretical knowledge*: Economic theory, game theory.
3. *Scientific techniques*: Experimental and computational economics are complements of the game theory. Laboratory experiments using existing matchings were used to understand both the strategic behaviors of the participants and the reasons for the success or failure of some mechanisms.
4. *Expert knowledge*: Is not convenient for the design to be entirely *a priori*? You can learn a lot from the history of similar markets or the history of the market to be perfected which

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[18] Gale & Shapley, « College Admissions and the Stability of Marriage », 1962.

[19] *Ibid.*, Roth & Sotomayor, « The College Admissions Problem Revisited », 1989.

[20] McVitie & Wilson, « Stable Marriage Assignment for Unequal Sets », 1970, Roth, « On the Allocation of Residents to Rural Hospitals », 1986.

are known by those who carry them forward. Sometimes there is opportunity and even need to support new designs in previous experiences.

5. *Common knowledge*: There was a crisis of confidence because students asked themselves if it served their interests or only those of hospitals and they asked themselves if they had to go outside this mechanism. Again, much can be learned from the common knowledge of the users of a system. There is a theoretical core but as Roth repeatedly insists, the design implies responsibility for detail, dealing with complications.
6. *Legal and normative*: The design must be compatible with the existing normative plexus at the various levels (country, states), for example, residences must conform to existing labor standards; the call to apply must be public.
7. *Philosophical*: The algorithm can be centralized through clearinghouses or decentralized through negotiations.
8. *Ethical*: A stable algorithm could be questioned because it does not guarantee affirmative policies, for example, the representation of ethnic minorities or because it prevents the family unit when applicants are married. The two algorithms work, but the optimum is not the same; who starts the process, the firms or the workers?
9. *Political*: Legislators formulate legal restrictions to which the design must adapt.
10. *Interaction of subsystems other than the economic one*: Natural, social, cultural, psychological, political systems: some designs reflect the fact that their adoption is, at least partially, a political process. In the design of the market, the following are involved: businessmen and managers, legislators and regulators, lawyers and judges, professional associations. The social legitimacy of the selection mechanism and its repair when it presents difficulties exceeds the economic dimension or the game theory.
11. *Budgetary and time constraints to execute the project*: Normally[21] no more than one year can pass between the commissioning of a new market design and its implementation.

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[21] Roth, « The Economist as Engineer », 2002, p. 1345.

4] Methodological Singularities

Another very interesting way of observing that technology is not reduced to science and its heterogeneous nature is the examination of certain technological families, that is, the set of technologies that are applied in different disciplinary fields and have, in the way of solving problems, common structural features[22]. Thus, consulting and auditing constitute technological families; although they originated in the economic sphere, today they pass through most disciplines. We find consulting or auditing in the field of health, engineering, ecology, law.

Consulting[23] comes from the result of a consultation, from requesting advice. The *International Council of Management Consulting Institutes* (ICMIC) defines it as follows,

> The service provided to business, public and other undertakings by an independent and qualified person or persons in identifying and investigating problems concerned with policy, organization, procedures and methods, recommending appropriate action and helping to implement those recommendations[24].

It is an onerous professional service that proposes the solution to a problem. Consulting provides advice but does not belong to the organization, it is external, it does not take responsibility for the implementation of the recommendation, at most it collaborates in it.

Consultants standardize solutions, propose models that they take from the knowledge pool, and the typical thing is to offer “tailored suits”; they anchor models in specific solutions for the organization that pays for that solution. The creative and distinctive part of consulting consists of these specific solutions.

We have indicated above that the scientific cycle of problem solving has the following sequence: problem → solution or design → test → design evaluation → new problems or design review.

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[22] Bunge, *Ontology II : A World of Systems*, 1979, p. 231-33, uses the term in a more restrictive way: a family belongs to a disciplinary sphere (the family of electric motors, the family of psychoanalytic therapies).

[23] We follow Scarano, « Familias de tecnologías socioeconómicas », 2017, which exhaustively deals with consulting as a technology.

[24] Cited in Reuvid & Curnow, « The International Consulting Industry Today », 2003 [2001], p. 17.

The typical activity of consulting is basically to detect and solve problems. In this way, the heart of the discipline is the problem/solution pair and offering this service is what allows it to be valued through a price in the market. While they have models, the solution is not as simple as passing from the general to the singular. To obtain the case of a generality, we must adapt the model to the context, to the idiosyncrasies of the organization, to the organizational culture and to the budget, to mention only a few aspects to be taken into account. Now, a critical step of science and most technologies, the testing of the hypothesis, is absent in this technology. Instead, rhetorical arguments play a fundamental role in the estimation of designs[25].

This imprint of consulting is surprising even when compared to those technologies in which tests are difficult. The above does not mean that consultants and their clients do not estimate the impact of performing a consulting. If it were not the case, they would be completely irrational behaviors. But they are not valued by the standard procedures of science or close to it; they are mainly rhetorical.

The testing to guarantee the performance of a nuclear power plant, a car, an airplane, which is crucial in engineering branches that build these artifacts, is not part of the consulting. This singularity has nothing to do with the fact that it is a socio-economic technology, because some of them, such as accounting or auditing, behave in a completely different way. They exacerbate the methodological step of testing their hypotheses.

5] Comments

We point out the novelty, systematicity and depth of Bunge's thinking regarding technology. His non-reductionist approach highlights the essential aspect that differentiates it from mere technique, the connection with science and its method. He inquired into this link throughout his extensive work and proposed different ways in which it manifests, the most detailed and fruitful for our point of view is the notion of design.

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[25] Cf. Abrahamson, « Managerial Fads and Fashions », 1991, Berglund & Werr, « The Invincible Character of Management Consulting Rhetoric », 2000, Ernst & Kieser, « In Search of Explanations for the Consulting Explosion », 2002.

However, there is also a different dimension to the previous one that gives identity to technology, and without which it would simply be reduced to science. We call it the inverse approach, that is, to make explicit the elements non-reducible to science or to its method that also characterize technology.

We show the inverse approach, firstly, through the constitutive components of technology, for example, common knowledge, expert knowledge, ethical and philosophical components. Secondly, through consulting, the methodological peculiarities that emerge due to the special components that conforms it.

The first analysis explains why technology cannot completely satisfy the canons of science—why it is not reduced to the latter—it has components that cannot fit that kind of knowledge. When scientific knowledge does not respond to a problem about getting the artifact, it is completed with the available knowledge even if it does not meet the requirements of scientific knowledge. In addition, by creating in reality a new type of object (artificial), its realization incorporates the dimensions imposed by human, political, ethical, and legal relationships. When objects are not created, for example, natural ones, a certain dimension can be abstracted for their study; when man creates them, he incorporates human relationships. Abstraction is subsequent to constituted reality, not prior to it.

The methodological singularities show how far a technology can be from science even if it is based on it. The touchstone of testing hypotheses is the essential critical feature of science and this technology eludes it. The usual thing in science is to look for generalizations; the typical thing of consulting are singular statements, the "tailored suits". It is a low-level technology, but it shows that there is a continuum of technologies that, at one extreme, come close to being almost confused with science and, at the other extreme, tenuously fulfill some requirement of science.

The program of inverse approach based on Bunge's conception allows a more realistic panorama of technology, which is less monolithic and calls for a direct study of technological diversity.

References

Abrahamson E., 1991, « Managerial Fads and Fashions : The Diffusion and Rejection of Innovations », *Academy of Management Review*, 16 (3), p. 586-612.

Berglund J. & Werr A., 2000, « The Invincible Character of Management Consulting Rhetoric : How One Blends Incommensurates While Keeping Them Apart », *Organization*, 7 (4), p. 633-55.

Bunge M., 1979, *Treatise on Basic Philosophy : Ontology II, a World of Systems*, vol. 4, 8 vol., Dordrecht, Reidel.

— 1985, *Treatise on Basic Philosophy : Epistemology and Methodology III, Philosophy of Science and Technology, Part II, Life Science, Social Science and Technology*, vol. 7, 8 vol., Dordrecht, Reidel.

— 1998 [1967], *Philosophy of Science I : From Problem to Theory*, New Brunswick, Transaction Publishers, rééd. de *Scientific Research I : The Search for System*, Berlin/New York, Springer-Verlag.

Ernst B. & Kieser A., 2002, « In Search of Explanations for the Consulting Explosion », *in* Sahlin-Andersson K. & Engwall L. (éd.), *The Expansion of Management Knowledge : Carriers, Flows, and Sources*, Stanford, Stanford University Press.

Gale D. & Shapley L.S., 1962, « College Admissions and the Stability of Marriage », *The American Mathematical Monthly*, 69 (1), p. 9-15.

McVitie D.G. & Wilson L.B., 1970, « Stable Marriage Assignment for Unequal Sets », *BIT Numerical Mathematics*, 10 (3), p. 295-309.

Mill J.S., 1967 [1844], « On the Definition of Political Economy, and on the Method of a Investigation Proper to It », *in* Robson J.M. (éd.), *The Collected Works of John Stuart Mill, Vol. IV : Essays on Economics and Society, Part I*, Toronto/London, University of Toronto Press/Routledge and Kegan Paul.

— 1974 [1843], *The Collected Works of John Stuart Mill, Vol. VIII : A System of Logic, Ratiocinative and Inductive, Being a Connected View of the Principles of Evidence and the Methods of Scientific Investigation (Books IV-VI and Appendices)*, Toronto/London, University of Toronto Press/Routledge and Kegan Paul, édité par J.M. Robson.

Niiniluoto I., 1997, « Ciencia frente a tecnología : ¿diferencia o identidad? », *Arbor*, CLVII (620), p. 285-99.

Reuvid J. & Curnow B., 2003 [2001], « The International Consulting Industry Today », *in* Curnow B. & Reuvid J. (éd.), *The International Guide to Management Consultancy : The Evolution, Practice and Structure of Management Consultancy Worldwide*, London, Kogan Page, p. 9-20.

Roth A.E., 1986, « On the Allocation of Residents to Rural Hospitals : A General Property of Two-Sided Matching Markets », *Econometrica*, 54 (2), p. 425-27.

— 2002, « The Economist as Engineer : Game Theory, Experimentation, and Computation as Tools for Design Economics », *Econometrica*, 70 (4), p. 1341-78.

Roth A.E. & Sotomayor M., 1989, « The College Admissions Problem Revisited », *Econometrica*, 57 (3), p. 559-70.

Scarano E., 2014, « Propuestas epistemológicas e Mario Bunge para comprender la tecnología : reglas, fines, acciones racionales, diseños », *in* Denegri G.M. (éd.), *Elogio de la sabiduría : ensayos en homenaje a Mario Bunge en su 95° aniversario*, Buenos Aires, Eudeba, p. 269-89.

— 2017, « Familias de tecnologías socioeconómicas », *Argumentos de razón técnica*, nº 20, p. 71-86.

— 2018, « Economía teórica e ingeniería económica », *Anales de la LIII Reunión Anual de la Asociación Argentina de Economía Política.*

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