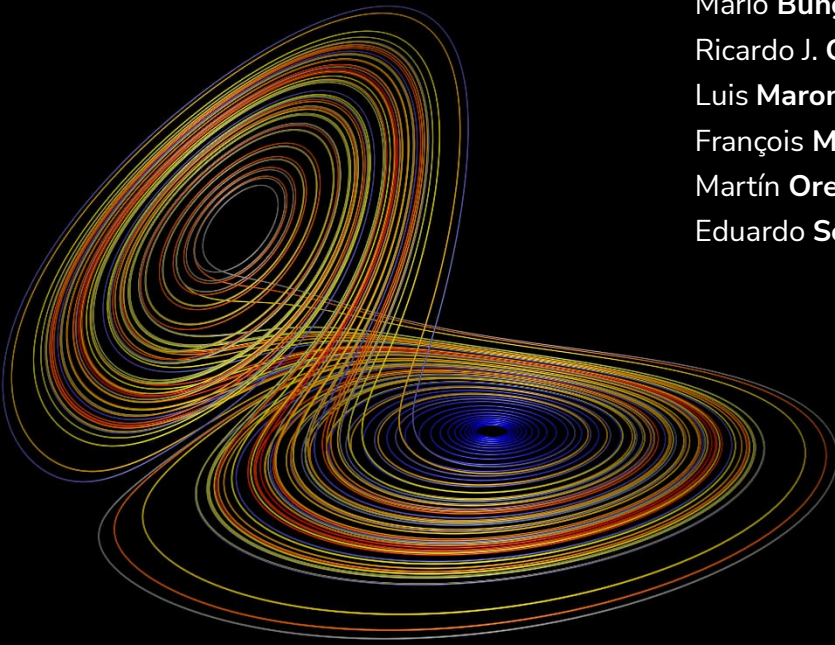


Metascience

Scientific General Discourse

N° 1–2020 Edited by François Maurice

Mario Bunge, Thinker of Materiality



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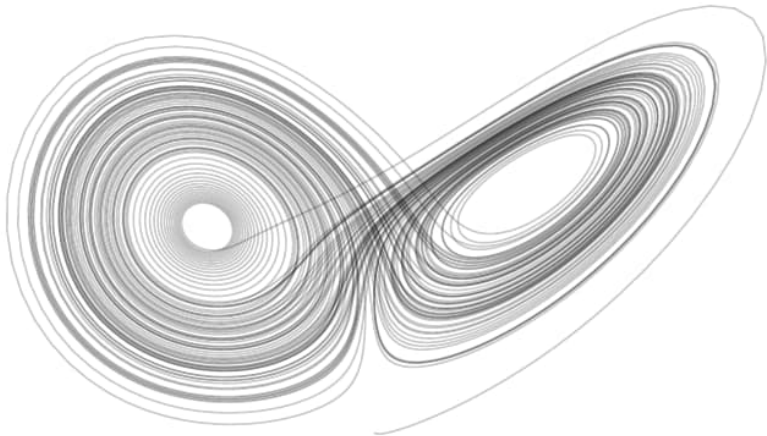
Society for the Progress of Metascience

Metascience

Scientific General Discourse

Edited by François Maurice

Mario Bunge, Thinker of Materiality



2020

Society for the Progress of Metascience

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The French edition of this first issue has seven more articles.

Metascience No 1-2020 (1st edition of the journal), **François Maurice (ed.)**

eISSN (en cours)

© Society for the Progress of Metascience, 2020
4744, rue Hochelaga, Montréal, H1V 1E3, Canada

<https://en.sopromet.org/>

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[Table of Contents]

Presentation. *Metascience* and the Bunge Alternative 7 François Maurice

The Bungean Solution 7

The Role of Sopromet and *Metascience* 10

And for the Little Story 14

Introduction. Mario Bunge's Project 19 François Maurice

The Project of a Lifetime 19

Reading Bunge 21

Contributions 24

1] Studies on Bunge's System 24

2] Applications or Extensions of Bungean Thought 25

3] Reflections and Testimonies 27

Selected Bibliography on Bunge 27

1

Studies on Bunge's System

Metascience: For a Scientific General Discourse 31 François Maurice

1] General Discourses 34

1.1] Reflection, Method, and General Discourse 34

1.2] Reflection and Philosophy 40

1.3] Transempirical Reflection 42

1.4] Philosophical Transcendence 44

1.5] Philosophy in Crisis? 48

2] Scientific General Discourse 51

2.1] General Postulates and Reflection 51

2.2] Contribution of Philosophy to Metascience 55

2.3] Characterization of Metascience 57

2.4] Classification of Metascience 59

- 2.5] Non-Metascientific Disciplines 66
- 2.6] A Metascientific Community 69
- 2.7] Bunge as the Alternative 72

2

Applications or Extensions of Bungean Thought

On the Kinds of Problems Tackled by Science, Technology, and Professions: Building Foundations of Science Policy 79

Luis Marone

- 1] Problems in Science, Technology, and Professions 82
- 2] Direct and Inverse Problems 84
- 3] Science and Technology Attack Inverse Problems to Reach Radical Invention 87
- 4] Case Study: Translational Medicine 90
- 5] Conclusions 92

The Inverse Approach to Technologies 97

Eduardo Scarano

- 1] Technology Reduced to Science: John Stuart Mill 98
- 2] Technology in Bunge 100
 - 2.1] Design and Planning 101
 - 2.2] The Scientific Study of the Artificial: Technology 103
- 3] The Inverse Approach of Technology 104
- 4] Methodological Singularities 109
- 5] Comments 110

A Critique of Meillassoux's Reflections on Mathematics from the Perspective of Bunge's Philosophy 115

Martín Orensanz

- 1] Meillassoux's Philosophy of Mathematics in *After Finitude* 116
- 2] A Brief History of Non-Euclidean Geometries 118
- 3] Bunge's Philosophy of Mathematics 128
- 4] Concluding Remarks 131

Mario Bunge: Epistemology is Here to Stay 135

Ricardo J. Gómez

- 1] Equivocity of the Term 135
- 2] The Death Sentence for Epistemology 137
 - 2.1] Latour on Special Relativity 139
- 3] Mario Bunge: The Counter-Figure to ‘We Have Never Been Modern’ 141
 - 3.1] Bungean Realism 143
 - 3.2] Bungean Realism and Quantum Mechanics 145
 - 3.3] Axiological and Practical Realism 147
 - 3.4] A Short Remark About Technology and Human Responsibility 148
- 4] Bungean Moral Realism: The Hard-Core of Epistemological Progress 151
- 5] Moral Realism as a Critical Foundation of the Theory of Rational Choice 154

3**Reflections and Testimonies****Criticism: Destructive and Constructive 161**

Mario Bunge

Metascience and the Bunge Alternative

François Maurice

The Bungean Solution

More than any other philosopher, Mario Bunge is unclassifiable. In 1982 John Wettersten wrote about the discomfort and frustration that one might feel when reading Bunge's work. He was trying to understand why his work was not seen as an alternative to the work of other philosophers¹.

Wettersten's answer relates to the problem of knowledge acquisition. If knowledge is contextual, relative to a frame of thought, how can we then rationally evaluate this frame of thought itself? Wettersten identifies two tendencies: either one maintains that frames of thought are chosen arbitrarily, which leads to relativism, or one maintains that there is only one immutable frame of thought, which leads to dogmatism.

Like many thinkers, Bunge tries to avoid relativism and dogmatism. But Bunge's proposed solution would cause this unease that Wettersten reports. Bunge's solution is to take for granted a set of general assumptions associated with science. By adopting a framework similar to that of science, it is then possible to make rigorous analyses and synthesizes within this framework, but still sensitive to the change that this general framework undergoes under the influence of scientific research. But is this frame of thought not chosen arbitrarily? It is not chosen arbitrarily, but it cannot be justified in a "strong", logical, philosophical, metaphysical or other way, which would lead us to dogmatism. It only takes a thought experiment, a reflection, to convince oneself that objects of knowledge are concrete objects that provoke our sensations and our perception. If we continue our reflection, we will see that these objects have their own qualities, what thinkers have called primary qualities, and

¹ Wettersten, « The Place of Mario Bunge », 1982.

that we wrongly attribute certain qualities that they do not have, called secondary qualities. Once this general premise has been admitted, it is easy to recognize that science provides us with a fairly accurate, although imperfect, account as to the nature of these concrete objects. In fact, the very success of science becomes part of our thinking. There is a back and forth between our reflections on the subject and this observation of the success of science. This success reinforces the idea that we are in concrete interaction with objects from the "outside world" and that it is these objects that are objects of knowledge. It is therefore rational to adopt the general postulates on which science is based, to adopt Bunge's solution to the problem of knowledge acquisition, and thus avoid the pitfalls, mentioned by Wettersten, which are dogmatism and relativism, in order to build a general scientific discourse, a metascience.

Why metascience? Why a new discipline? The general assumptions on which science is based are not philosophical, despite the fact that it is common to say otherwise. They are not philosophical because they come from a pre-methodical reflection. There is no method, be it philosophical, scientific or metascientific, that allows us to establish them. The thought experiment that distinguishes primary qualities from secondary qualities requires no advanced training in philosophy or science. Just use our ability to think. Furthermore, the philosophical doctrines themselves are based on a set of pre-methodical postulates. It is only once these postulates have been established that one can set in motion a particular philosophical method specific to each doctrine. Thus, thinking about primary qualities and secondary qualities is part of the more general problem of distinguishing between appearance and reality. What is an appearance? What is reality? As several thinkers have pointed out, the division of philosophy into doctrines comes in large part from the answers proposed to these questions. But answers advanced by each doctrine do not come from a philosophical method. Before even starting research, you must have at least a basic idea of the object of knowledge. In other words, you have to get an idea of the nature of appearances and reality before proposing an approach and methods to account for it. The existence of pre-methodical, non-philosophical and non-scientific postulates justifies a metascience insofar as it relies on the same general postulates as science. These postulates are not problematized even if they can be criticized and adjusted according to the advancement of science. This is what we

defend in our contribution "Metascience: for a general scientific discourse" in this first issue of *Metascience* entitled *Mario Bunge, Thinker of Materiality*.

Why materiality? Why not materialism? Philosophical doctrines are normally referred to by words ending with suffixes -ism or -logy. Bunge also uses an impressive number of -isms to qualify his thinking. We argue that Bunge's positions are not philosophical, but rather the result of a pre-methodical reflection, and the fact that they are not problematized, but rather taken for granted, takes him away from philosophy. Thus, simultaneously supporting general postulates similar to those of science evacuates philosophical discourse and brings Bunge's way of reasoning closer to the way scientists reason. Bunge adopts a scientific posture, not a philosophical one. Now, if the research program we are proposing is based on the same postulates as science, and if every metasciences share the same objects, problems and methods, it would no longer be necessary to use any -isms since metasciences will then form a unified disciplinary field in the same way as factual and formal sciences form unified disciplinary fields. "Isms" are necessary where doctrines exist, and doctrines proliferate where there are no common objects, problems and methods. Factual and formal sciences use very few expressions in -ism to designate doctrines. If scientists were to focus on defining doctrines whenever they did not immediately agree on a solution to a problem, they would indeed produce a large amount of -isms. However, they prefer to examine solutions already available, propose new solutions and test those solutions. This is only possible because they share a common approach, because they agree on the objects and problems to be studied and on methods to be used, even if it is still possible to re-evaluate objects, problems and methods. Thus, metasciences should produce very few -isms, starting with materialism. It is useless to maintain a "materialism" in order to oppose it to an "idealism", an "immaterialism" or a "spiritualism". Matter is the object of direct study of science and indirectly that of metascience. Bunge constructs a general scientific discourse, metascientific theories, based on the general postulates of science, including that of taking for granted the existence of a unique and concrete world. Science provides the results needed to study matter in general. There cannot therefore be several materialisms since our general conception of matter comes from a single source, science, which is interested in physical, chemical, living and

thinking matter. Hence the interest in physical, chemical, biological, psychological and sociological materiality, and not in materialism.

We are aware that there are many thinkers who implicitly or explicitly adopt a scientific attitude and, therefore, that they support a set of assumptions similar to those Bunge adopts and which is generally attributed to science. This is the first objective that the Society for the Progress of Metasciences must set itself, that of reaching all these thinkers, scientists or philosophers, who are already adopting the Bunge alternative.

The Role of Sopromet and *Metascience*

Why the epsilon in *Metascience*? It was important to stand out from the journal *Metascience*, published by Springer, in association with the Australasian Association for the History, Philosophy and Social Studies of Science (AAHPSSS). It had to stand out not only for the name, but above all because the purpose, scope and intended audience of the two journals are entirely different. *Metascience* specializes in book reviews, hence its subtitle, *An International Review Journal for the History, Philosophy and Social Studies of Science*. It covers all fields or disciplines which are interested in science, as its subtitle clearly indicates, whether it be philosophy, sociology or the history of science. The journal claims to be non-specialized because it is intended to be accessible to all researchers in these fields or disciplines.

As for *Metascience*, it specializes in the conceptual study of science with a view to producing a *scientific general discourse*, this expression then serving as a subtitle for the journal. It is a specialized journal, in the sense that it proposes to found a new discipline, metascience, and that it is addressed to all those interested in the nature of scientific products—concepts, propositions, theories—outside their social context, in the same way that one can be interested in a literary or artistic work for itself. The study of science, however, cannot be reduced to a logical analysis of it; logic is only a tool for the scientist and the metascientist and not an approach or a method. The nature of scientific production can only be grasped if there is a metascientific theorization, that is to say the elaboration of ontological, semantic, epistemological and methodological theories, theories whose starting point is intended to be identical to that

of science: a set of general postulates in the world and on knowledge of it. We owe this approach to the study of science to Mario Bunge.

What tools and resources are available to us to continue Mario Bunge's research program? To our knowledge, there is none. We have therefore created the **Society for the Progress of Metasciences** (Sopromet), a non-profit association dedicated to the promotion of the *conceptual sciences* or *metascience* in order to produce a *scientific general discourse*. Founded in 2018, Sopromet is a non-institutional initiative that receives no subsidy. Here are some of the goals that Sopromet has set for fulfilling its mission:

1. Supporting a meta-scientific research program
2. Building a community of metascientists
3. Promoting the professionalization of metascientific research
4. Promoting the creation of departments of metasciences
5. Organizing an annual congress
6. Creating a metascientific lexicon
7. Dissemination of metascientific research to a wide audience
8. Demystifying philosophy
9. Distinguishing the metascientific approach from the philosophical approach

Metascience will act as a catalyst and hopefully help achieve Sopromet's goals. The journal claims Bunge's work. The claim is not for the purpose of exegesis, but rather with the aim of continuing the research program developed by the author of the *Treatise on Basic Philosophy*². The *Treatise* is the culmination of some twenty-five years of research and reflection on the nature of science, but also on the nature of philosophical research. The *Treatise* had and still exerts a great influence on several thinkers. In 1990, he was the subject of a collective study, *Studies on Mario Bunge's Treatise*, under the direction of Paul Weingartner and Georg J.W. Dorn. This study involved thinkers from various backgrounds, philosophers, but also scientists. It would be futile to seek to associate the *Treatise*, or Bunge's work, with a philosophical current. Bunge's thought was associated with analytic philosophy or logical empiricism, but even a cursory reading of Bunge's work makes us see the gap between Bunge's approach and that of these philosophical doctrines.

² Bunge, *Treatise on Basic Philosophy*, 1974-1989.

We have already noticed that Bunge's scientific approach, adopting the general assumptions of science and not problematizing them, makes the *Treatise* unclassifiable within philosophy, that the *Treatise* alone is the foundation of a metascientific research program, the founding work of a new branch of scientific knowledge, metascience or the *conceptual sciences*, thus forming a scientific triad with the *factual sciences* and the *formal sciences*.

Without the assistance of **Éditions Matériologiques**, the journal would only be available in electronic format; the availability of a journal in paper format is also an asset for the dissemination of knowledge. The **EM** was ideally suited to participate in this project since they specialize in the publication of works of science and philosophy of science, and they have also published the translation of two works by Bunge, *Philosophy of Medicine* and *Between Two Worlds*.

Although the tools are lacking, Sopromet and *Metascience* did not emerge in a cultural vacuum. Over the centuries, several philosophers have contributed to metascience, just as many of them have contributed to science. We can add to the objectives that Sopromet has set to itself, that of identifying the metascientific contribution of these thinkers, a work already well advanced thanks to Mario Bunge. Closer to home, there are thinkers and projects close in spirit to that of Sopromet. We are thinking, among other things, of the series "Sciences & Philosophie" at Éditions Matériauxologiques, directed by Philippe Huneman, Guillaume Lecointre and Marc Silberstein, to Max Kistler's project, *Metascience of Science/Métaphysique des sciences*, that of Tuomas Tahko in Bristol, *MetaScience*, and an organized conference by Zongrong Li, *Developing Mario Bunge's Scientific Philosophical Program*, for 2021 (for more information, 2320129239@qq.com). We also think of thinkers such as Elliott Sober, in philosophy of biology, or Gustavo Romero, in philosophy of physics, whose research for us is more about metascience than philosophy. Without going into details—which we reserve for our article "Metascience: for a general scientific discourse"—a thinker is a metascientist if he does not postulate any principle foreign to matter, which is the subject of study of all sciences.

The first objective of *Metascience* is to attract authors who will make an original contribution to metascience, notably through the development of semantic, ontological, epistemological and

methodological theories, these disciplines being treated metascientifically rather than philosophically. That said, metascience is practiced in many ways, as is science. Although the development of very general theories is the ultimate in research, most scientists do not conceive of such theories and most metascientists will not conceive far-reaching ontology, semantics, epistemology and methodology. A contribution may be the development of a more restricted theory, such as a theory of factual truth that would be integrated into a general semantics. It can also be a work of clarifying a concept, by a characterization or definition, or a theory, which can then take the form of a bungean axiomatization (dual axiomatics), one of the most remarkable contributions of Mario Bunge³. We can also think of the work of validating metascientific theories, whether by confronting them with contemporary scientific theories in all fields or by case studies from the history of science. An important application of metascientific theories would be the ontological, semantic, epistemological and methodological analysis of academic pseudosciences, notably doctrines in the social sciences based on the rational choice “theory”, in order to pinpoint precisely the unscientific assumptions on which they are based. If there is validation, there is data collection. There is therefore work to excavate, to catalogue and to classify metascientific data. This metascientific knowledge must be taught and passed on to students, disseminated to a wide audience. One imagines then the writing of textbooks and popular works, in which an important place would be reserved to the notion reflection and various transempirical thought experiments. Finally, there is the application of this knowledge to many situations, wherever it is relevant to use a general science-based thought. As can be seen, metascientific research is diverse and of varying difficulty. There is something for all tastes and talents. And we just hovered over the subject!

This inaugural issue of *Metascience* is also a special issue since it is dedicated to paying homage to Mario Bunge. Originally, it was a question of taking advantage of the occasion of its 100 years to underline its contribution to knowledge, but also to mark the affiliation that we claim with its thought. The death of Mario Bunge in

³ The expression *dual axiomatics* appears in two texts by Bunge : « Why Axiomatize ? », 2016, and *Doing Science*, 2017, sect. 5.4. For examples of dual axiomatization, see *Foundations of Physics*, 1967.

early 2020, unfortunately, obliges us to pay him a posthumous tribute. We have therefore not imposed the editorial policy of *Metascience* on the contributors to this issue so that they can contribute to this tribute each in their own way. Nevertheless, many of the articles on this issue can be considered as metascientific contributions, or of metascientific inspiration, or as applications of the metascientific approach to various fields.

Next issues will therefore be *more and more* oriented towards the metascientific research program that we are proposing. The Bungean approach to general knowledge is the only one of its kind, at least in such an achieved form, so it is normal that there is some uncertainty as to the details of the research program, in particular the criteria for text evaluation. This is not specific to the conceptual sciences, but also affects the factual and formal sciences; scientific criteria are refined and clarified over time, although the general scientific approach remains the same.

We will edit the second issue of *Metascience*, but we hope that future members of Sopromet will volunteer to edit subsequent issues. We will need the help of collaborators to assess both the metascientific and scientific aspects of the articles. Membership of Sopromet will therefore be possible in a few months when a transactional page is put online on the Sopromet's website.

And for the Little Story

In the spring of 2016, I was looking for a publisher for my translation of this little gem written by Mario Bunge that is the *Philosophical Dictionary*⁴, at once irreverent, daring and serious. It didn't take long to find the Éditions Matériologiques and its publisher Marc Silberstein, whose name was familiar to me since he had published a translation of *Scientific Materialism*⁵ from Mario Bunge while he was editor of the series "Matériologique" at the Éditions Syllepse. The project was accepted immediately because "the *Dictionary* is one of our favorite MB books" and that two other Bunge's books were being translated at the time⁶. I understood then that I had stumbled upon the den of the bungeans in France.

⁴ Bunge, *Philosophical Dictionary*, 2003.

⁵ Bunge, *Le matérialisme scientifique*, 2008 [1981].

⁶ Bunge, *Philosophie de la médecine*, 2019 [2013], Bunge, *Dictionnaire philosophique*, 2020 [2003].

In the spring 2017, Marc Silberstein asked me to participate in the collective *Qu'est-ce que la science... pour vous?*⁷ (What is Science... to You?) I brought out on this occasion the ideas of scientific triad, scientific general discourse and conceptual sciences. On the other hand, although the text was very critical of philosophy, I still used the concept of scientific philosophy instead of that of metascience.

I learned from Marc Silberstein in the summer of 2018 that Springer would publish a collective in English in 2019 in tribute to Mario Bunge for his 100th birthday⁸. He planned to participate in this tribute by the simultaneous publication of my translation of *Philosophical Dictionary* and that of Pierre Deleporte of *Medical Philosophy*: “It will be the small contribution of French speakers to this event dear to our hearts.” It didn’t take more to tell Marc Silberstein that French speakers could do a little more.

For some time now, I have been considering the idea of creating an association to support a research program inspired by the work of Mario Bunge. I planned to found the association and launch its journal in 2021 or 2022. Now that I knew that Springer was organizing a “writing festival”, a *festschrift*, I could not miss the opportunity to participate in the festivities. So I announced to Marc Silberstein the creation of the Society for the Progress of Metascience, whose first issue of his journal, *Metascience*, would pay tribute to Mario Bunge. At the time, I was only considering publishing in electronic format. In turn, Marc Silberstein takes the ball and run with it and offered to publish a paper version of the journal.

The Society for the Progress of Metascience and its journal *Metascience* were founded in the summer of 2018. So it was between spring 2017 and spring 2018 that I completely broke away from philosophy. So it took me almost 25 years to cut all ties with philosophy, one by one, whereas I had always associated philosophy with rational discourse and science! The three key moments of this journey were the equating of philosophy with secular theology by a friend, the discovery of the *Philosophical Dictionary*, and the invitation of Marc Silberstein to write a text for *Qu'est-ce que la science... pour vous?* The idea that philosophy is a secular theology

⁷ Silberstein, *Qu'est-ce que la science... pour vous?*, 2017.

⁸ Matthews, *Mario Bunge: A Centenary Festschrift*, 2019.

allowed me to glimpse the notion of general discourse, that philosophy is only one general discourse among others. The discovery of Mario Bunge's work exposed me to a discourse that seemed less and less philosophical and more and more scientific as I dived into it. The writing of *Une triade scientifique?*⁹ at the invitation of Marc Silberstein, gave me the opportunity to develop the notions of scientific triad, general scientific discourse, and conceptual sciences, but not yet of metascience, which will not become clear until a few months later. Each, in their own way, triggered a process of reflection, a synaptic chain reaction.

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⁹ Maurice, « Une triade scientifique ? », 2017.

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Mario Bunge's Project

François Maurice

This first issue of *Metascience* pays tribute to Mario Bunge on the occasion of his 100th birthday. This is not the first time, and certainly not the last, that thinkers pay tribute to Mario Bunge or that his work is the subject of a study, and rightly so, because the man is a humanist and the work is worthy heir to the Enlightenment. Mario Bunge has made significant contributions to a wide range of disciplines: physics, philosophy, sociology, psychology, cognitive sciences. This issue is also a way to make Bunge's thinking known to a French readership.

The Project of a Lifetime¹⁰

On New Year's Eve of 1937, at the age of 18, Mario Bunge resolved to study only serious intellectual subjects. He moves up a gear. He chooses to study physics at university and philosophy on his own. He is thus a physicist by training and a philosopher by vocation.

He had just spent a few relatively difficult years in high school. However, the last two years of primary school went well. The teachers of the progressive primary school Escuela Argentina Modelo were competent and motivating: "I flourished at that school, where I was put in charge of the classroom library, was elected senator of our miniature parliament, made some friends, and earned some medals. I looked forward to doing even better in high school. How utterly mistaken I turned out to be!"

The Colegio Nacional High School in Buenos Aires did not make a good impression on the young man. He had just left a progressive elementary school and enjoyed some freedom at home. The Colegio

¹⁰ We freely draw inspiration from Mario Bunge's autobiography, *Between Two Worlds*, 2016, to introduce you to this scholar of contemporary Enlightenment. All quotes in this section come from this autobiography.

offered only discipline, and merit was assessed only by exam scores. For Bunge, the school was more like a correctional facility than a place of learning. He rebelled. He published a short-lived *Magazine against the Professors*, one of whose professors, caricatured as a chimpanzee, made the headlines. He got away with a fourteen days' suspension: "Even I was surprised at my irreverence, because I had behaved well in my elementary schools."

The Colegio "frees" the student at the end of 1936 because he does not do well in most subjects: "I was a mediocre student because I was neither motivated nor fond of most of my teachers." In the same year, Bunge completed all subjects as a "free student" at the Colegio Nacional Sarmiento, with the exception of trigonometry, a subject in which he failed twice. He studied *Plane Trigonometry* by Isaac Todhunter, published in 1859, and then easily passed the trigonometry exam. He fell in love with mathematics, so he began to study *Calculus Made Easy* by Silvanus P. Thompson, published in 1910, a work which appealed to the notion of infinitesimal rather than the formal notion of limits. He received his high school diploma in 1937 and then enrolled in the Faculty of Physicomathematical Sciences at the National University of La Plata, an ideal place for a theoretical mind: "The young La Plata University was perhaps the most advanced in Latin America, because it assigned priority to the basic sciences [...] instead of being a factory for producing lawyers, physicians and bookish engineers [...]"

The year of resolution was a defining year: "That year of 1937, so critical for me, I read more than at any other time in my life." While reading Bertrand Russell's *Problems of Philosophy*, published in 1912, immediately convinced him that psychoanalysis was "pure fantasy", it took him ten years to realize that the "Hegelian verbiage" of dialectical materialism concealed two doctrines interesting in the embryonic state: epistemological realism and ontological materialism. He was impressed by the pre-Socratic, Spinoza and French Enlightenment philosophers. He also realizes that most philosophers have never practiced science. In order to do better than them, he studied physics for fourteen years and received his doctorate in 1952 from the University of La Plata. From 1943 to 1951, he worked under the direction of Guido Beck (1903-1988) on problems of nuclear and atomic physics. Bunge only considered himself a professional philosopher after two decades of philosophizing and only after he had published a few books and a dozen articles. The

demands Bunge had placed on himself made him go a long way in order to reach his goal: “to join philosophy with science.”

After returning from a postdoctoral stay with David Bohm in Sao Paulo in 1953, Bunge embarked on two long-term research projects: the study of the philosophy of physics and its foundations, and the study of categories of determination, including causality and chance. These projects occupied him from 1954 to 1970 and led to the publication of *Causality* and *Metascientific Queries*, both in 1959, then to that of *Foundations of Physics* and *Scientific Research*¹¹, both in 1967. The *Treatise on Basic Philosophy* was born a few years later, in 1974, the culmination of this search for a link between philosophy and science.

Reading Bunge

Mario Bunge's project has led him to write more than 150 books and 540 articles or chapters, including translations into several languages. The work covers all branches of philosophy, from ontology to ethics, including semantics, epistemology, methodology, praxeology and axiology, as well as a wide range of scientific disciplines, from physics to sociology, including chemistry, biology and psychology. Undoubtedly, Bunge's magnum opus is the *Treatise on Basic Philosophy*. The first volume of the *Treatise* was released in 1974, the last in 1989. There is a before and an after the *Treatise*.

There was also a before and an after *Foundations of Physics* and *Scientific Research*. The year is 1967. For Bunge, the situation is clear. In his preface to *Foundations of Physics*, he invites us to roll up our sleeves since in any case the analytical tools for metascientific research are available:

There is little excuse for failing to attempt it, as all physical theories teem with logical and semantical difficulties, and the great majority of them are in their infancy as regards logical organization and physical interpretation. The prime matter—supplied by the physicist—and the tools—wrought by the mathematician, the logician and the philosopher of science—are there.

This work of axiomatization of theories of physics was undertaken to combat operationalism and to remove from the field of physical theories any concept pertaining to psychology. For Bunge,

¹¹ *Scientific Research* was republished as *Philosophy of Science* in 1998.

without this double axiomatization, formal or logical, and factual or semantic, to discuss the interpretation of a theory is only tantamount to “hand-waving, when not magic-wand-waving.”

With *Scientific Research*, Bunge offers us a manual of “methodology”, each section of which ends with a set of 10 problems, which makes a total of 930 problems to be solved. Many of these problems could be the subject of a master or doctoral thesis, and some of them would occupy a lifelong researcher. Answers to problems are not provided! Fortunately, each chapter ends with a detailed and commented bibliography. Let us understand that this is a manual of methodology in the Bungean sense, and not a manual of method, that is to say a manual which explains the methods specific to a discipline, the methodology here being the study of methods, the normative branch of epistemology. *Scientific Research* is an opportunity not only to deal with the methodology of science, but also the methodology of philosophy and metascience. The successes of formal logic and semantics “suggest adopting a clear methodology, more precisely one that draws on that of science.” A significant part of the work is also devoted to the semantics of the factual sciences, a theory necessary for the dual axiomatization of *Foundations of Physics*.

There was also a before and an after *Causality* and *Metascientific Queries*. The year is 1959. Several of the main Bungean themes are present: the dichotomy between formal and factual sciences, the notion of factual semantics, the unity of science, the nature of scientific laws, the different meanings of “law”, the notion of levels of organization, that of novelty and emergence, the different categories of determination, including causality and randomness, the lawfulness principle], scientific explanation and prediction, as well as a conception of metascience. Make no mistake, *Causality* is not just about causality; the work is sharp and wide, as evidenced by the subtitle: *The Place of the Causal Principle in Modern Science*. In the same way that *Scientific Research* is the companion of *Foundations of Physics*, *Metascientific Queries* is that of *Causality*: one is the general framework in which the research of the second takes place. We will find similar couples a few years later with *Philosophy of Psychology* and *The Mind-Body Problem*, then *Finding Philosophy in Social Science* and *Social Science under Debate*.

After the publication of *Foundations of Physics* and *Scientific Research* in 1967—and a few other texts in the same year and the following years!—during a trip to Spain, while staying with his family in a rented house near Marbella, Bunge recalls in his autobiography that “in the backyard there was a green lawn without trees and surrounded by a high wall, so there was nothing to do but think. There I had the idea of expanding my work to encompass all the main branches of philosophy.” It is an understatement! Not only will Bunge publish a treatise on philosophy which will cover all branches of philosophy, but he will also give himself the task of studying the main scientific disciplines in the light of his philosophical theories.

The *Treatise* is therefore the culmination of some twenty-five years of research and reflection on the nature of science, but also on the nature of philosophical or metascientific research. But to fully appreciate both the *Treatise* and the entire work, one must keep in mind the fiction/reality dichotomy and the distinction between reflection and theorization. From the dichotomy between fiction and reality follows other dichotomies: between the formal and the factual, between a concept and the object to which it refers, between an attribute and the property it represents, etc. So the world should not be confused with our representation of it. This implies that there are no philosophical, metaphysical, logical or linguistic links between us and the world. But, instead of concluding that the world is then inaccessible, Bunge reflects on the situation, takes note of the success of science, adopts the same general postulates to which science subscribes, to finally develop general theories, a theorization that is not about the facts of the world but their scientific representation. To adopt the same general postulates as science is to say that Bunge does not problematize scientific facts in the same way as his fellow philosophers.

This state of mind is reflected in Bunge's work through the use of a singular expression: to take for granted. We find the expression everywhere in Bunge's work, and without an understanding of it, the expression will appear incomprehensible or trivial. Aren't we saying that nothing should be taken for granted? Isn't it peculiar to a philosopher to question everything? Bunge disagreed. He takes for granted an astonishing quantity of principles and postulates, the justification of which is found in a reflection on the world, on our relationship to it, and on the success of science. If science is

successful, the majority of assumptions taken for granted by scientists must be the right ones. Why problematize them if they are the source of such success? Why not adopt them and thus build general theories, ontologies, epistemologies, methodologies and semantics, on a common basis with science? That's what he did. It must be understood that these general postulates are for Bunge a springboard for the development of his philosophical or metascientific theories; they are not the culmination of metascientific research but its beginning.

At the end of this introduction, we have grouped together a few books and journal numbers devoted to the thought of Mario Bunge. For the French readership, we have also grouped books, articles and chapters of Mario Bunge as well as texts devoted to his thinking available in French. This is not the first attempt to introduce Mario Bunge into the French-speaking world, but it seems to remain hermetic to his thinking. Note the effort of Éditions Vigdor to have published in the '90s three translations by Adam Herman of Mario Bunge's text as well as to have produced two videos in which Mario Bunge explains his vision of quantum physics and democracy. Publishing Bunge in French is a militant gesture.

Contributions

The eight contributions to this issue come from authors of different backgrounds, as it should be for a thought that covers as broad as that of Mario Bunge. Like Bunge's project, the following contributions are neither part of the analytic movement nor the continental movement in philosophy. Note, however, that the contributors to this first issue of *Metascience* do not necessarily endorse Sompromet's research program or the journal's editorial policy. We can reasonably think that they were willing to participate in the issue in order to pay tribute to a thinker dear to them. Nevertheless, we distinguish three types of contribution: 1) studies on the Bunge system; 2) applications or extensions of Bungean thought; 3) reflections and testimonies.

1] Studies on Bunge's System

François Maurice, in his contribution "**Metascience: for a Scientific General Discourse**", defends a non-philosophical

interpretation of Bunge's work by revisiting the problem of the nature of philosophy, including the way it has to problematize reality and the knowledge of it, as well as that of the nature of human reflection, which does not present itself as the prerogative of philosophy, but as "the most fairly distributed thing in the world." In order to take into account the particular nature of philosophy and the universal nature of reflection, Maurice advances the notion of general discourse. Philosophy then appears as a general discourse among others. Since Mario Bunge neither problematizes reality nor knowledge of it in the same way as philosophers, he cannot be considered as a philosopher, but rather as a metascientific. By separating the faculty of reflection from the philosophical discourse, it is then possible to envisage the development of a general scientific discourse, a metascience, the objects of study of which are the products of science, i.e. concepts, propositions and scientific theories, and whose main task is the development of metascientific theories, as found in Mario Bunge's *Treatise on Basic Philosophy*.

2] Applications or Extensions of Bungean Thought

Luis Marone, in his contribution "**On the Kinds of Problems Tackled by Science, Technology, and Professions: Building Foundations of Science Policy**", proposes to distinguish the components of the system of human knowledge, namely the science, technology and professions, based on an analysis of the types of problems encountered in each of them. He puts forward a typology of problems and solutions to these problems where the notions of direct problems and inverse problems, dear to Bunge, play an essential role. From this typology, it is then possible to classify activities within science, technology or professions. This understanding of the distinct nature of the activities of the system of human knowledge is essential for the formulation of a science policy for integral development.

Eduardo Scarano, in his contribution "**The Inverse Approach to Technologies**", offers us a study of the components of technology, especially the non-scientific components, through an approach complementary to that of Bunge. Scarano's analyses reveal no less than a dozen components of the technology. Although aware of the existence of non-scientific components of technology, Bunge was primarily interested in the link between science and technology. The study of the components of the technology, what Scarano calls the

inverse approach (not to be confused with an inverse problem), allows a tidy classification of technologies. In fact, Scarano postulates the existence of 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.”

Martín Orensanz, in his contribution “**A Critique of Meillassoux’s Reflections on Mathematics from the Perspective of Bunge’s Philosophy**”, criticizes the main thesis defended by Meillassoux in his book *After Finitude* in light of Bunge’s philosophy of mathematics: “all those aspects of the object that can be formulated in mathematical terms can be meaningfully conceived as properties of the object in itself”, or as Orensanz reformulates it, “any property which can be mathematized can be construed as a primary quality”. Orensanz’s critique has as its starting point an ambiguity in Meillassoux’s conception of the nature of mathematics and that of objects in themselves and their primary qualities, which compromises Meillassoux’s very thesis. By appealing to the Bungean dichotomy between the factual and the formal, Orensanz refutes the Meillassian thesis while betting that Meillassoux’s philosophy can hold up if it benefited from Bunge’s mathematical philosophy.

Ricardo Gomez’s contribution, “**Mario Bunge: Epistemology is here to Stay**”, is a defense of the Enlightenment, of modernity, of epistemology, and of Mario Bunge, contemporary representative of modernity, and a destructive criticism of Latour’s notion of non-modernity. Two brief comments by Gómez on Latour’s conceptions say it all: “Enough is enough”, and a little further, “Enough, again”. Latour builds a straw man and then tells us that we have never been this straw man. It introduces ill-defined and ad hoc concepts, unrelated to scientific disciplines, such as “hybrids”, “networks”, “hybridization”, “purification”: for Gómez, it is a “creative paraphernalia of an alternative version of modernity and what it is to be modern.” Before even tackling this notion of non-modernity, Gómez gives us a taste of Latour’s argumentative method by criticizing a text by Latour on special relativity, “A Relativistic Account of Einstein’s Relativity”, whose conclusion is unequivocal: “All these statements show that Latour has not the slightest idea of what Einstein holds.”

3] Reflections and Testimonies

Mario Bunge, in his contribution “**Criticism: Destructive and Constructive**”, invites us to consider constructive criticism as more important than destructive criticism, although the latter proves necessary. Bunge calls upon his experience as a critic of sterile philosophical schools to deliver the message “the most effective criticism is the one accompanied by a suitable substitute”, and for Bunge a solution often takes the form of a philosophical theory.

These and other contributions, published in various languages, including English and Spanish, demonstrate the potential of a research program inspired by Mario Bunge's project. This project is part of the humanist and scientific tradition of the first Enlightenment in ancient Greece and the second Enlightenment in Europe. The researcher, unlike followers of the contemporary Counter-Enlightenment sects, does not conclude in the face of a difficult and complex problem that there is no solution or that all solutions are equal. No, he lifts up his sleeves, he works hard, he thinks, he analyzes, he synthesizes, he advances solutions, he tests them, he offers them for examination, in short, he confronts reality, at the risk of undermining his own beliefs.

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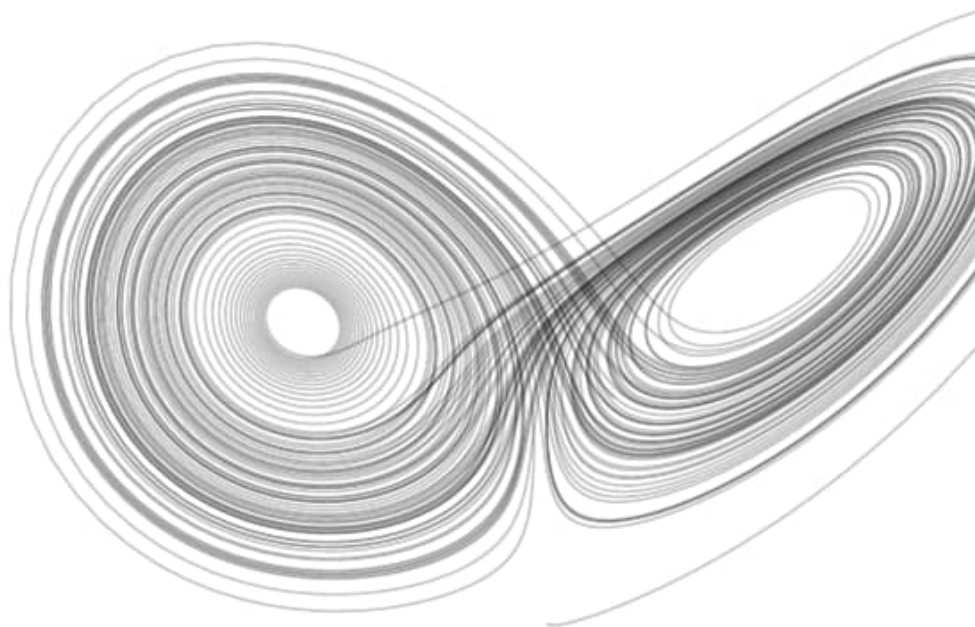
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Studies on Bunge's System



Metascience: For a Scientific General Discourse

François Maurice¹

Abstract — Human produce discourses on the world: mythologies, religions, mysticisms, philosophies, science. The majority of those discourses are transcendent in nature. Following a conceptual clarification based on the notions of reflection and general discourse, philosophy appears as a transcendent general discourse among others; hence the failure of the latter to account for the world and science; hence the need for a non-transcendent general discourse, a properly scientific general discourse, a metascience. In light of these redefined boundaries, it will be proposed to base metascience on an interpretation of Mario Bunge's work. This interpretation is based on a set of general postulates that Mario Bunge adheres to and taken for granted by scientists. It is proposed that supporting such a set of postulates without problematizing them in the manner of the philosophers, makes Bunge's thinking no longer philosophical.

Résumé — L'humain produit des discours sur le monde : mythologies, religions, mysticismes, philosophies, science. La majorité de ses discours sont de nature transcendante. À la suite d'une clarification conceptuelle fondée sur les notions de réflexion et de discours général, la philosophie apparaît comme un discours général transcendant parmi d'autres ; d'où l'échec de celle-ci à rendre compte du monde et de la science ; d'où la nécessité de disposer d'un discours général non transcendant, un discours général proprement scientifique, une métascience. À la lumière des frontières ainsi redéfinies, il sera proposé de fonder la métascience sur une interprétation de l'œuvre de Mario Bunge. Cette interprétation se fonde sur un ensemble de postulats généraux auxquels Mario Bunge adhère et tenus pour acquis par les scientifiques. Il est proposé que soutenir un tel ensemble de postulats sans les problématiser à la manière des philosophes, fait en sorte que la pensée de Bunge ne relève plus de la philosophie.

¹ Graduated in social statistics, mathematics and philosophy, independent researcher, founder of the Society for the Progress of Metasciences and translator in French of the *Philosophical Dictionary* by Mario Bunge published at Éditions Matériologiques under the title *Dictionnaire Philosophique*.

[The philosopher's] imagination should be impregnated with the scientific outlook and [...] he should feel that science has presented us with a new world, new concepts and new methods, not known in earlier times, but proved by experience to be fruitful where the older concepts and methods proved barren.

BERTRAND RUSSELL

My philosophical development

The idea behind the [Bungean] program is as commonsense as could be. This may sound disappointing, as it lacks all extravagance, but then this is what the program is all about.

The idea is to stay well within one world [...].

JOSEPH AGASSI

Ontology and its discontent

Only philosophers and inmates in a lunatic asylum think that someone can create reality rather than just alter it.

MARIO BUNGE

Chasing reality

The human need to explain the world is profound. In general, the explanations put forward by science do not satisfy this need. So we're looking for a different kind of explanation. Often the difference between a scientific explanation and a more satisfactory explanation is often translated by the idea that one seeks *the why* of things and not *the how*. To explain is to seek meaning in existence and therefore meaning in our lives. Humans need a general discourse about the world.

To meet this need, proposed explanations have taken several forms. Several general discourses on the world have been proposed. These general discourses on the world are, for example, animism, myths and religion. One thing in common with these discourses is the place reserved for one form or another of transcendence, to something more beyond mere material existence, something that cannot be grasped by the natural faculties of the human being. Intuition, reason, reflection, creativity, will, feeling, perception, etc. The apprehension of this transcendent reality can then be done through the intermediary of unnatural faculties: Intuition, Reason, Reflection, Creativity, Will, Sensation, Perception, etc. Often, a

general transcendent discourse is integral or total. In this case, such a discourse maintains a cosmology which explains the place of the human in the world, an ideology which explains the place of the individual in society, and a gnoseology, what the human is entitled to know, but especially what he is forbidden to know.

It is common to identify philosophy and general discourse, that is to say to affirm that philosophy is the general discourse par excellence; there would be general reflection only philosophical. We will show that philosophy is a type of general discourse invented by humans in the same way as other general discourses. And if it is one type of general discourse among others, then we can question its relevance in the same way that we question the relevance of animism, myths and religions.

To do this, we will have to focus on the notions of worldview, reflection, pre-methodic reflection, trans-empirical reflection, general postulate, and method. A fair appreciation of these concepts makes us understand that in the methodological order, the adoption of general assumptions precedes the development and use of an approach or method. Thus, the adoption of a number of assumptions only requires our natural ability to think. It is neither a scientific method, nor a religious method, nor a philosophical method, nor a metascientific method that dictates to us the assumptions on which our thinking will be based. If our argument has value, then we can propose a general scientific discourse based on a number of postulates obtained by a pre-methodic reflection. Therefore, we can disprove the widely held idea to justify the use of philosophy: scientists philosophy in spite of themselves.

This text offers a research program inspired by the work of Mario Bunge and in the spirit of the Enlightenment. In fact, it is more than a research program because we propose to establish a new discipline, or rather a new field of science. This scientific field, metascience, can be described as a scientific general discourse. Our re-drawing of disciplinary boundaries is based on the observation that general reflection is not to be confused with philosophical reflection. As we will try to show, philosophy does not have a monopoly on general thinking.

Our task is both easy and arduous. It is easy because we have an example of an accomplished metascientist, Mario Bunge. It is enough to use his work as often as necessary to support our point,

while bearing in mind that it is a starting point for any metascientific research. We will therefore characterize metascience in the second part entitled “Scientific General Discourse.” But before we even characterize metascience, we must demonstrate that philosophy is a general discourse among others, and, even more difficult, convince non-transcendent thinkers that they do not practice philosophy. This is the objective of the first part, “General Discourses.”

1] General Discourses

1.1] Reflection, Method, and General Discourse

Traditionally, philosophers have argued, including Bunge, that science is based on philosophical principles or assumptions and that it can't do without philosophy. We support the idea that these general postulates are not of a philosophical nature. If they are not philosophical, what is their nature then? To answer this question, we must distinguish worldview, reflection, method and general discourse. A vision of the world, or *Weltanschauung*, is a set of inarticulate beliefs as to the nature of reality. A vision of the world does not seek or desire coherence, which implies that philosophy cannot be confused with a vision of the world (Vuillemin 1986, p. viii) because “any philosophy worthy of the name, not being simply a bag full of bits and pieces but an articulate cluster of parts, becomes intelligible only through the relation of its different philosophical themes to a highest principle” (ibid., p. 128-29). Reflection is a natural faculty in humans. Thinking and reasoning are acts that humans spontaneously perform (which does not mean that there is no effort to be made). Thus, for Descartes, “common sense is the most shared thing in the world.” However, “it is not enough to have a good mind, but the main thing is to apply it well.” We therefore need a method which makes it possible to “conduct one's reason well and seek the truth in the sciences.” Descartes is, of course, neither the first nor the last philosopher to develop a philosophical method in order to reflect well and thus produce a general discourse. But, thinking about objects, using a method to guide this thinking, to finally reach or produce knowledge, requires from the outset to adopt certain general postulates as to the nature of the world and the objects that compose it, as well as to the nature of thought, and therefore the link between the world and our thought. However,

this reflection is pre-methodical. What do we mean by pre-methodical thinking?

There is no method to convince ourselves or reinforce our belief that the world is of a certain nature. We think, we weigh the pros and cons, we put forward some examples, but in the end we decide according to a particular worldview. As far as Bunge is concerned, the success of science is convincing enough to adopt, and not to problematize, the general assumptions of science. But these general assumptions of science have not been demonstrated, any more than those of philosophical or religious doctrines cannot be demonstrated. The demonstrations come only after a set of general assumptions has been adopted. These assumptions then constitute a set of premises, most often implicit, to any demonstration that is within a given frame of thought. Let's take one example. Let's think about the important phenomenon of perception. What causes perception? Is it caused at all or is it an autonomous phenomenon? If it is provoked, is it caused by material, immaterial, spiritual objects, etc.?

The answer to these questions does not depend on a method, but on a pre-methodical reflection. Thus, the Cartesian method only makes sense within the framework of a certain set of general postulates, postulates to which Descartes arrives after a pre-methodical reflection. This applies to any method whether philosophical, religious, mystical or scientific. Thus, Perrin's demonstration of the existence of the atom is only valid if one adopts the general assumptions of science. But these general assumptions are not obtained by the scientific method; they are pre-methodical. To argue that it is material objects interacting with us that provoke perception is not demonstrated by the scientific method. Another example, again linked to the question of perception, is that of the dichotomy between primary and secondary qualities. It is through a pre-methodical reflection that we convince ourselves that objects possess properties that are not those that are spontaneously attributed to them. In this way, we could continue our pre-methodical thinking and thus develop a set of general postulates specific to science. We'll come back to that in the second part. For now, we want to return to the question of the nature of these general assumptions.

Since these general assumptions are obtained by pre-methodical reflection, they cannot be considered as philosophical postulates.

Philosophical schools themselves need to think about the general assumptions they will adopt. Only then can they construct a method for philosophizing and developing a general philosophical discourse. Thinking is not a method, it is a faculty, and thinking about general assumptions in a particular frame of thought requires neither a method nor even extensive training in any field, be it philosophical, religious, mystical or scientific. Of course, the above is a posteriori reconstruction of what is actually happening. In fact, there is a back-and-forth between pre-methodical reflections, method and the general discourse that is being developed. It was important for us to highlight the non-philosophical nature of the general assumptions of science.

We thus note that there are several general discourses about the world and about human nature: philosophical, religious, mystical, etc. Oddly enough, science does not have its own general discourse. We will come back to this in the second part since for the moment we want to underline the transcendent nature that many of these discourses have taken. What do we mean by transcendent? In his *Vocabulaire technique et critique de la philosophie*, one of the meanings attributed by Lalande to transcendent is “what does not result from the natural play of a certain class of beings or actions, but which implies the intervention of a principle outside and superior to it.” In addition, in his *Dictionnaire de la langue philosophique*, one of the meanings attributed by Foulquié to transcendent is that “which is beyond or outside the domain considered and is not of the same nature as this domain.” The two meanings are not mutually exclusive and in fact complement each other. In a frame of thought which postulates only the existence of material objects, we can advance that any general discourse which postulates the existence of objects of a nature different from concrete or material objects, which implies appealing to principles external to these objects, is a discourse transcendent in relation to this frame of thought. It is within this frame of thought that science and its method are developed, and it is within this framework that a general scientific discourse, a metascience, is developed, of which Bunge laid the foundations. Again, it is neither philosophy, nor science, nor metascience that dictates the basic postulates of any thought because there is no philosophical, metascientific or scientific method that comes into play here. Methodologically, you must think and then convince yourself

to adopt some elementary postulates before even undertaking a philosophical, scientific or metascientific research.

Mythical, religious and mystical discourses are therefore transcendent discourses in relation to a general scientific discourse. The case of philosophy is more complicated because there are transcendent doctrines and immanent doctrines. We believe, however, that the majority of philosophical doctrines are transcendent. The idealist doctrines are obviously so. The empiricist doctrines seem more down to earth, but it turns out that they are transcendent when we examine them from the perspective of a general postulate, the dichotomy between the factual and the formal, advanced by several philosophers, taken for granted by Bunge and, it seems, by the majority of scientists. This dichotomy is a special case of a more general dichotomy between the world and our representation of the world, or between the real and the fictional.

At the root of empiricism is the idea that we do not have “direct” access to the world beyond perception, or, to put it another way, there are no *logical* or *necessary* links between our perceptions and the objects that would produce them. Here, it must be understood that the formal takes precedence over the factual. It is true that such logical links do not exist, but if they do not exist it is because the objects in question are not formal objects. This is where empiricist transcendence comes to light. We then call upon principles external to concrete objects and we grant logic an ontological, epistemological and methodological status. Logic then becomes a *philosophical logic* and no longer just a formal logic. This philosophical logic would be able to tell us what exists or not, what is knowable or not and, if so, how to acquire knowledge. If we are thinkers who take for granted the general postulates of science, notably the existence of the concrete world and the dichotomy between the factual and the formal, then logic is not an ontology, epistemology or methodology. Now, if we don't have direct access to trans-empirical objects, especially those studied by science, how do we form concepts about them? Bunge provides us with the answer: “The transempirical concepts do not originate in perception, i.e. they cannot be learned from experience but must be acquired by *reflection*” (Bunge 1983b, p. 161, our italics).

We therefore propose a preliminary breakdown of general discourses; the study of general discourses is a research project in

itself, especially the psychological and sociological aspects. The importance of redefining the boundaries we are proposing is that any general discourse that is not clearly mythical, religious or mystical is attributed to philosophy. But since philosophy is largely dominated by transcendent philosophies, and even, we believe, that philosophy is inherently transcendent, then any general discourse runs the risk of being contaminated by transcendent considerations.

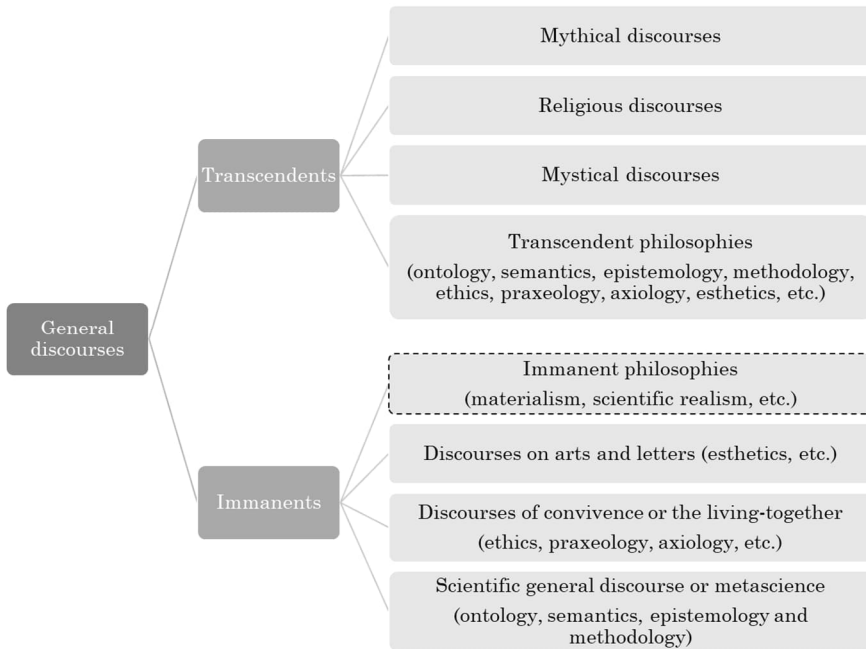


Figure 1: Preliminary representation of some general discourses

To associate immanent discourses with philosophy is a consequence of the weight of tradition. Not knowing what these immanent discourses are, we place them among the philosophical doctrines. But, from our point of view, the writings of the same immanent thinker, according to the object of each writing, can be associated either with a discourse on arts and letters, or with a discourse of connivance or the living-together, or with a general scientific discourse or metascience. This is what **Figure 1** attempts to show by the dashes around the category of immanent philosophies. From our point of view, this category should disappear in favor of the other three categories of general discourse. And these three discourses are autonomous even if they can influence each other. They are

autonomous in the sense that there is no strong or necessary, philosophical, scientific, metascientific, logical, religious, or other link that connects them. This autonomy of immanent discourses is an additional reason for not grouping them under a common denomination that is philosophy.

We were led to reflect on the nature of reflection, method and general discourse, noting that Mario Bunge took for granted an impressive amount of general postulates. Most thinkers may hold such a large number of postulates, but Bunge had made a habit of spreading them out into the open. He also argues that these assumptions are the ones on which science is based, which is defensible given the nature of these assumptions. What is most surprising, however, is not that a thinker puts forward a few assumptions and argues that science conforms to them, since after all this is what philosophers of science do, it was rather that this same thinker adopts these postulates to construct his semantic, ontological, epistemological and methodological theories. Instead of questioning the assumptions that can reasonably be attributed to science, Bunge relies on them to develop his general thinking and theories about the world and science. As Mahner notes: “Modern metaphysics involves more than just a collection of general principles: it must present itself as a theory incorporating ontological concepts, consistent with the results of science” (Mahner 2013, p. 44). Thus, Bunge *does not problematize* the general assumptions of science as one might expect from a philosopher.

If we distance ourselves from philosophy, what do we see? A general discourse among others. The resemblance between Bunge’s thought and philosophical doctrines is due to the fact that we are in the presence of general discourses about the world and about knowledge of this world. Other thoughts produce general discourses, such as religions, myths and several mystical doctrines. At the foundation of each discourse is an attitude and an approach. Bunge resolutely adopts a scientific attitude and approach. It is for this reason that we can identify his thought with a *scientific general discourse*. Since Bunge is interested in knowledge of the world, and since nowadays a good part of this knowledge comes from science, and, finally, since the success of science is obvious, he extracts and adopts what he believes to be the most general assumptions of science. Just as it is a starting point for science, it is a starting point for Bunge’s thought.

So, contrary to what one might think, Bunge's methodological starting point is not science or common sense, but the most general transempirical concepts at the foundation of science. These concepts are understood neither by perception alone nor by reason alone. In fact, these concepts cannot be grasped, but must be constructed after reflection. It is a creative act and not a simple apprehension of a perceptual or intellectual given. Reflection and creation go hand in hand. Reflection is a faculty, while a general discourse is a construction. Reflection allows Bunge to identify the general postulates on which science rests. From these postulates, he elaborates his general discourse. Thus, Bunge does not seek to problematize the starting point of the sciences, he seeks to identify it and to rely on it in order to develop a scientific general discourse, a *metascience*.

1.2] Reflection and Philosophy

To think is to call upon an arsenal of cognitive processes to learn (acquire new knowledge) or to find a solution to a problem (which is a form of learning): compare, generalize, instantiate, memorize, remember, invent, deduce, calculate, associate, preach, classify, predict, focus, pay attention, analyze, synthesize, perceive, explore, form concepts and propositions, learn a skill, criticize, theorize, plan, speak, write, decide, choose, etc. In short, thinking is a complex cerebral process (formerly we spoke of operations of the mind) which involves a large amount of an individual's cognitive resources in order to produce, transform or use knowledge (Bunge 1983b, p. 23).

Every human thinks. Reflection is natural and spontaneous. As soon as we encounter a problem, and unless it immediately endangers our lives, we have the choice to ignore it, hoping that it resolves itself, avoid it or run away from it while taking it into account, or confront it directly in order to solve it. In any case, we are thinking. It seems that there are several degrees of reflection depending on the object or problem about which we are thinking. Most of the time we think about practical issues, whether in our private lives or in our public life. We also reflect on our relationships, private or public, which can lead us to moral reflection.

However, reflection alone does not produce valid arguments or theories, although it is necessary to think in order to argue and theorize. There is no general method for thinking, let alone algorithms that would achieve knowledge, because to think is to continually

making assumptions over and over, then thinking again about these assumptions and decisions. And making assumptions and making decisions are creative acts, that is, we create new assemblies of neurons or psychons (*ibid.*, pp. 41–42, 2008, p. 80). And while no algorithm can create material objects, the brain, a material object par excellence, can create fictions, such as an algorithm, by ideation and abstraction, which are material processes (Bunge 1974a, p. 13, 1983b, p. 56).

Although it is true that the same person can think in the context of several general discourses simultaneously or move from one discourse to another without too much difficulty, it does not follow that if I think, I necessarily practice a philosophy, unless I identify reflection and philosophy, and then the very term philosophy loses all its meaning. Any reflection takes place within a framework whether this framework is mythical, religious, philosophical or scientific.

Thus, reflection is not to be confused with philosophy. Philosophers were not mistaken. They sought to develop methods to know reality, because reflection alone is not systematic enough and does not produce theories. Plato developed dialectics, Aristotle syllogistic, Descartes wrote the *Discourse on the Method*, Husserl proposed phenomenological reduction and the Vienna Circle, logical analysis. General discourses cannot therefore be confused with philosophy because reflection is not unique to philosophers and philosophers propose particular methods for obtaining knowledge and producing theories.

Reflection requires no advanced philosophical, scientific or meta-scientific training. It is enough, in general, to have some life experience and elementary education to be able to reflect on the living-together and about the world. Thinking about more advanced topics, on the other hand, requires further learning on the part of a person. Again, reflection is not a discourse or a system of thought or a theory; it is a brain process. And the products of reflection do not form a discourse or a system of thought or a theory. We will come back to that in the second part when we characterize metascience.

In any case, the study of reflection is a matter of psychology. For our purpose, it suffices to admit that there is a human faculty that allows us to make hypotheses, that is to say propositions which are

not the fruit of a logical deduction, hypotheses which, concerning the world, often relate to objects that lie beyond perception.

1.3] Transempirical Reflection

Reflection is therefore not to be confused with philosophy. Reflection can be practiced by all, in the sense that there is no need to be a scientist, a metascientific or a philosopher to think of some general questions about the living-together and the world. Let us take an example of reflection which does not require special training. A transempirical reflection, a reflection about what lies beyond sensations and perception, is a thought experiment that allows us to realize the difference between the properties that belong to things, the primary qualities, and the sensations that our interactions with things provoke in us, the secondary qualities. Thinking about the distinction between primary and secondary qualities is one of the most important thought experiments an individual interested in knowing the world can have. Such a reflection allows us to move away from common sense, which attributes the secondary qualities or sensitive qualities to the object that provokes them in us.

The primary qualities are properties that belong to objects. These are properties that exist independently of sentient beings. Secondary qualities are properties that are wrongly attributed to the objects with which we interact when they are in fact sensations caused by these objects. This reflection is in principle accessible to all, at least it does not require a thorough knowledge of either science, metascience or philosophy. The conclusion that any reasonable person will reach will be to admit the distinction. Science and metascience take this distinction for granted, which is not generally the case with transcendent philosophical doctrines. Philosophers will tend to problematize the distinction because they seek a “strong” link, *philosophical, metaphysical, logical, linguistic, discursive*, that would unite perception with the perceived object.

Note that such a thought experiment, although it is within the reach of the greatest number, is not obvious. Even if we can suppose that some individuals among our distant ancestors practiced it and that they arrived at the reasonable conclusion which we reached, it was still necessary to wait a few millennia before thinkers clearly stated it, such as Democritus, and it took two more millennia for psychosocial conditions to be met for the distinction to become attractive to members of the emerging community of early modern

scholars, such as Descartes, Galileo, Locke and Newton. The distinction between primary qualities and secondary qualities makes it possible to dissolve a philosophical problem described as fundamental by Bouveresse following Vuillemin:

If philosophy were to be characterized therefore by reference to a fundamental question, it would be that of the distinction between reality and appearance. And since there are, for reasons that are not accidental but intrinsic, several possible ways, fundamentally different and incompatible between them, to draw the dividing line between reality and appearance, it helps to understand why philosophy has always presented itself so far in the form of an irreducible plurality of systems that history has never managed to separate (Bouveresse 2012 p. 41).

Each philosophical doctrine, at least among transcendent doctrines, therefore attempts to determine the border between appearance and reality. The distinction between appearance and reality bears witness to transcendence in philosophy, while this distinction is rejected by Bunge and by science: “In the philosophical tradition appearance is the opposite of reality. This is mistaken, for an appearance is a process occurring in the nervous system of some animal, hence it is just as much of a fact as an external event. (Bunge 2020, p. 26).”Appearances” are facts of the world just like all other facts of the “external world.”

There is therefore no opposition between appearance and reality; there is only reality. The problem of distinguishing between reality and appearance therefore becomes a false problem. The rejection of this distinction, the refusal to see an opposition “between what is really and what appears only to be” (Bouveresse 2012, p. 8; italics in the original), will result in Bunge’s general discourse about the world, his ontology, which does not try to establish what is, since there is only reality and this is studied by the sciences. Bungean ontology is an abstract representation of the world obtained by a study of scientific constructs and by an ordering of the general postulates of science. Such an ontology does not concern objects which would be more real than the concrete objects studied by the sciences.

Some will protest against the restrictive and dogmatic nature of metascience. The framework of thought that we will propose in the second part, rather than hindering creativity, will stimulate it and

direct it towards avenues of research that were previously closed by the old philosophical frameworks. You only have to look over the work of Mario Bunge, especially his *Treatise on Basic Philosophy*², to convince yourself that the work that awaits the metascientists is immense. To use another image, the exploration of the forest is just beginning and Bunge opened a first path (several paths in fact!). The problems to be solved will require a good dose of creativity and any creativity requires its framework.

1.4] Philosophical Transcendence

Vuillemin explains the nature of philosophy by its simultaneous adoption, from its origins, of the axiomatic method, newly invented, and of the postulate of the appearance/reality dichotomy:

To sum up, philosophy results from the reorganization of the two dimensions of mythical signs. The mythical story gives way to the quest for true principles according to the standards of the axiomatic method. This was the first, foundational relevance of axiomatics to philosophy. At the same time, however, philosophy intends to reform and to restore mythical ontology dismissed by axiomatics. A determinate ontology takes the place of the equivocal reference to reality. The second connection of axiomatics with philosophy is through demonstration. But the requirement of consistency, which no material consideration comes to hinder in axiomatic method, has, in philosophy, to cope with ontology. Between self-evident principles equally recommended by common sense but mutually inconsistent, a choice is imposed on philosophy which explains its divisions. Finally, philosophy is like axiomatics in so far as both seek truth. But in contradistinction to scientific truth, its consideration of ontology makes philosophy generalize an opposition which is only of local and minor importance in science. Competing philosophical

² The *Treatise on Basic Philosophy* consists of 8 tomes in 9 volumes: *Semantics I: Sense and Reference* (1974a), *Semantics II: Interpretation and Truth* (1974b), *Ontology I: The Furniture of the World* (1977a), *Ontology II: A World of Systems* (1979a), *Epistemology I: Exploring the World* (1983b), *Epistemology II: Understanding the World* (1983c), *Epistemology III, part 1: Formal and Physical Sciences* (1985a), *Epistemology III, part 2: Life Science, Social Science and Technology* (1985b), *Ethics: The Good and the Right* (1989). In his memoirs, *Entre deux mondes* (2016, p. 323), Bunge considers that his book *Political Philosophy* (2009b) constitutes the 10th and last volume of the *Treatise*.

systems struggle for recognized, if not fixed, frontiers between appearance and reality. (Vuillemin 1986, p. 114)

But since we can neither agree on a set of axioms nor on the line between appearance and reality, philosophy then split into a plurality of doctrines.

We believe that most philosophical doctrines are transcendent precisely because these doctrines are based on this division between appearance and reality, and that the boundary they seek to draw calls upon principles foreign to the concrete world. And this border will be established by each doctrine using pre-methodical reflection. We do not yet philosophize when we draw the line between appearance and reality; we put forward our object of study and it is only then that we will philosophize by using methods that we believe suitable for this object. Although the majority of philosophers these days do not openly discuss Being, this god of philosophers, they are always animated by his search and by the discovery of an infallible faculty of knowing it.

The faculty to achieve this can be Intuition, Reason, Reflection, Creativity, Will, Sensation, Perception, etc., which gives rise to different philosophies, for example rationalism, intuitionism, empiricism, etc., but in all cases these faculties have nothing to do with intuition, reason, reflection, creativity, will, sensation, perception, etc., with which we are all endowed naturally. We must therefore pay attention to the use that philosophers make of these terms. Even if a philosopher does not write the word with a capital letter, it is a supernatural faculty that he has in mind and not a natural faculty. We note, however, that most philosophers wander from a natural conception to a supernatural conception of these faculties, without always realizing it, that is to say in good faith, which is worse than a philosopher who would assume the transcendent nature of his thought and would develop a coherent discourse, for want of being reasonable and rational.

It is quite common to associate philosophy with rational discourse, which makes our characterization of philosophy as a transcendent general discourse seems even stranger. The form of philosophical transcendence is special. This transcendence seems to be unique to the West, which inherited it from ancient Greece. It is a discursive, rationalizing, logicizing, linguistic, axiomatizing transcendence. Of course, transcendent philosophical discourses are

based on discussion and debate, which is far from the case with other forms of transcendent discourses. Even irrationalist philosophical schools, often with an obscure style, produce numerous academic publications to defend their positions, organize seminars and congresses, and pass on their “knowledge” to students. It is perhaps no coincidence, however, that this discursive transcendence appears at the same time as democracy, public debate, argumentation, sophistry, rational thinking, science, logic, theoretical mathematics and the general need for theorization.

From the origins of philosophy, philosophers have therefore given to the “discursive,” “logic” and “language” a semantic, ontological and epistemological role. To grant such powers to discursiveness, to believe that it is possible to discuss ontological, semantic and epistemological subjects on the basis of “discursive,” “logical” or “linguistic” considerations, is to show transcendence. Since the real world is not made of discursive, logical or linguistic relations, since our relation to the world is neither discursive, neither logical, nor linguistics, a conclusion to which all elementary reflection arrives, it is therefore not possible to use logic or language to deal with a single problem concerning the world or our knowledge of it. This original sin is called *panlogism* (or *logical imperialism*) and *glossocentrism* (or *linguistic imperialism*) by Bunge³.

True logic is a *formal science*, like mathematics, distinct from the *factual sciences*, wrongly called empirical sciences, and the *conceptual sciences*, i.e. metasciences⁴. We will return to this scientific triad in the second part, for the moment it suffices to accept the reasonable idea that logic and language say nothing about the world and how to know it. As we have just indicated, a simple reflection is enough to understand that a “logical” relationship is not to be confused with a concrete, material relationship. The fact that transcendent philosophers insist on taking the path of discursivity, while

³ Bunge discusses an example of panlogism in *Evaluating Philosophies* (2012a, chap. 19), and criticizes Chomsky’s glossocentrism in “Philosophical Problems in Linguistics” (1984).

⁴ A treatment for the formal/factual dichotomy is found in Chapter 8, Sections 1 and 2, and in Chapter 10, Section 2.1 of *Semantics II: Interpretation and Truth* (1974b), in Chapter 5, Section 2.2 of *Epistemology I: Exploring the World* (1983b), in Chapter 1, Sections 1.1 and 2.1 of *Epistemology III, part 1: Formal and Physical Sciences* (1985a) and in Section 1.4 of *Philosophy of Science I: From Problem to Theory* (1998a).

understanding the distinction between factual relationship and formal relationship, can only be the product of a transcendent belief. They must necessarily assume that reality is not material, from which the appearance/reality dichotomy follows.

Empiricism is often seen as the most relevant philosophical doctrine for science. However, empiricists do not hesitate to use *logicist fallacies* to make us believe that only sense data are knowable: because there are no “logical” relationships between our sensations, perceptions, impressions or experiences and the objects that would cause them, because an immediate or direct knowledge of these objects is impossible, then, necessarily, these objects do not exist or, if they exist, they are not knowable. The empiricists wanted to combat the excesses of rationalism, but on the basis of rationalist or rationalizing reasoning. By wanting to fight Reason, they lost their reason by raising Sensation or Perception or Experience to the rank of supernatural faculties in the same way as Intuition, Reflection, Creativity, Will, etc. Empiricism is transcendent. It is transcendent because it involves a principle foreign to material objects. He judges the link between objects, in particular between objects and us, on the basis of logical principles, or rather of philosophical-logical principles since it is no longer a question of formal logic, which says nothing about the world.

A basic reflection makes us conclude that the world is not made up of logical relations, that our relation to the world, of which we ourselves are only a tiny part, does not fall within any logic, that interesting knowledge is rarely immediate, that sensations are provoked by our interaction with objects independent of us, objects that existed before our birth, which exist even when we do not interact with them, that will exist after our death and after a possible disappearance of humanity, and that knowledge of objects involves natural sensations and mental faculties, including reflection and creativity. In short, the appearance/reality dichotomy must be rejected, but the formal/factual dichotomy must be accepted.

Philosophy, by keeping the door open to one form or another of transcendence, by favoring discursivity and postulating the existence of supernatural faculties at the expense of the natural faculties we are endowed, excludes itself from any modern rational debate whose canons were gradually established from the Renaissance. We do not announce the death of philosophy, we do not work on yet

another re-foundation of philosophy, we do not propose an anti-philosophy or a post-philosophy or a trans-philosophy. Philosophy will not disappear since every transcending discourse that appears on Earth seems to find a buyer at any time. There will always be philosophers as there will always be religious and mystics of all kinds.

1.5] Philosophy in Crisis?

In *Philosophy in Crisis*, Bunge lays out ten causes, among others, to the crisis of philosophy, and thirteen options available to philosophers who wish to reconstruct philosophy ... or perpetuate the crisis. The ten causes of the crisis of philosophy identified by Bunge are: 1) excessive professionalization, 2) confusion between philosophizing and chronicling, 3) mistaking obscurity for profundity, 4) obsession with language, 5) idealism, 6) exaggerate attention to mini-problems and fashionable academic games, 7) insubstantial formalism and formless insubstantiality, 8) fragmentarism and aphorisms, 9) detachment from the intellectual engines of modern civilization, 10) ivory tower.

The choices available to philosophers who wish to reconstruct philosophy or perpetuate its crisis are: 1) Authentic/fake, 2) Clear/obscure, 3) Critical/dogmatic, 4) Deep/shallow, 5) Enlightened/obscurantist, 6) interesting/boring, 7) materialism/idealism, 8) noble/vile, 9) Open/closed, 10) Realist/fantastic, 11) Systemic/fragmentary, 12) Topical/anachronistic, 13) Useful/useless).

Of course, the two lists overlap and the second option of each alternative from the second list constitute an additional cause for the crisis in philosophy. The diagnosis is final and the treatment is up to the seriousness of the disease:

So much for a diagnosis of the ailments of contemporary philosophy. Every one of them ought to suffice sending the dear old lady to the emergency wing. All ten necessitate sending her to the intensive care unit. The adequate treatment of the patient is obvious: A transfusion of new and tough problems whose solution would advance knowledge; intensive exercises in conceptual rigor resulting in the elimination of pseudophilosophical toxics; selected morsels of mathematics, science, and technology; training in the detection and inactivation of ideological minefields; and renewal of contacts with the best philosophical tradition. (Bunge, 2004, Section 10.2)

Unfortunately, the treatment will not be effective. It is not possible to cure the patient because she does not have any disease. Philosophy is no sicker than religion. The state in which philosophy is found is in its natural state. Doing philosophy means supporting many of the second terms of the alternatives presented by Bunge. For example, supporting one form or another of idealism, rather than materialism, is essential for a philosopher, just as it is essential for a religious to believe in deities. Doing philosophy also means problematizing the general postulates on which science is based. Without this questioning of the elementary and reasonable postulates of science, philosophy no longer has its *raison d'être*.

The lamentable state in which philosophies find themselves is seen by the way philosophers argue: both common sense and science are used to defend the same thesis, and then ignore them a few paragraphs later in the name of a less naïve and more sophisticated philosophical position, but without explaining why common sense and science no longer do the trick. Thus, when reading philosophers, we learn that an effective recipe for writing a text in the analytic dialect of philosophese is to concoct a counterfactual proposition, sprinkle it with a little of relativism, add a pinch of possible worlds, to brew everything with supervenience, then, finally, to cook to modal logic to give a semblance of consistency⁵.

The multitude of philosophical doctrines is not a sign of a crisis, but a normal situation for any transcendent discourse. Thus, the phrase “it is *philosophy* that demands it,” often presented with this emphasis in italics, makes no sense. What philosophy? Analytic philosophy or continental philosophy? Relativism? Antirealism? Or rationalism or empiricism? Who knows! There are so many incompatible “philosophical methods” that it is impossible to know what the expression might mean. When slipped at the right time into an “argumentative” text, the mind is stunned and no longer able to think, especially since the expression is used in the singular, which gives more weight to the author’s belief. We dare not reply because philosophy is a mystery and it is both admired and feared.

Equally problematic is the expression “philosophical category.” It suffices to call on this expression to claim an imperium on a notion, whether it comes from common sense, the arts and letters, or

⁵ Adapted from Maurice, “Une triade scientifique ?” (2017, p. 171).

technologies and sciences. The same remark is obvious. Is this an analytic category? Or a continental category? Relativist? Antirealist? Or again, rationalist or empiricist? Although it is argued that the various philosophical currents, movements and doctrines belong to the same activity known as philosophy, it makes no sense to convey these expressions without any other qualifier. Transcendent philosophical doctrines share a family resemblance, but they do not share an approach and methods as is the case with the sciences. At most, they share an attitude, a feeling that the world is more than matter (but what exactly?), and, therefore, that the real relation between material objects are not immanent in them (therefore transcendent, but what transcendence?), and that a particular faculty, a sixth philosophical sense, makes it possible to apprehend them (what faculty and how does it operate?).

Similarly, the abundant literature that focuses on defending the need for scientists to collaborate with philosophers neglects the heterogeneous nature of philosophy, a heterogeneity that comes, as we have seen, from the many ways that it is possible to draw the line between appearance and reality. This heterogeneity is constitutive of philosophy: “The plurality of philosophies, their rivalry, their polemics recalled to the reason, from the outset, that to pose is to divide and choose” (Bouveresse 2012, p. 130). The tasks assigned to philosophy would be the clarification of scientific concepts, the critical appraisal of scientific assumptions and methods, the formulation of new concepts and new theories. Philosophy would be able to do this work because it would share with science the tools of logic, conceptual analysis and rigorous argumentation (Laplane et al. 2019). We agree with these authors that a certain type of discourse should in principle correspond to this characterization. But why associate such a discourse with philosophy when philosophical doctrines are plural and irreducible? Many philosophers would not agree to define the nature of philosophy in the way that these authors define it. What do a discourse as described by these authors and transcendent doctrines have in common? We also agree with these authors that several thinkers have contributed substantially to debates in science, including those mentioned by way of illustration in this article, but why associate them with philosophy, when this activity is very heterogeneous?

Thinkers who make a contribution to science necessarily adopt a set of general postulates similar to those attributed to science,

otherwise their contribution could not fit into a scientific debate. In other words, their exchanges, not only between themselves, but between them and the scientists, are established within a unified framework of thought. In fact, a plethora of philosophies do not use the tools mentioned by the authors of this article, or if they claim to use them, it is in a very strange way, far removed from the scientific practice. Are the logical and conceptual analyzes within the framework of possible worlds, presented in a rigorous argumentative style, of the same nature as those of sciences and metasciences? Logic, conceptual analysis and rigorous argument are of no use if the same general assumptions are not shared with science from the start. So there is no crisis in philosophy.

We will therefore propose in the second part not the establishment of a crisis unit to find a solution to a problem that does not exist, but rather a research program for the development of a general discourse properly scientific.

2] Scientific General Discourse

2.1] General Postulates and Reflection

Philosophical doctrines are normally referred to by words ending in the suffixes *-ism* or *-logy*. Bunge also uses an impressive number of *-isms* to qualify his thinking. We defend the idea that the majority of these positions are not philosophical, but the result of a reflection, and that the fact of not problematizing them, but rather of taking them for granted, is anti-philosophical. Thus, and paradoxically, supporting these general postulates simultaneously evacuates the philosophical discourse and brings Bunge's way of reasoning closer to the way scientists reason. In other words, Bunge adopts a scientific posture and not a philosophical one.

The set of general postulates supported by Bunge, combined with a keen sense of critical thinking, coupled with an ever-active mind that never sinks into intellectual laziness, combined with a thought that continually refuses any form of transcendence, ensures that Bunge does not practice a form of philosophy. He invented a new way of constructing a general discourse about the world and science. This general discourse can be called *metascience*, a term already used in the past by Bunge in a sense quite similar to our own. Bunge has managed to extract the general discourse from the mystical mire in which he has been bogged down for millennia. This is a

revolution. A revolution for the general thought or a revolution of human reflection. Bunge has built a new framework for reflection, a framework radically different from that of philosophy, but fundamentally in line with that of science. Nearly 2,600 years after the first scientific and metascientific revolution, almost 500 years after the second scientific revolution, we are witnessing the second metascientific revolution.

What are these general assumptions taken for granted by Bunge? Here is a non-exhaustive list of points of view that can be reached with a greater or lesser effort of reflection:

ONTOLOGY: 1) autonomous existence of the world, 2) uniqueness of the world, 3) materialist monism, 4) reism, 5) pluralism of properties, 6), essentialism of properties, 7) systemism, 8) emergentism, 9) levels of reality, 10) dynamism, 11) evolutionism, 12) lawfulness principle, 13) *ex nihilo nihil fit*, 14) fictionalism, 15) causal determination, etc. EPISTEMOLOGY: 1) knowledge of the world is possible, 2) objective knowledge, 3) scientific realism, 4) moderate skepticism, 5) moderate empiricism, 6) moderate rationalism, 7) fallibilism, 8) meliorism, 9) moderate pluralism of explanations, etc. METHODOLOGY: 1) justificationism, 2) testability, 3) confrontation of hypotheses with reality, 4) scientism, etc. SEMANTICS: 1) creation of mental objects by abstraction (constructs or construction of the mind), 2) distinction between a construct and a sign that designates it, 3) reference to the “external world”, etc.

It is these and several other positions, which, if supported simultaneously, no longer form a philosophical thought. These general assumptions are methodologically at the foundation of science and metascience.

Let's go back to reflection for a moment. We were saying that you don't have to be trained in science, philosophy and metascience to think about some general questions. Thus, we can argue that the majority of doctrines listed above are the result of a reflection and not the application of a philosophical, metascientific or scientific method. Reflection precedes science and metascience, and dispossesses philosophy of its status of general discourse *par excellence*. It is for this reason that factual sciences are independent of philosophy and metascience. It is also what explains the mystery of scientific progress despite the fact that *the sciences are not well founded philosophically*. The best scientists are thoughtful, which allows

them to implicitly support very general hypotheses which then form a frame of thought for their scientific research.

It is often argued that science presupposes philosophical conceptions. In fact, what science presupposes in order to function properly consists of very general conceptions which are arrived at by reflection and not by any sophisticated philosophical or metascientific method. The “philosophical” presuppositions of science, which science takes for granted, Bunge would say, are questioned by the various transcendent philosophical doctrines while science and metascience take them as a starting point for their research. These are not philosophical, nor even scientific or metascientific presuppositions, because there are no particular methods to conceive them, as there are methods in science and metasciences, and also “methods” for the different philosophical doctrines. We are simply using our natural ability to think at a higher level than the common thinking we use in everyday life. As Claude Bernard remarked (1865, p. 83): “I think there is only one way for the mind to reason, as there is only one way for the body to walk.”

So therefore, trusting science to explain the world is not a philosophical position. This is the result any elementary reflection achieves after examining the issue. In fact, science imposes itself on us just as the world imposes itself on us. Try to live for a single moment by going against the laws of nature or try to establish a large electricity production and distribution network without having a good deal of scientific and technical knowledge. Despite the disinterested aspect of much of scientific research, science imposes itself because it works, and, if it works as well, it is because it deeply explains the phenomena. An interesting indicator of the veracity of science is the use made of it by large organizations which seek to take, keep or extend their political, economic and social power. Thus, States, armies, political parties and large corporations of all countries, in short the establishments, use science more often than mystical thinking, despite the fact that philosophers still have doubts about the value and merits of scientific propositions. People who run these organizations may well be great mystics or great religious themselves, but like everyone else they live with several general discourses. Even in everyday life, although the majority of people are mystical to varying degrees, strangely, if their health, comfort or finances are at stake, they will trust science and technology. This includes philosophers.

Bunge's use of general presuppositions is what sets him apart from philosophers who defend one form or another of scientific realism. These philosophers stop where Bunge begins. They take science seriously, but only to highlight the most general conceptions that underlie scientific activity, which is not always easy, let's face it. They sometimes make relevant criticisms of philosophical doctrines, but they repeat the same mistakes as philosophers. They try to find solutions, within a scientific realist framework, to pseudo-problems raised by philosophers and they address subjects that fall within the scope of factual sciences. Debates are increasingly similar, within the small community of scientific realists, to the debates of analytical philosophy: increasingly sophisticated, but less and less relevant. These scientific realists may no longer be philosophers because they do not believe in a form of transcendence, but they have not become metascientists, confining themselves to a reflection on general scientific postulates. The reflections of these thinkers are interesting and shed light in different ways on the results of reflection. Their writings can thus serve as an introduction to what must be taken for granted to practice science and metascience.

It should be noted in passing that it is common to associate critical thinking with philosophy. Yet anything that is interesting in critical thinking is not philosophy. For example, learning to identify fallacies is not a matter of philosophy, but rather of argumentation theory. Although the establishment of critical thinking courses was initially a departmental strategy to attract new clients, the fact remains that those who have specialized in critical thinking are no longer true philosophers. The fact that you are professionally a philosopher does not mean that you are intellectually a philosopher.

In general, Bunge avoids philosophical pitfalls and goes beyond this work of reflection in order to propose metascientific theories, i.e. ontology, semantics, epistemology and a methodology of factual sciences. These theories are not used to defend the general assumptions adopted by Bunge, since these assumptions, these elementary positions, are taken for granted by himself. Rather, Bunge's theories are based on these elementary positions, as well as the theories of science, which means that he can rule out many philosophical pseudo-problems and can solve many conceptual or metascientific problems. Whether all of the general assumptions presented above are not exhaustive or that some of them are being debated should

not be an excuse to adopt any philosophical transcendence. Bunge's approach is correct.

2.2] Contribution of Philosophy to Metascience

Bunge was forced to assimilate much of the philosophical doctrines because before him metascience did not exist, or the little that existed was buried under mountains of philosophical ideas. But why have philosophers been able to produce some interesting results? Philosophical doctrines are the only ones among the transcendent general discourses to offer answers to general questions which do not appeal to a notion of entities which would enter into communication with us. This means that philosophers often ask relevant questions. Let us not forget, philosophy is addressed to intellectuals who postulate principles transcendent to matter, but without being able to eliminate matter; matter is therefore associated with appearances, in ways that differ from one doctrine to another. Philosophers do not seek Communion, but Comprehension, which is perhaps a form of intellectual Communion. They search beyond matter and in spite of science, but this search takes the form of an apprehension of Being using their *own* Faculties. Most mystics and religious claims to be in communion or in communication with spiritual entities. They would not dare to say that it is by their own means that they reach Knowledge. This is not the attitude of a philosopher, who thinks he can attain Knowledge through the faculties he possesses in his own right. This characteristic of philosophy justifies talking about a metascientific revolution in ancient Greece, although at that time, science, metascience and philosophy were not well distinguished. Thus, as early as Antiquity, thinkers advanced interesting metascientific notions. Then, in the modern era, science gradually separated from philosophy. It remained to separate metascience from philosophy, which took a few more centuries, until the appropriate conditions were put in place and a thinker of Bunge's stature took advantage of it. Thus, to fully understand the history of the general thought, it is necessary to separate, among philosophers, their logical, mathematical, scientific and metascientific contributions from their philosophical doctrines.

Philosophers often raise judicious questions, but almost always put forward answers which appeal to principles foreign to matter. Philosophers, especially transcendent philosophers, seek too far. A recovery work patiently undertaken by Bunge was then necessary.

An example of recovery is Bunge's integration of Russell's definite description concept into his semantic theory (see Bunge 1971, 1974b, chap. 9, sect. 3). Once this recovery work is completed, it will no longer be necessary for metascientists to refer to philosophers except for historical reasons, that is to say for the history of meta-science. It would no longer be necessary to use any "isms" since metasciences will then form a unified disciplinary field in the same way as factual and formal sciences form unified disciplinary fields⁶. "Isms" are necessary where doctrines exist, and doctrines proliferate where there are no objects, problems and methods in common, and there can be no objects, problems and methods in common where a thought confuses reality with fiction.

Thus, metascience does not reject the contributions that some philosophers may have made to the advancement of knowledge. It is preferable, however, to recover these contributions under the name of a general discourse distinct in its approach to those of philosophical discourses. Despite our attachment to philosophy, despite our affection for the very word philosophy, it would be unreasonable to use an overloaded expression, an expression that refers to a transcendent general discourse, a discourse that is not able to account for the world and science. In other words, the term "philosophy" is unrecoverable. The use of another word is not only necessary because the approach of metascience is different from the philosophical approach, but it will also allow minds attracted by general reflections, really eager to know this world, which can be confused by the multitude of philosophical systems as well as by the captivating arguments of philosophers, to distinguish metascience from philosophy. One should not be impressed by the quibbles of transcendent philosophy. We must not engage in debates with analytic scholastics or with the continental cabal.

The use of the term "metascience" is therefore not innocent. It is not simply a question of replacing one term with another, but of

⁶ In *Emergence and Convergence*, Bunge characterizes the unity of the factual sciences in the following way: "By definition, all of the factual sciences study facts, whether actual or really possible. And all of them, even the social sciences, are expected to study them in a scientific manner, that is, in accordance with the scientific method rather than by navel contemplation, crystal ball gazing, trial and error, or discourse analysis. That is, beneath appearances, the sciences are ontologically and methodologically one: all of them study putatively real things and their changes, in a distinctive manner that is quite different from the way theologians, literary critics, shamans, or even craftsmen proceed." (2003a, p. 270).

changing the approach as to how to construct a general discourse about the world. In philosophical jargon, metascience is realism and materialism, although these “isms” no longer have their *raison d'être* once one refuses any form of transcendence and one refuses to enter into a game whose rules were established by a thought in search of transcendence and whose criteria are foreign to science and metascience. Because of its transcendent nature, philosophy cannot be a judge of science or metascience, or even collaborate with them.

2.3] Characterization of Metascience

Since the beginning of the 20th century, the term “metascience” has been used sporadically in ways quite close to each other, but without separating metascience from philosophy⁷. For our part, we will use it to designate both a general discourse on the world and a general discourse on science, the two discourses complementing each other. In order to name the metascientific disciplines, we use the names of some philosophical disciplines. Thus, we welcome within metascience semantics, ontology, epistemology and methodology. Note that these disciplines do not play exactly the same role within metascience. While semantics, epistemology and methodology study science in order to produce semantic, epistemological and methodological theories on it, and thereby a general discourse on science, ontology, meanwhile, aims to produce ontological theories about the world, that is to say a general discourse in the world, based on scientific results (Kirschenmann 1982, p. 94). Although distinct, these four disciplines influence each other.

⁷ For a characterization of metascience by Bunge, see the first chapter of *Metascientific Queries* (1959b). In addition to this work, Bunge uses the expressions “metascience” and “metascientific” essentially in six other texts: “Laws of Physical Laws” (1961a), “The Weight of Simplicity in the Construction and Assaying of Scientific Theories” (1961b), *Method, Model and Matter* (1973a), *Philosophy of Science I: From Problem to Theory* (1998a), *Philosophy of Science II: From Explanation to Justification* (1998b), *Causality and Modern Science* (2009a). In his autobiography, *Between Two Worlds* (2016, p. 102), Bunge tells us that he supported the thesis of the identification of philosophy with metascience in “¿ Qué es la epistemología? ” (Minerva 1, 1944, pp. 27–43), but then realized that science supports a number of postulates and thus scientists cannot avoid philosophizing. From our point of view, scientists who take the trouble to think in general terms do not philosophize. To philosophize, you have to adopt a philosophical method, while the act of thinking does not require any particular method. Descartes had clearly seen the difference between reflection, or reason, and method (unfortunately, his method is philosophical rather than metascientific). This is one of the central points of our text.

The primary interest of metasciences is the development of a general discourse on the world, an ontology, but this cannot do without a general discourse on science since science is our main tool of knowledge. Thus, if we wish to discuss properties in general, an ontological concept, it would be wise to observe and then to theorize how properties are conceived by the sciences. In other words, our conceptualization of the general concept of property must be compatible with the way in which the most advanced sciences conceptualize the multitude of properties with which they are confronted. In return, this general conceptualization of properties, which is then intended to be more precise, clearer, can be used for different purposes. This conceptualization can lead scientists, especially those from the least advanced or most difficult disciplines to study, to reconsider their own notion of property, which in turn will make it possible to further refine the general notion. The general discourse which is then constructed, the metascientific vocabulary which is thus developed, can thus serve as a common discourse for the scientists themselves, but can also be used for teaching science and popularizing science. Note that it is not a question of proposing a universal language for communication as it was proposed for the ido, nor a technical language to express scientific theories, since in the latter case mathematics already play this role. It is about building a general representation of science, using semantic and epistemological theories, as well as a general representation of the physical, chemical, biological, psychological and social world, using ontological theories.

The term metascience thus seems appropriate to describe these disciplines that analyze scientific production, such as scientific concepts, propositions and theories, in order to produce analyses and syntheses, using metascientific concepts, propositions and theories. Metasciences are conceptual sciences in that they study constructions of the mind, more precisely scientific productions, and produce constructs that are neither formal nor factual, that is, constructs that do not fall within the purview of formal sciences or factual sciences⁸. An important consequence of the above is that there would

⁸ It should be noted that formal sciences also study concepts of a particular nature, that is, formal concepts and not factual concepts, i.e. concepts produced by the factual sciences. The formal sciences study formal concepts on two levels: object language and metalanguage. There is thus logic and metalogics, and mathematics and metamathematics. The factual sciences, on the other hand, study concrete objects,

be at least three concepts of truth: formal truth, factual truth and conceptual truth⁹. Thus, with each scientific discourse would correspond a concept of truth.

The prefix *meta-* can evoke, depending on the discipline, an idea of transcendence, of higher level, of a goal, an idea of cause, of change, of displacement, or even of reflexive self-reference. It also expresses an idea of posterity, change, transformation, as well as an idea of proximity and resemblance. We exclude the idea of transcendence as well as that of superiority to characterize metascience. We prefer the idea that *meta-* evokes reflection, a reflection on science, but also that it refers to the idea that *metascience* is *with-science*.

2.4] Classification of Metascience

In order to continue our characterization of metasciences, we propose a preliminary classification of these. It is experience that will ultimately dictate the division of the metasciences, in the same way that experience dictates the division of the sciences.

We have already mentioned four metascientific disciplines: ontology, semantics, epistemology and methodology. In fact, we distinguish between general ontology, semantics, epistemology and methodology, and particular ontology, semantics, epistemology and methodology, the two kinds associated with each of the four major scientific fields of physics, chemistry, biology and *psychonology*¹⁰. So there are general metasciences and specific metasciences.

but produce concepts to do so. Since logic and mathematics already have their own metascience or general discourse, i.e. metalogics and metamathematics, we allow ourselves to restrict the application of the expressions *metascience* and *conceptual sciences* to factual sciences.

⁹ Bunge proposes four concepts of truth in Chapter 8, section 1.3 of *Semantics II: Interpretation and Truth* (1974b): logical, mathematical, factual and philosophical truth. In the case of factual sciences, he advances the notion of *partial truth*. The partial truth is dealt with by Bunge on several occasions: *The Myth of Simplicity* (1963, chap. 8), *Semantics II: Interpretation and Truth* (1974b, chap. 8), *Epistemology II: Understanding the World* (1983c, appendix 3), *Emergence and Convergence* (2003a, chap. 15, sect. 3), *Matter and Mind* (2010, chap. 15), “The Correspondence Theory of Truth” (2012b). See also the treatment by Jean-Pierre Marquis (1990, 1991, 1992) and in this issue, “Vérité partielle et réalisme scientifique”.

¹⁰ In order to avoid using the expressions “psychology” and “metapsychology”, concepts already loaded with multiple meanings, we formed these neologisms, *psychonological* and *psychonology*, on the basis of *psychon*, to designate this level of

At the most general level of particular metasciences, we find *metaphysics*, *metachemistry*, *metabiology* and *metapsychology*. Note that we give a limited meaning to metaphysics: metaphysics is the *metascience of physics*. The metaphysician is then a physicist who conceptually studies physics in its semantic, epistemological, methodological and ontological aspects in order to obtain metascientific results and ideally producing metascientific theories. These four particular metasciences, metaphysics, metachemistry, metabiology and metapsychology are said to be integrative because they are linked to the four integrative levels of organization of reality: the physical, the chemical, the biological and the psychological. Note that scientists have divided their four main disciplinary fields according to the four levels of organization of matter¹¹. This is no coincidence since the properties studied at each level of organization cannot be reduced to the properties of the other levels¹².

We must dwell for a moment on the notion of level since the notion is important in itself for the classification of the metasciences, but also because we present a conception of levels slightly different from that which Bunge usually advances. Since he started thinking about the concept of level over sixty years ago, Bunge has conceptualized levels of reality slightly differently from one era to the next. In fact, what seems to be constant in Bunge is to admit the existence of physical, chemical and biological levels. Things get a little less clear after the biological level. Very often Bunge postulates a social level after the biological level, sometimes this social level is preceded by a psychological level, but this psychological level is often a sub-level of the biological level. Sometimes a technical and semiotic level is added¹³. Bunge also maintains that each *integrative* level can be analyzed in as many sub-levels as necessary, micro, meso,

organization that is the *thinking matter* and all the disciplines that are interested in it.

¹¹ There are still debates about the nature and the number of levels. We adopt in this text a conception of the organization of matter in four levels.

¹² See Bunge (1959a) for a discussion of the imperfect correspondence between ontic and epistemic levels.

¹³ For some representations of levels in Bunge, see, in particular, “Levels: A Semantical Preliminary” (1960, sect. 9), “Emergence and the Mind” (1977b, p. 504), *Ontology II: A World of Systems* (1979a, p. 46), *Épistémologie* (1983a, chap. 7, sect. 4), *Matérialisme et humanisme* (2004, sect. 3.13 et 4.3), *Le matérialisme scientifique* (2008, chap. 2, sect. 6), *Matter and Mind* (2010, sect. 5.8), *Evaluating Philosophies* (2012a, sect. 18.3).

macro, mega, etc.¹⁴, which we call *integrated* levels. For example, physics can be subdivided into microphysics, mesophysics, macrophysics and megaphysics. We believe that psychological and social levels are part of this last pattern.

Within the framework of the concept of metascience defended here, *psychonology* covers the whole of disciplines grouped under the human sciences, social sciences, psychology and neurosciences, in the same way as physics, chemistry and biology embrace all disciplines that deal respectively with physical, chemical or biological systems. In other words, psychonology is concerned with human in what distinguishes it from the three other levels of organization of matter. More precisely, psychonology is interested in *thinking matter*, in the same way as physics, chemistry and biology are interested respectively in physical, chemical and living matter. This thinking matter has systemic or emerging properties, such as the faculties of reasoning, thinking, abstracting, socializing, setting standards, making plans, and many others, whose physical, chemical or biological matters are not endowed. Thinking matter is conceived as matter in its own right. We are organisms, biological beings, within which a *non-physical, non-chemical* and *non-living* matter develops: psychological, mental or thinking matter. The elemental neural unit of thinking matter is called *psychon* by Bunge. It is the smallest unit able to perform a mental function (see in this regard, Bunge 1979a, chap. 4, sect. 1.2, 1980, chap. 2, sect. 2, 1983b, chap. 1, sect. 1.1). These objects or systems are no longer living matter. Analogy: the cell is not a chemical reactor.

Although the idea of thinking matter has been in the air for several decades, it is not easy to accept. There is a very noble ideological reason which exerts undue pressure to the point of preventing even some scientists from exercising a critical reflection on the question: human beings would not be apart from the animal kingdom! However, our ancestors correctly perceived the unique nature of human beings in the same way that they correctly perceived the unique nature of life. The incorrect interpretations they may have formulated of human nature (and also of the nature of the non-

¹⁴ On the concepts of micro-, meso-, macro-level, etc., see “The Power and Limits of Reduction” (1991, sect. 3), *Finding Philosophy in Social Science* (1996, chap. 10, sect. 5), *Emergence and Convergence* (2003a, chap. 9, sect. 2), *Matter and Mind* (2010, sect. 5.8).

living and the living), particularly in terms of superiority, illustrated by the notion of *scala naturæ*, or the Great Chain of Being, must not be a hindrance to the acceptance of the idea of thinking matter.

Animal romanticism and the fear of making the same mistakes as our predecessors do not mix well with critical thinking. The idea that humans are no longer animals is not in itself a theological idea. The prowess of “higher animals”, as wonderful as it may seem to us as lovers of nature, has nothing in common with those of thinking matter. This amounts to saying that the animal brain is not endowed with psychons. In other words, the so-called superior animals do not think. The “mental” functions that we attribute to them would be advanced biological functions. It is not these functions that would distinguish thinking matter from biological matter. Or these functions would be necessary for the appearance of thinking matter but not sufficient. Does this make humans external to nature? No, since thinking matter is anchored in living matter, the latter is anchored in chemical matter, and the latter is anchored in physical matter. The idea of thinking matter will not instantly resolve psychonological problems. Like any general hypothesis resulting from a reflection on the concrete world, it should help to steer minds towards relevant questions.

We now advance the idea that the social is not an integrative level, but rather a level integrated into the psychonological. Let us take the biological as an analogy. Let's also take two extremes of this level of organization, the living cell, the basis of living matter, and an ecosystem. According to the notion of integrated levels, we say that the study of cells is a matter of cytology, the micro level, and the study of ecosystems is a matter of ecology, the macro level. It is clear that it is not the ecosystems which metabolize but cells. However, scientists still include ecosystems in the biological or the study of ecosystems is part of the biological sciences, with the contribution of other disciplines if necessary. Likewise, we believe that societies, although they do not think, should be included in the psychonological, the basic unit of which is the psychon, the micro level, which “thinks” or performs a mental function. In other words, the study of societies is part of the psychonological sciences. Thus, the social is a macro level integrated at the integrative level which is

the psychonological. We therefore propose a representation of levels of reality as illustrated in **Figure 2**¹⁵.

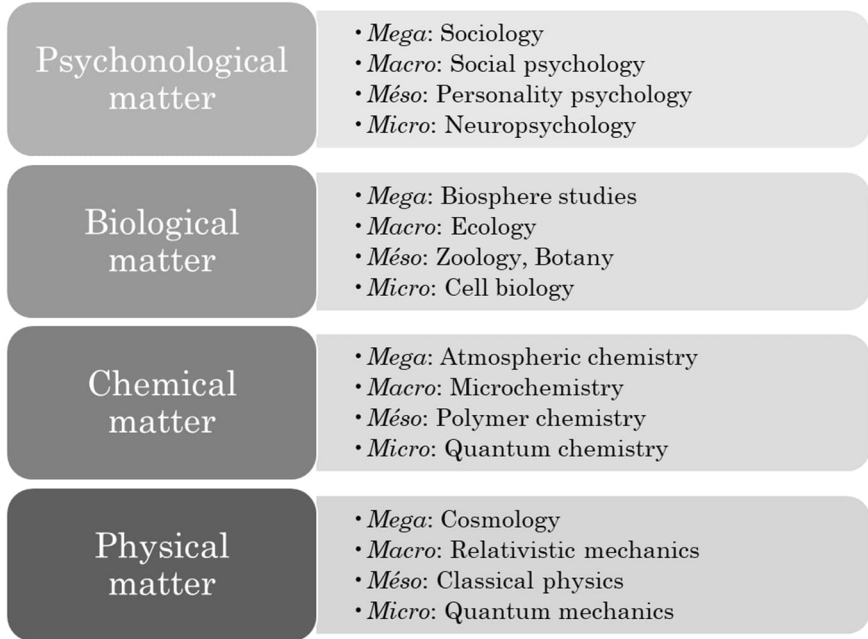


Figure 2: Representation of ontological levels
Disciplines are indicated for illustrative purposes.

In any event, all of the above is analogy, informed, we hope. It is scientific advances in neuropsychology, and an in-depth knowledge of them, that will inform us and inform metascientific research. In the meantime, we can think about the problem by studying the question of the reducibility of chemistry to physics and that of biology to chemistry (see Bunge 1973a, 1979b, 1982).

To summarize the above discussion, we propose this preliminary classification of metasciences. There are four disciplines in their most general conception: 1. general semantics, 2. general epistemology, 3. general methodology, 4. general ontology. So there is a general metascience. Then there are the same four disciplines, but associated with the four main disciplinary fields of physics, chemistry, biology and psychonology. So there is the semantics, the epistemology, the methodology and the ontology of physics, chemistry, biology

¹⁵ We have not included a technical and semiotic level, concepts advanced by Bunge, since our reflection on the relevance of these levels is not yet finished.

and psychology, which gives the following four integrative meta-sciences: 1. metaphysics, 2. metachemistry, 3. metabiology, 4. metapsychology.

Thus, general metasciences are fed by four *specific metasciences*, which are fed by the four main disciplinary fields of the factual sciences: physics, chemistry, biochemistry and psychology. More specifically, if you specialize in a scientific discipline, for example sociology, which is part of psychology, we will then speak of *metasociology* or *metascience of sociology*, an integrated and not an integrative metascience, and you will invest yourself in research on semantics, epistemology, methodology and ontology of sociology in order to ideally produce metasociological theories, that is to say a general discourse on sociology (semantics, epistemology and methodology) as well as a general discourse on the social world (ontology). **Figure 3** shows schematically the links between the factual sciences and the conceptual sciences.

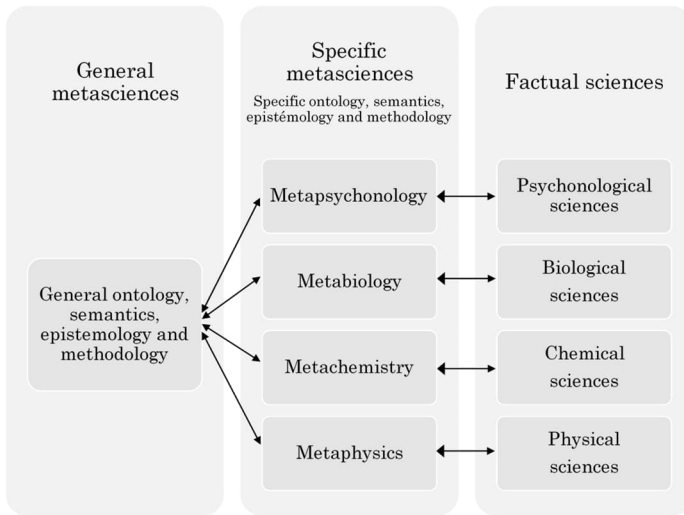


Figure 3: Links of influence between the conceptual and the factual sciences
The arrows indicate the direction of influence. For a double arrow, a larger tip indicates a stronger influence. In order not to burden the figure, we have omitted the arrows of “vertical relations”: the particular metasciences are all linked together by reciprocal relationships two by two, while the major disciplinary fields of factual sciences are linked together by one-sided relationships that range from the physical sciences to the psychological sciences.

The diagram is designed from the point of view of metascience. There is no link of superiority implied by placing the metasciences on the left. Note that the disciplines of the particular metasciences

and those of the factual sciences in **Figure 3** do not have the same kinds of relationships with each other. While there is a dependence of nature that unites the factual sciences, this dependence is circumstantial in the case of metasciences. Thus, any metascience can influence any other metascience, which is not the case with the factual sciences. Constructs of psychological sciences have no influence on constructs of physical, chemical and biological sciences, while some constructs of physical, chemical and biological sciences have influence on psychological sciences. Ontologically, nomic relationships, i.e. laws, of a level are constrained by the nomic relationships of the levels that precede it, which requires that statements that describe the nomic relationships of a given level be consistent with statements that describe the nomic relationships of the levels preceding it. On the other hand, psychological sciences can have an influence on the teaching of science and on the creativity of scientists, but the constructs of the other three major disciplinary fields do not contain any constructs from psychological sciences.

Let us take note of the almost complete absence of the concept of threshold in philosophy, linked to the concept of emergence. However, threshold phenomena are well known to the factual sciences. Just think of the phase transitions in physics. Any specialist, be it in physics, chemistry, biology or psychology, can name dozens of examples of threshold phenomena that give rise to the emergence or submergence of properties. In other words, a critical reflection, once exposed to examples of thresholds and to the radical transformations that physical, chemical, biological and psychological matter undergo at certain thresholds, leads us to conclude that reality is organized into levels. The refusal to admit the phenomena of threshold, emergence and qualitative leaps, as well as the notion of level, is linked to the transcendent nature of philosophy. A transcendent philosophical mind cannot be satisfied with a scientific explanation of these phenomena. There would be a “philosophical” explanation, an answer to *a why* and not only to *a how*, and this explanation should expose a necessary philosophical connection, other than a necessary link inherent in matter. However, there is no *explanation* for the fact that objects exhibit a particular property. The question, “Why this property rather than another?” is a particular case of the question, “Why something rather than nothing?” And this last question is a theological question, as Bunge points out, or more generally a transcendent question. For philosophers, science

offers no explanation because it cannot say why the world is what it is and not something else.

Finally, the term “level” is unfortunate but it is consecrated. It leads us to think that there is a hierarchical order. The only order that characterizes the level structure is that of precedence, “Level 1 precedes level 2”, i.e. a level precedes another level if and only if all objects in the second level are composed of objects from the first level (i.e. objects that have the characteristic properties of the first level). The expression also suggests that reality is made up of homogeneous layers. But as Bunge points out, levels are constructs and not concrete objects, that is, we group with the mind all physical, chemical, biological and psychological objects into distinct sets¹⁶. In fact, objects in all four levels interact and interpenetrate. Hence the complexity of reality and the difficulty of studying it.

2.5] Non-Metascientific Disciplines

We said that any transcendent general discourse can reduce any other discourse to its own frames of thought. Metascience, as an immanent general discourse, does not purport to replace the general discourse of connivance or living-together, consisting of axiology, ethics and praxeology, even if the latter can use scientific and metascientific results in the context of their reflections. Thus, there is no metascientific axiology, ethics and praxeology as there can be axiology, ethics and praxeology in philosophy¹⁷. Metascience is therefore radically different from transcendent general discourses since it does not attempt to find a link that would unite natural laws with human laws. Human laws are conventions while natural laws are representations of natural regularities that exist objectively, independently of us. No law of nature prevents us from adopting anti-social conventions. In fact, all societies of all times have condoned barbaric practices, and any establishments have always

¹⁶ For the notions of level and precedence, see Bunge (1979a, chap. 1, sect. 1.5).

¹⁷ Volume 8 of Bunge’s *Treatise on Basic Philosophy, Ethics: The Good and the Right*, is an arbitrary addition. There is no necessary connection between Bunge’s ethics and his metascientific theories. The author of the *Treatise* was reasonable enough not to attempt to make such connections. There is a tension in Bunge’s work between his desire to know the world and make a representation of it based on science and his desire to be part of the philosophical tradition and to be recognized as a professional philosopher. It was this same tension that made him abandon the use of the expressions *metascience* and *metascientific* after the 1970s in favor of the expressions *philosophy of science* or *foundations of science*.

maintained, explicitly or implicitly, a double morality, one that applies to them and another that applies to us. Metascience is therefore not concerned with the living-together. That said, Mario Bunge's contribution to the general discourse of connivance is just as exceptional as his contribution to the scientific general discourse.

Unlike transcendent philosophies, metasciences do not attempt to advance "interpretations" of formal sciences. There are already *formal metasciences* that deal with logic and mathematics: meta-logic and metamathematics. Although independent of the conceptual sciences and the factual sciences, the formal sciences play a considerable role in the development of knowledge. The neutrality of the formal sciences, the fact that they say nothing about the concrete world, which is the responsibility of the factual sciences, and that they say nothing about the world in general and the factual sciences that study the world, which is the responsibility of the conceptual sciences, allows us to have a rigorous common language. Formal sciences are a subject of study for logicians and mathematicians and a tool, an organon, for scientists and metascientists¹⁸. Note that metascience is a subject of study for metascientists and an organon for factual science, and the latter is a subject of study for scientists and an organon for any endeavor that requires scientific results to succeed. The scientific triad made up of formal, factual and conceptual sciences is a subsystem of the *system of human knowledge* as conceptualized by Bunge (1983c, chap. 14, sect. 3.1). It is the *system of scientific knowledge*. **Figure 4** shows schematically the links of dependence or influence within the triad.

¹⁸ For examples of formalization of metascientific theories see the first four volumes of the *Treatise on Basic Philosophy*. Pay particular attention to the fact that Bunge uses general mathematics to formalize his concepts and theories. He makes extensive use of set theory, but also group theory. These general theories can be applied in the same way that geometry, algebra and analysis can be applied. This is to say that Bunge associates *metascientific* semantic postulates with his formalism, just as factual sciences associate *factual* semantic assumptions with their formalisms. In other words, Bunge's formalism refers to extra-logical or extra-mathematical objects, the concepts of factual science, objects that Bunge has set himself to study, in the same way that the formalisms of factual sciences refer to extra-logical or extra-mathematical objects, objects of the world, objects that science has given itself to study.

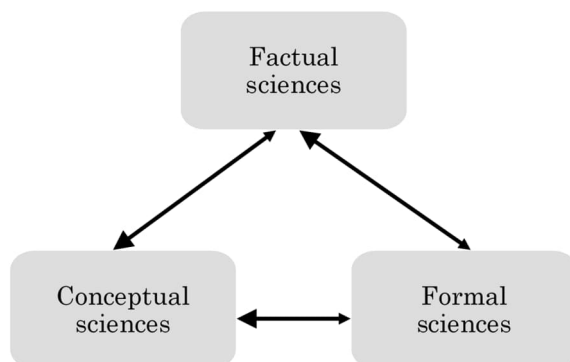


Figure 4: *Links of influence within the scientific triad*
The arrows indicate the direction of influence.
For a double arrow, a larger tip indicates
a stronger influence.

Another discipline which is not a metascience, but which is of great importance for his development, is the history of science. Bunge points out that this is a large laboratory for the metasciences (Bunge 2003a, p. 173). Another laboratory is the critical analysis of academic pseudosciences, such as psychoanalysis, neoclassical economic theory, game theory, decision theory, rational choice theory, ethnomethodology, etc. The application of metascientific concepts and theories should make it easier to identify such pseudosciences. We also mentioned that a major task awaiting metascientists for years to come is the operation of recovering philosophical concepts with metascientific value. Such texts of critical analysis of philosophy can be an opportunity to distinguish the metascientific approach from the philosophical approach.

Contrary to a practice that seems to be spreading, we exclude from metascience the sociology of science, the history of science, the philosophy of science and science studies. Sociology and history of science are not metasciences since they are factual sciences. In general, it does not occur to us to name *metaculture* or *metasociology of culture*, the sociology of culture, or, again, to name *meta-education* or *metapsychology of education*, the psychology of education. Being interested in culture or education does not make a discipline a metaculture or a meta-education. So why would being interested in science make history or sociology a metahistory or a metasociology? History and sociology of science study concrete facts in their historical and sociological contexts, and not the products of science

detached from these contexts. As far as transcendent doctrines in the philosophy of science are concerned, they can only confuse metascientific research and hinder the development of a scientific general discourse.

Be careful not to confuse *history of science* with *history and philosophy of science*. This last discipline treats the history of science from a philosophical point of view, and therefore, very often, in a transcendent way. A true history of science is practiced by historians who use historical methods, research methods specific to this factual discipline. Finally, “science studies” are part of a reactionary, irrationalist and anti-scientific social movement of intellectuals within universities. “Studies” form a heterogeneous set of ideologies and philosophies that passes for multidisciplinary and interdisciplinary. This cultural movement seeks to discredit scientific disciplines and replace them with “studies”. Intolerance towards this movement is essential since the search for truth is denigrated within the institutions that are tasked with advancing science (Bunge 1995).

2.6] A Metascientific Community

To escape the influence of transcendent philosophy is not easy if we are too attracted to general discourse, and not enough to factual science. In fact, even if we have a real desire to know the world and even though we believe that science is the best way to achieve it, it remains difficult to detach ourselves from philosophy since it is the only example of general discourse that presents itself to us.

Unfortunately, being a scientist and immersing yourself in Bunge’s metascientific spirit will not be enough at this stage of metascience development. It cannot be assumed that Bunge recovered everything that needed to be recovered or that he had properly recovered everything that he himself had recovered. It is the nature of scientific research to constantly revise its concepts and theories. Nevertheless, you will have to familiarize yourself with philosophy. If you are already a philosopher, professional or not, you already know philosophy. If you are also a teacher or professor-researcher in philosophy, you can desert transcendent philosophical sects and become a masked metascientist within departments of philosophy. In any case, all you have to do is become a scientist and develop your metascientific mind.

If you are a scientist with a penchant for generalizations, interested in general questions about the world and science, reading Bunge's work will help you develop your critical thinking and metascientific spirit, but you will be still forced to read a good number of philosophical texts, if only to follow Bunge's thought, who, as the first metascientist, refers to many philosophers as well as many philosophical doctrines. There is no ideal course for a student who would like to become a metascientist. The only advice we can offer at this point is that of reading scientific realists and Bunge's work while learning philosophy, but also studying a science. And that of keeping both feet on the ground ... on this Earth.

What are the safeguards for the metascientist? What can keep him with both feet on the ground? Factual and formal sciences have equipped themselves to prevent unbridled speculation from hindering their development. This does not prevent pseudoscientific theories being developed or even that academic pseudosciences are developing in a remarkable way. However, in general, the whole thing is kept under control within the physical, chemical and biological sciences. It is only in the psychonological sciences, for which there is also a lot of serious research, that literate charlatans can still prosper. Do we have a set of criteria in metascience that would avoid the wildest speculation? We think so. We mentioned that all the doctrines supported by Bunge ensure that his thinking is no longer philosophical. It is therefore enough to support a set of similar points of view to avoid slipping too often. In other words, we take as our starting point the general postulates mentioned before, which are taken for granted by science and now by metascience. Without these restrictions, the scientific general discourse will never reach sufficient unity of thought; the plethora of philosophical doctrines is not a mark of open-mindedness. Even if the list of general postulates will never be exhaustive, even if certain general postulates are problematic and subject to debate, there is no need to question the existence of reality or to believe that you are the only spirit to exist!

Of all the general postulates necessary for metascientific research, the most important is the *reality/fiction dichotomy*, which involves other dichotomies: factual/formal, thing/construct, property/attribute, etc. If you fail to convince yourself that constructs of the mind do not muddle with concrete objects, it is unlikely that you will be able to advance any metascientific research. In science, even

if a researcher maintains many beliefs, he will still undertake his research according to scientific criteria. Unlike science, metascience requires the researcher to have a clear and distinct idea of reality and constructs. The reality/fiction dichotomy is not only a necessary safeguard for metascientific research, but it also constitutes a criterion of demarcation between metascience and transcendent philosophy. Any idea which implies a confusion between reality and fiction, between the factual and the formal, a thing and its construct, a property and its attribute, must be classified among the transcendent philosophical ideas and be rejected for this reason.

Even the good faith reader might be tempted to think that it is risky to categorically exclude some philosophical ideas. Doesn't history show that ideas rejected at one time were accepted in later times, both in the factual and formal sciences? As long as a concept is factual or formal, there is a possibility that it is right; it must pass the tests and meet the evaluation criteria of science. This does not apply to the strictly philosophical concepts, which presuppose a form of transcendence. As soon as there is reification or ideaefication, there is transcendence¹⁹. More precisely, as soon as an ontological, epistemological and semantic quality is attached to a "logic", there is reification and therefore transcendence. There will never be anything good to draw from conceptions that postulate the existence of fiction, as Laplace argued before Napoleon I according to an anecdote reported by Victor Hugo (1972):

Mr. Arago had a favorite anecdote. When Laplace published his *Celestial Mechanics*, he said, the emperor [Napoleon I] brought him in. The emperor was furious. "How," he cried, seeing Laplace, "makes you the whole system of the world, you give the laws of all creation, and in all your book you do not speak once about the

¹⁹ We find the following definitions in Bunge's *Philosophical Dictionary*: **Reification**: The treatment of a property, relation, process, or idea as if it were a thing. Example: "I have worries" instead of "I am worried"; the popular notions of energy, mind, justice, and beauty as entities; the ideas that language (rather than a speaker) is creative and grows in the mind; and the theses that biospecies are individuals, and that lineages are historical entities. **Ideaefication**: The construal of concrete things or processes as ideas, in the manner of Plato and Hegel. Contemporary examples: the identification of a solid body with the set representing it; of a basket of goods with the vector representing it; and of a social mechanism with a theoretical model of it.

existence of God!” “Sire,” replied Laplace, “I did not need this assumption.”

We can therefore reject without further ado all transcendent philosophical concepts without fear of missing out on history or of remaining in the annals like the one who has not been able to appreciate an idea at its true value.

2.7] Bunge as the Alternative

From the point of view of metascience, Bunge is the last of the philosophers and the first metascientist. He retains from philosophy the idea of a complete system that would integrate semantics, ontology, epistemology, ethics, axiology and praxeology, but he refuses to problematize in the same way as philosophy. In particular, he rejects the appearance/reality dichotomy, fundamental to transcendent philosophers. Since Bunge is the first true metascientist, it is therefore wise to take his work as a starting point. This starting point must remain what it is, a starting point. The research program we are proposing is not free of pitfalls. The biggest trap that awaits us is that of indulging in intellectual laziness and indulging in a futile exegetical exercise. Yes, we must immerse ourselves in Bunge’s work, just as physicists have imbued themselves with the works of Kepler, Galileo or Newton, and yes we must assimilate the way of thinking of this thinker, which is none other than the way that scientists think, but, no, we must never debate what the master really said. The aim is not to develop a school of thought, but rather to develop a representation of the world in accordance with science. Bunge’s work should not be seen as a system of thought to be preserved, but rather to be surpassed.

What is most important in this work is not the results, although it was a feat of having produced them, but the way of thinking that led to them. The exercise is not easy since general discourses tend to split into separate schools of thought. One of the objectives of *Metascience* is to promote the development of metasciences in a unified framework. In fact, the future of metascience rests on the usefulness of metascientific results for the sciences, and this usefulness has not been proved. So far, scientists have managed to solve their problems with some implicit preconceptions while submitting themselves to the standards, criteria and methods of science. In any case, we must never lose sight of the fact that we want to know the world,

the natural world, the concrete world, the material world, the worldly world. This future also depends on our ability to develop a community of researchers who agree on the objects of study of metascience, on relevant and acceptable problems, on the methods for studying them and on the criteria for evaluating metascientific results.

Just as the scientific approach is one, but made up of a multitude of methods, the metascientific approach should be one, but made up of a plurality of methods. We are Bungeans as we are Galileans.

Acknowledgements

I thank Matias Valazquez for his comments on the first draft of this article. I thank Isabelle Martineau for her comments, suggestions and countless discussions throughout the project; many ideas would not have emerged without these discussions. I also thank Marc Silberstein for the trust he has placed in me to carry out this editorial project; my situation on the margins of the institutions did not frighten him. Finally, I thank all programmers, especially those who offer free and quality software, without which the intellectual work would be much heavier; these tools make up for the lack of resources of an independent researcher.

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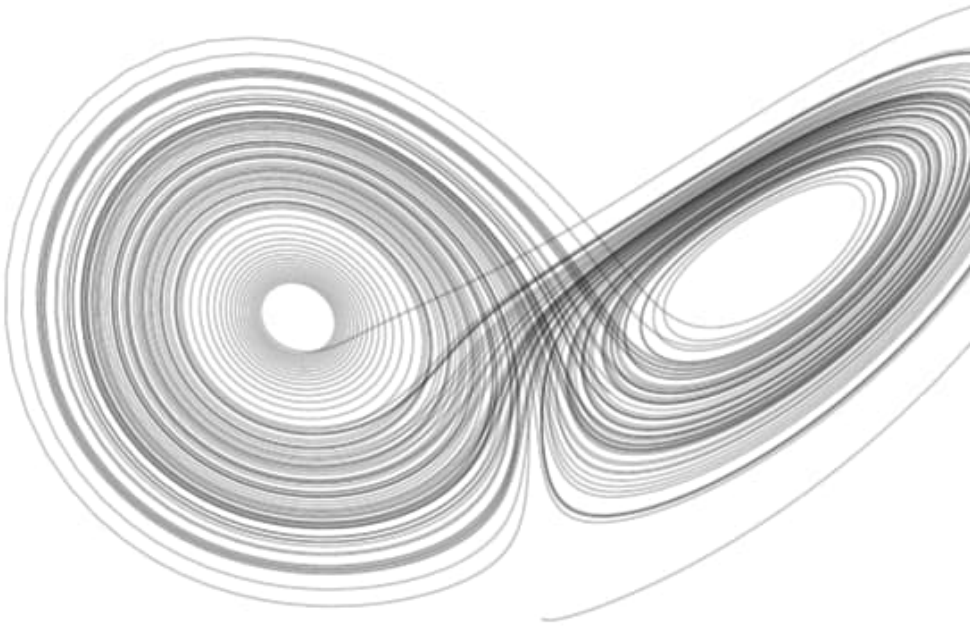
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2
**Applications or Extensions of
Bungean Thought**



On the Kinds of Problems Tackled by Science, Technology, and Professions: Building Foundations of Science Policy

Luis Marone¹

Abstract — Science, technology, and professions form a system with strong interactions. Yet, these activities attack different kinds of problems which require different kinds of solutions. The problems that trigger scientific and technological research remain insufficiently solved or unsolved, therefore their possible solutions must be invented (i.e. they are partially or totally original) and, consequently, they should be tested against reality by researchers before considering them as true or useful. On the contrary, the problems that trigger professional inquiry are already solved, or have at least some partial solution at hand that is available in the form of a technical protocol. This solution is applied with caution but without testing (i.e. the professional assumes that the solution works because it was already challenged by researchers). Moreover, science and technology tackle unsolved inverse problems, which allow the radical advancement of knowledge, and genuine innovation. A science policy based on a clear distinction between creative and routine activities (i.e. a creatively friendly policy) offers an opportunity for societies to reach value-added innovative economic and integral development.

Résumé — La science, la technologie et les professions forment un système de fortes interactions. Pourtant, ces activités s'attaquent à différents types de problèmes qui nécessitent différentes solutions. Les problèmes qui aiguillonnent la recherche

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scientifique et technologique demeurent insuffisamment résolus ou non résolus, donc leurs possibles solutions doivent être inventées (c.-à-d. qu'elles sont partiellement ou totalement originales) et, par conséquent, elles doivent être testées contre la réalité par les chercheurs avant de les considérer comme vraies ou utiles. Par contre, les problèmes qui aiguillonnent une investigation professionnelle sont déjà résolus ou une solution partielle est disponible sous la forme d'un protocole technique. Cette solution est appliquée avec prudence sans être testée (c'est-à-dire que le professionnel suppose que la solution fonctionne parce qu'elle a déjà été mise à l'épreuve par les chercheurs). De plus, la science et la technologie s'attaquent à des problèmes inverses non résolus, ce qui permet l'avancement radical des connaissances par de véritables innovations. Une politique scientifique fondée sur une distinction claire entre les activités créatives et les activités routinières (c.-à-d. une politique respectueuse de la créativité) offre à la société la possibilité d'un développement économique et intégral à valeur ajoutée.

Those who design or put into practice scientific or technological policies must face the dilemma of discriminating scientific research correctly from its various related activities². Although it seems a truism, failing to distinguish genuine scientific research from technology or from solving practical problems by the direct application of well-established solutions may be an obstacle to reach knowledge-based integral society development³.

A first confusion is between basic science (i.e. the disinterested search for new scientific knowledge) and applied science (i.e. the search for new scientific knowledge of possible practical utilization)⁴. This mistake has some important implications. One of them is about scientists' rights to freely choose their research problems, which are more restricted in applied science⁵. Another implication is that whereas all outputs of basic research (i.e. both the provisional corroboration or refutation of ideas) are acceptable and useful in principle, the outputs of applied research that fail to corroborate a potentially applicable idea are "less useful" because they do not provide a technological *knob* to be further investigated and developed by technologists⁶. Consequently, the search for applied knowledge may impose some ethical dilemmas which are not

² Bunge, « Ciencia básica, ciencia aplicada y técnica », 1997.

³ *Ibid.*, Sábado, *Ensayos en campera*, 2004, Marone & González del Solar, « Imagenación e innovación », 2005, « El valor cultural de la ciencia y la tecnología », 2006, « Crítica, creatividad y rigor », 2007.

⁴ Bunge, *Dictionary of Philosophy*, 1999.

⁵ Bunge, *Doing Science*, 2017.

⁶ Marone, « Aportes de la ciencia básica a la cultura y la sociedad », 1994.

always attended: the pressure to obtain and publish potentially applicable results (i.e. those that show that a given treatment has an effect) may predispose researchers against the null hypotheses of their statistical tests⁷. Such pressure goes against objectivity and demotivates the careful corroboration of robustness of research findings before publication⁸.

Another confusion is between applied science and technology (i.e. the branch of knowledge concerned with designing new artefacts and action plans). Although modern technology is widely based on science (e.g. it is capable of being perfected with the help of scientific research), it should not be confused with applied science, since the latter is limited to seeking new knowledge with practical potential⁹. Implications of the mistake are the underestimation of the design phase and the economic constraints of genuine technological development. They are parts of the design of artefacts but not of applied science. Bunge evaluated some tunnel-viewed economicist “scientific” policies:

When science is privatised, the scientific project turns at best into a technological adventure, without regard for either morality or the public interest. For example, some private pharmaceutical companies have patented many of our genes, so that we no longer fully own ourselves. *And some universities are currently trying to shift their professors from papers to patents.* Fortunately, others are working against this trend, and towards a free-access policy. For example, the exemplary Montreal Neurological Institute and Hospital is refusing to patent any of the discoveries of their researchers¹⁰.

A scientific culture must emphasise intellectual enterprise and the finding of innovative ideas communicated by means of original papers, whereas a technological culture must promote practical thinking and the design of innovative artefacts. Despite these different goals, scientists often aspire to contribute basic information to technologists, and technologists read (and sometimes write) papers to find (or discuss with colleagues) some key pieces of

⁷ *Ibid.*

⁸ Baker & Penny, «Is There a Reproducibility Crisis?», 2016.

⁹ Bunge, *Dictionary of Philosophy*, 1999.

¹⁰ Bunge, *Doing Science*, 2017, p. 42 (the italics are mine).

knowledge (e.g. possible technological *knobs*) that could inspire the devise of efficient artefacts. (By the way, such artefacts may occasionally be used by scientists for designing and performing experiments.) Emphasis on papers or patents should then be balanced in a healthy science-technology system¹¹.

Finally, an often-disregarded confusion is between science and technology, and the practical enterprise of using knowledge and artefacts (often developed by researchers and engineers) to solve local problems¹², in other words, using *professional* capacity to solve problems as craftsmen or servicemen¹³. This mistake may have harmful consequences for science and society. It is frequently committed by public servants and politicians who call for assembly-line products (e.g. vaccines, lithium chloride to produce lithium metal), or services (e.g. a DNA sequencing for a case of forensic medicine, or local sea pollution monitoring) from scientists and technologists, instead of asking for solutions to unsolved, authentic scientific or technological problems.

Herein, I will review the main characteristics of science, technology, and professions, with emphasis on the problems that these activities attempt to solve. In so doing, I will use and expand some concepts of Mario Bunge's philosophy. Important as the distinction between basic and applied science may be, I will nevertheless consider both disciplines together (i.e. "science") in this essay.

1] Problems in Science, Technology, and Professions

It is well known that engaging in an inquiry of any kind is to tackle cognitive problems. For example, a well-written scientific paper starts by stating the problems it tackles, and ends up by listing some open problems¹⁴. Epistemic or practical problems are knowledge gaps which can be handled in a promising fashion and which, to be authentic, must arise against some background knowledge rather than in a vacuum¹⁵.

¹¹ Sábato, *Ensayos en campera*, 2004.

¹² Marone & González del Solar, «Imaginación e innovación», 2005, «El valor cultural de la ciencia y la tecnología», 2006.

¹³ Bunge, *Dictionary of Philosophy*, 1999.

¹⁴ Bunge, *Chasing Reality*, 2006.

¹⁵ Bunge, «Inverse Problems», 2019.

Marone and González del Solar¹⁶ proposed that the kinds of problems confronting science, technology, and professions, and the nature of solutions that such problems require, reveal their similarities and differences (Table 1). Although science, technology, and professions form a system with context (e.g. the society in which they develop together with its cultural assumptions), composition (e.g. each activity), and structure (e.g. the flux of information between the components)¹⁷, such activities start with problems of a very different kind. Science and technology apply scientific method to elucidate problems but, whereas scientific problems are purely cognitive, technological problems imply conceptual as well as practical challenges (Table 1). What problems in science and technology have in common is that they must both be questions that are not completely solved because a satisfactorily solved problem is neither scientific nor technological at present. This is the reason why genuine outputs of science and technology (i.e. “solutions to problems”) must be original to some detectable degree and, consequently, they should offer the evidence that shows that the novel hypothesis is true to some degree or the novel artefact works, as part of their labour (Table 1). Thus, science and technology should provide society with the burden of proof. On the contrary, professions solve problems without the need of inventing original ideas, but using confirmed ones which professionals assume are correct (**Table 1**).

Unfortunately, some people confound the original products of science and technology with industrial products, be they mass-produced artefacts like telephones, or services like a proven therapy¹⁸. Assembly-line products and services use huge amounts of scientific and technological knowledge nowadays, but they do not carry out research. Of course, although professionals do not test the hypotheses that underpin their rules of action, they apply such rules cautiously, contemplating the contingencies that may affect their application, and monitoring partial results (e.g. think about a physician carefully applying a given therapy, or the so-called adaptive management in wildlife conservation). Lastly, professionals often

¹⁶ Marone & González del Solar, «Imaginación e innovación», 2005, «El valor cultural de la ciencia y la tecnología», 2006.

¹⁷ Bunge, *Ontology II: A World of Systems*, 1979.

¹⁸ Marone & González del Solar, «Imaginación e innovación», 2005, «El valor cultural de la ciencia y la tecnología», 2006.

detect new problems while monitoring their actions, some of which could be unsolved problems that will trigger scientific or technological investigation (e.g. when a physician detects a previously unreported syndrome, or when a technician identifies a consistent lack of efficiency in an artefact), highlighting the systemic nature of science, technology, and professions.

Given the central role that problems play in distinguishing science from its related activities, let's look in depth at the taxonomy of problems in order to offer a more complete characterisation of all three activities.

Table 1: Characteristics of problems, solutions, and proofs in three activities: Science, technology, and professions (services).

<i>Properties</i>	Science	Technology	Professions
<i>Driving force</i>	Curiosity	Curiosity—Practical	Practical
<i>Goal</i>	To know	To know and design	To apply a known solution to a “local problem”
<i>Deals with problems</i>	Cognitive—Unsolved	Cognitive and practical—Unsolved	Practical—Solved
<i>Deals with problems *</i>	Inverse—Direct	Inverse—Direct	Direct—Inverse
<i>Solutions</i>	Original	Original	“Already Proven”
<i>Burden of proof</i>	Its own	Its own	“Given”

* In bold letters, the most typical problem of every activity.

2] Direct and Inverse Problems

The philosophical literature about problems in general is poor¹⁹. Moreover, the most challenging and rewarding scientific and technological problems are inverse (or backward) problems, the existence of which is usually ignored by policy makers, public servants, and philosophers²⁰.

Bunge (2006) offered the following definitions:

¹⁹ Bunge, *Chasing Reality*, 2006, « Inverse Problems », 2019.

²⁰ *Ibid.*

A direct or forward problem is one whose research goes down either the logical sequence or the stream of events; that is, from premise(s) to conclusion(s), or from cause(s) to effect(s).

An inverse or backward problem is, in contrast, one whose research goes up either the logical sequence or the stream of events; that is, from conclusion to premise(s), or from effect to cause(s).

Direct problems call for analysis, or progressive reasoning, but inverse problems require synthesis, or regressive reasoning. Work on direct problems is basically one of discovery (i.e. unveiling the consequences of a known process), whereas the investigation of inverse problems usually calls for creativity and radical invention of ideas in science, and devices in technology²¹.

Some not completely independent examples of inverse problems are (a) guessing an unobservable object from the behaviour of observable things, (b) conjecturing the mechanism involved in changes of observable things, and (c) guessing the cause of something given certain effects. All the attempts of going up from data to hypothesis as the “problem of induction”²², “abduction”²³, “inference to the best explanation”²⁴, or to “free creations of the human mind”²⁵ are inverse problems²⁶. Guessing natural selection from phenotypic variability and resource shortening, constructing empirical or physiological models for studying seedling emergence, inferring the distribution of a bird population or metapopulation from a set of isolated geographical “records”, or guessing an *unknown* illness from its symptoms are all examples of inverse scientific problems. The radical inventions of new devices or the finding of a new use for an extant device are, in turn, examples of inverse technical problems.

²¹ Bunge, *Chasing Reality*, 2006.

²² *Ibid.*

²³ Peirce, *Collected Papers of Charles Sanders Peirce: Pragmatism and Pragmatism*, 1934.

²⁴ Harman, «The Inference to the Best Explanation», 1965.

²⁵ Einstein, *Out of My Later Years*, 1950.

²⁶ Bunge, *Chasing Reality*, 2006.

In contrast, predicting phenotypic changes starting with natural selection²⁷, seedling emergence from physiological models²⁸, the presence of individuals at a given location starting with the theoretical population distribution²⁹, the manifestation of certain symptoms given a known illness, or the output of an artefact (e.g. be it a robot or a therapy) knowing the way the artefact works (e.g. the theory on which it is based), are all direct problems. (Note that all these direct problems enable us to test the hypotheses guessed or inferred while resolving the corresponding inverse problems; see the previous paragraph).

Inverse problems may have multiple solutions or none³⁰. The invention of theoretical hypotheses is a good example because, by definition, a hypothesis goes beyond the data relevant to it in at least one of two ways: either because the hypothesis involves a leap from some existents (sample) to all possibles (universe), or because it includes concepts that, like those of mass, behaviour, competition, natural selection, or national sovereignty, do not occur in the data because they are not experiential in a direct way³¹. There can be no “vertical” inference from data to high level laws because the latter contain concepts absent from the former. Since experience cannot generate any high-level concepts or hypotheses, these must be invented. And invention is anything but a rule-directed process, one subject to algorithms that could be fed into a computer. In short, since data do not exude hypotheses, hypotheses must be invented (an inverse problem) and, of course, more than one hypothesis can be invented to account for the same pattern or problem³².

²⁷ Marone *et al.*, «La teoría de evolución por selección natural como premisa de la investigación ecológica», 2002.

²⁸ Rotundo, Aguiar & Benech-Arnold, «Understanding erratic seedling emergence in perennial grasses using physiological models and field experimentation», 2015.

²⁹ Cueto *et al.*, «Distribución geográfica y patrones de movimiento de la Monterita Canela (*Poospiza ornata*) y el Yal Carbonero (*Phrygilus carbonarius*) en Argentina.», 2011.

³⁰ Bunge, *Chasing Reality*, 2006.

³¹ *Ibid.*

³² *Ibid.*

3] Science and Technology Attack Inverse Problems to Reach Radical Invention

Most demanding and interesting scientific and technological problems are inverse: given an unsolved problem, scientists and technologists must infer or guess the solution. The Problem → Solution(s) scheme depicts an inverse problem. However, science and technology also need to solve important direct problems, particularly when they put to trial hypotheses invented to solve the inverse problems. In such cases, scientists “transform”³³ an inverse problem into a direct one:

Evolutionary biology, like cosmology, geology, and archaeology, is a historical science. Hence its practitioners face a large family of inverse problems of the Present → Past type. In particular, the reconstruction of any lineage (or phylogeny) is tentative if only because of the large gaps in the fossil record. However, qualitative novelties emerge in the course of individual development, which can be monitored and altered in the laboratory. Therefore, some of those novelties can be caused deliberately in modern organisms. This is why some inverse problems in evolutionary biology and genetics can be transformed into direct problems, at least in principle. Actually, this is how evolutionary biology became an experimental science between the two world wars: by tampering with the genome, first with X-rays, and nowadays chemically as well. [...] Certainly, evolutionary biology is not the sole abode of inverse biological problems. Every attempt to find the unknown organ that discharges a known function (or performs a certain role) requires research into an inverse problem. This holds, in particular, for the task of the cognitive neuroscientist, said to be that of “mapping the mind onto the brain”. However, here too many an inverse problem can be transformed into a direct one. For example, by tampering with the brain, the neuropsychologist can cause mental disorders or deficits in experimental subjects. [...] The problem of identifying the gene(s) “responsible” for a given phenotypic trait is of the inverse type. For example, if an adult mammal does not tolerate dairy products, it is because it cannot synthesize lactase, the enzyme involved in the digestion of milk; and in turn lactase deficiency is due to the lack of the gene involved in its synthesis. The researcher is thus faced with

³³ Sensus *ibid.*

the inverse problem: Metabolic disorder → Enzyme deficiency → Genetic disorder. Once the suspect genes have been fingered, the problems of finding out the corresponding enzymes can be tackled. The solution to these direct problems should solve the original inverse problem³⁴.

This is the interplay of inverse and direct problems in science. In technology, it follows a similar path. Convincingly, however, in science and technology inverse problems are more intriguing, more demanding in ingenuity and experience than the corresponding direct problems. Unlike direct problems, there are no special rules or algorithms for solving the most fascinating inverse problems. But once a tentative solution is at hand, researchers “transform”³⁵ the inverse problem into one or more direct ones to test the degree of truth or the efficacy of the proposed solution. An issue that public servants in science and technology, the media, and people in general do not always consider is that inverse problem solving is a risky and uncertain task. To solve them, scientists propose plausible but original hypotheses that could be right but also (most times) could be wrong. Society and officials should be prepared to stimulate (responsible) adventure, without punishment to (responsible) researchers who fail to find a solution to a difficult inverse problem.

What about professional problems? Professional activity often begins by diagnosing the origin or cause of a problematic situation (e.g. illness from symptoms, artefacts break from malfunction, nitrogen deficiency from crop decay, food resources decline from consumer population reduction). It uses the scheme Effects → Cause(s), which is an inverse problem. The inverse problems tackled by professionals have nevertheless some peculiarities. Firstly, they only characterise the initial phase of professions (i.e. diagnosis), but not the typical and important phase of problem solving (i.e. action). Secondly, professional diagnosis is carried out by using previously built critical pathways, which go through the stream of events along a known pathway that has already been investigated and established by researchers as a protocol, or even an algorithm.

After diagnosis is made, the typical professional problem is a direct one. Professionals assume the diagnosed cause and, then

³⁴ *Ibid.*, p. 169-170.

³⁵ Sensus Bunge, *Chasing Reality*, 2006.

arbitrate the means (rules) to control outputs or effects through a direct problem of the form Cause → Effect(s). Rules may be applied, for instance, to fabricate vaccines or tablets, to administrate a therapy or an action plan for the management of a complex organisation. Updated knowledge, critical thinking, and responsibility—but not originality—are the hallmarks of professions. A sick person of a tractable illness demands a wise and accountable physician, but not a creative (let alone reckless) one. Professionals often solve direct problems in a routine fashion since they calculate building structures, carry out biochemical analyses, produce high-quality chocolate, monitor the organic material in a stream or people's body temperature, or determine the traceability of imported products.

Finally, almost the whole national budget of developed and developing countries (often >99%) is devoted to “professional policy” (e.g. public health, education, justice, infrastructure, logistic, product or service provision), whereas just a small fraction is devoted to science and technology (the figures are here notably variable between countries but usually <1%). Bunge warned that some universities are trying to shift their professors from papers to patents³⁶. His warning should be extended: some politicians and public servants are trying to shift researchers from papers and patents to the development of mass-produced artefacts or services. In doing so, the 1% national budget would subsidise the other 99%. Politicians do not appear to appreciate that, to a large extent, science and technology are directed to resolve unsolved inverse problems. When routine activities replace original and risky ones, some cultural values like creativity and imagination are discouraged. This hampers value-added innovative economic and integral development of societies³⁷.

In the next section I will assess, as an example, the interplay of direct and inverse problems in a specific area of knowledge: translational medicine.

³⁶ Bunge, *Doing Science*, 2017, «Evaluating Scientific Research Projects», 2017.

³⁷ Bunge, «Ciencia básica, ciencia aplicada y técnica», 1997, Sabato, *Ensayos en campera*, 2004, Marone & González del Solar, «Imaginación e innovación», 2005, «El valor cultural de la ciencia y la tecnología», 2006, «Crítica, creatividad y rigor», 2007.

4] Case Study: Translational Medicine

Translational medicine was created with the commendable goal of facilitating the transformation of basic research results into clinical applications. It aims at establishing bridges between the so-called basic and clinical medicine, bridges that can help in “crossing the valley of death”³⁸, an area of knowledge that despite years of basic research would not have resulted in sufficient profits in terms of new treatments, diagnoses and prevention protocols³⁹.

Translational medicine consists of two stages or approaches. The goal of T1 is to guide basic knowledge for the development of drugs, diagnostic markers or treatments. In other words, to invent promising treatments that can be mass-produced by the pharmaceutical industry and used in clinical medicine. The objective of T2, in contrast, is assuring that the new treatments developed in T1 are applied correctly to sick populations. The production of a new drug could, therefore, be the final point of T1 and the starting point of T2, since T2 looks to improving the organization of the health system, making it accessible to the whole population⁴⁰.

Butler asserted that basic and clinical research had strong relationships during the first half of the twentieth century, but the situation radically changed with the commencement of molecular biology in the 1970s⁴¹. Translational medicine was then an attempt to put both disciplines together again. However, the best application of translational medicine confronts various dilemmas, one of which is avoiding the confusion between “the invention of treatments” and “carrying them out in practice”⁴². Another dilemma is that T1 appears to hoard most of the grants in the biomedical sciences⁴³.

The application of the model in Table 1 to distinguish basic and clinical research makes clear that clinics incorporate some professional characteristics (e.g. the proximity to patients).

³⁸ Butler, «Translational Research», 2008.

³⁹ Becú-Villalobos, «Medicina traslacional», 2014.

⁴⁰ Butler, «Translational Research», 2008, Becú-Villalobos, «Medicina traslacional», 2014.

⁴¹ Butler, «Translational Research», 2008.

⁴² Becú-Villalobos, «Medicina traslacional», 2014.

⁴³ *Ibid.*

Notwithstanding, both activities refer primarily to research, although differing in the way they carry out the task. Both confront similar inverse problems (e.g. inferring original hypotheses about an unknown illness) but, while clinical research is directed towards finding disease-pattern hypothesis in actual human populations by using observational-correlational approaches (i.e. it is some kind of instrumentalist research), the so-called basic research (which, by the way, should be better named “lab research”) is more usually directed towards finding and testing hypotheses on causal mechanisms of illness by using distinct laboratory settings and experimentation (i.e. it is realistic research)⁴⁴. Although such epistemic differences are usually clear, researchers and meta-scientists scarcely explore them. The professional and investigative sides of the basic/clinical approaches have not received sufficient attention.

Translational medicine includes the scientific and technological, as well as professional, phases of the discipline in a clearer, although usually implicit, way. From definitions and according to Table 1, T1 develops science and technology, but not professions (e.g. T1 develops biomarkers, gene therapy or pharmaco-genomics). T1 would conclude when the prototype of a new device has been developed and tested. T2, in turn, is primarily professional because its main target is the organization of health services to reach the whole society. T2, notwithstanding, can also investigate because it might occasionally face some unsolved problems. But T2 research is not proper biomedical research because it confronts problems typical of the behavioural and social sciences (e.g. which actions better stimulate vaccination adherence, the dialogue between researchers and physicians, or the commitment of patients to therapy; which accounting tools assure the availability of hospital inputs despite erratic funding; what plans optimise the flux of information within the hospital). The kind of problem investigated, the environment (e.g. a hospital) in which the inquiry is carried out, and the devices used for obtaining information are substantially different between T1 and T2. Incidentally, such differences can partially explain and justify distinct grant sizes in T1 and T2.

An important final point, when T2 claims public funding to enhance the provision of hospital nursing, to improve the patient/physician ratio, to buy drugs, or finance the training of hospital staff,

⁴⁴ Bunge, *Medical Philosophy*, 2013.

such public funds should not come from scientific and technological granting agencies but from professional agencies (e.g. the Ministry of Health) directed to assure the provision of appropriate health services. Said in another way, the usually scarce funds intended to promote innovation will not be used to solve professional problems.

5] Conclusions

Science, technology, and professions form a system with multiple interactions, all of which are important human activities, and none of them may be considered hierarchically superior to the others. The development of each activity drives the progress of the others, generating virtuous circles of problem solving, tackling different kinds of problems. In some instances, the same person can advance two or even the three activities simultaneously. Nevertheless, similarities and even synergism should not lead to a confusion between science, technology, and professions. Confusing the creative with the routine activities may be particularly pernicious for the advancement of them all.

The problems that trigger scientific and technological research remain insufficiently solved or unsolved, therefore their possible solutions must be invented (i.e. they are partially or totally original) and, consequently, they should be tested against reality by researchers before considering them as true or useful. On the contrary, the problems that trigger professional inquiry are already solved, or have at least some partial solution at hand that is available in the form of a technical protocol. This solution is applied with caution but without testing (i.e. the professional assumes that the solution works because it was already challenged by researchers). Whereas all activities benefit from an informed and critical education, science and technology also need an education prone to creativity, imagination, and risk in order to flourish.

Mario Bunge's assessment of inverse and direct problems may be a fertile way to assess science, technology, and professions⁴⁵. A direct problem is one whose research goes down the stream of events, whereas an inverse problem is one whose research goes up the stream of events. The most exciting problems are inverse scientific and technological ones (i.e. the invention of a plausible solution to

⁴⁵ Bunge, *Chasing Reality*, 2006.

an unsolved question), although both activities also resolve direct problems (e.g. the deduction of predictions for testing hypotheses or prototypes). In contrast, the typical professional problems are direct ones (e.g. action or the application of a given protocol to resolve a local problem). Professionals, however, resolve inverse problems during the diagnostic phase of their activity as well (e.g. when an electrical technician goes from a light cut to a short circuit), but the diagnostic pathway in the professional activity has been previously established and described in a protocol (the problem, however, may have multiple solutions, which is typical of inverse problems). The model based on unsolved/inverse *against* solved/direct problems may be especially suitable to evaluate the scientific, technological, and professional phases of several complex human activities like translational medicine.

It is the task of the philosopher and sociologist of science to emphasise the role of original thinking in science, technology, and integral social development⁴⁶ (Einstein 1950, Bunge 1997, Sábato 2004, Marone and González del Solar 2007), especially in developing countries. People in these countries rarely benefit from an innovation-based economy and development themselves because their officials in the educational system only associate creativity, originality, and imagination with the fine arts.

Acknowledgements

Founding for this study was provided by CONICET (Consejo Nacional de Investigaciones Científicas y Técnicas of Argentina), recently through PIP 0469. I wish to thank M. Bunge, R. González del Solar, M. Kary, A. Castro-Vázquez, M. Cabido, G. Lovrich, J. Lopez de Casenave, F. Milesi, S. Camín, L. Giojalas, R. Pol, M. Aguiar, J.L. Yela, M. Spínola, J. Polop, A. Mazzolari, N. Unsain, and other colleagues and students with which I discussed these ideas along the years. They sometimes coincided with me, but not always, which fortunately maintain the conversation alive. Mario Bunge inspires this and others of my research projects. I acknowledge Mario for his infinite generosity and

⁴⁶ Einstein, *Out of My Later Years*, 1950, Bunge, « Ciencia básica, ciencia aplicada y técnica », 1997, Sábato, *Ensayos en campera*, 2004, Marone & González del Solar, « Crítica, creatividad y rigor », 2007.

friendship. This is contribution number 106 of the Desert Community Ecology Research Team (Ecodes).

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The Inverse Approach to Technologies

Eduardo Scarano¹

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 sense².

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*

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 wealth³. 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 desirable⁴.

Technology is applied science; the combination of means to obtain an end is resolved exclusively within the field of science⁵. The determination of the ends is done by Teleology or the Doctrine of ends and expressed through normative sentences⁶. 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

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 pre-scientific 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 reality⁸, 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.

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 manifestations¹⁰.

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 natural¹¹.

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

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 knowledge¹². 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 inter-related 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 things¹⁴. 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

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 knowledge¹⁵.

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

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 scientifiably. 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 techniques¹⁶ associated with the scientific method. Of course, we also find concepts and technological theories. Items 3 and 4 include pre-scientific 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 design¹⁷. 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.

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 clearing-house 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: $f_2 P f_1, f_1 P f_4, \dots$, 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 empty¹⁸.

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 market¹⁹.

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 matching²⁰.

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

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*: Normally²¹ no more than one year can pass between the commissioning of a new market design and its implementation.

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 features²². 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.

Consulting²³ 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 recommendations²⁴.

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.

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 Reuid & 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 designs²⁵.

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.

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.

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A Critique of Meillassoux's Reflections on Mathematics from the Perspective of Bunge's Philosophy

Martín Orensanz¹

Abstract — Quentin Meillassoux is one of the leading French philosophers of today. His first book, *Après la finitude: Essai sur la nécessité de la contingence*, first published in 2006 and translated into English in 2008, has already become a cult classic. It features a *préface* by his former mentor, Alain Badiou. One of Meillassoux's main goals is to rehabilitate the distinction between primary and secondary qualities, typical of pre-Kantian philosophies. Specifically, he claims that mathematics is capable of disclosing the primary qualities of any object: "all those aspects of the object that can be formulated in mathematical terms can be meaningfully conceived as properties of the object in itself." (Meillassoux, 2008: 3, emphasis removed). Here we will use Bunge's philosophy of mathematics in order to challenge the preceding assumption.

Résumé — Quentin Meillassoux est l'un des principaux philosophes français d'aujourd'hui. Son premier livre, *Après la finitude. Essai sur la nécessité de la contingence*, publié pour la première fois en 2006 et traduit en anglais en 2008, est déjà devenu un classique culte. Il comporte une préface de son ancien mentor, Alain Badiou. L'un des principaux objectifs de Meillassoux est de réhabiliter la distinction entre qualités premières et qualités secondes, typique des philosophies pré-kantiennes. Plus précisément, il affirme que les mathématiques sont capables de révéler les qualités premières de tout objet: « tous les aspects de l'objet qui peuvent être formulés en termes mathématiques peuvent être considérés de manière significative comme des propriétés de l'objet en soi. » Ici, nous allons utiliser la philosophie mathématique de Bunge pour remettre en question l'hypothèse précédente.

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1] Meillassoux's Philosophy of Mathematics in *After Finitude*

First, it will be necessary to indicate that Meillassoux rejects a thesis which he calls “Pythagorean”. Whether or not this has anything to do with what Pythagoras actually upheld, Meillassoux uses that term to refer to the thesis that mathematical statements, such as formulas and equations, are as real as any object in the Universe. Contrary to this point of view, he claims that mathematical statements are not real but ideal instead. This is found in his discussion of the accretion of the Earth, where he says:

Consequently, our Cartesian physicist will maintain that those statements about the accretion of the earth which can be mathematically formulated designate actual properties of the event in question (such as its date, its duration, its extension), even when there was no observer present to experience it directly. In doing so, our physicist is defending a Cartesian thesis about matter, but not, it is important to note, a Pythagorean one: the claim is not that the being of accretion is inherently mathematical—that the numbers or equations deployed in the ancestral statements exist in themselves. For it would then be necessary to say that accretion is a reality every bit as ideal as that of number or of an equation. Generally speaking, statements are ideal insofar as their reality is one of signification. But their referents, for their part, are not necessarily ideal (the cat is on the mat is real, even though the statement “the cat is on the mat” is ideal). In this particular instance, it would be necessary to specify: the referents of the statements about dates, volumes, etc., existed 4.56 billion years ago as described by these statements—but not these statements themselves, which are contemporaneous with us².

Nevertheless, there is some ambiguity in the preceding distinction between statements and their referents. This was noted by Graham Harman in his book on Meillassoux’s philosophy. Harman explains this ambiguity in the following way:

Meillassoux says that the Cartesian position towards physics (and he takes the side of Descartes on most issues) must be distinguished from the Pythagorean position that the mathematical is reality itself. The Cartesian position is supposedly different in so far as it is

² Meillassoux, *After Finitude*, 2008 [2006], p. 12.

the *referent* of equations which has existence independent of humans, not the equations themselves. This sounds plausible enough in Descartes's case, given the explicit role in his philosophy of physical substance. But assuming that Meillassoux means to take an anti-Pythagorean line in this passage (which he probably does), it remains unclear what *his* residual "referent" would be beyond the mathematical other than the "dead matter" that we have already found lacking³.

Meillassoux's philosophy of mathematics is ambiguous on this point because, on the one hand, he claims that mathematical statements can disclose the primary qualities of an object, such as its length, height, figure, and so forth. These primary qualities are properties that the object has in itself, independently of the presence of human beings. So, for example, an object that has a triangular shape has a mathematical property independently of the presence of human beings. But on the other hand, the rejection of the "Pythagorean" thesis entails that the object in question cannot have a triangular shape by itself, since the concept of "triangle" is a term used in the statements of geometry, understood as a branch of mathematics. Having indicated this ambiguity, we will assume that Meillassoux's view on this issue is that objects in themselves have primary qualities, which are inherently mathematical. These properties are real, while the mathematical statements that disclose them are ideal. Such a view is at odds with Bunge's philosophy of mathematics. Consider the following statement:

There is no reason to expect that pure mathematics is capable of disclosing, without further ado, the structure of reality⁴.

Why not? Because pure mathematics, by itself, only deals with constructs. In order to study reality, we need empirical science; pure mathematics alone is insufficient for that task. To be sure, Meillassoux is aware of this: "For what is at stake here", he says, "is the nature of scientific discourse, and more particularly of what characterizes this discourse, i.e. its *mathematical* form⁵." And, later on, he says, "it is the discourse of empirical science as such that we are

³ Harman, *Quentin Meillassoux*, 2015 [2011], p. 207.

⁴ Bunge, *Ontology I: The Furniture of the World*, 1977, p. 150.

⁵ Harman, *Quentin Meillassoux*, 2015 [2011], p. 26.

attempting to understand and to legitimate⁶". Thus, Meillassoux recognizes that there is a difference between pure mathematics and empirical science. Furthermore, he believes that one of the salient features of empirical science is that it relies heavily on mathematics; not entirely, but to a large extent. Of course, Bunge does not have any qualms with this. The decisive issue here is: What do the statements of empirical science refer to, especially those that rely heavily on mathematics? Meillassoux seems to believe, in agreement with Descartes and Locke, that properties such as length, height, figure, among others, are not merely technical terms of the vocabulary of geometry, but real properties that can be found in external objects instead. We will see that this is not the case according to Bunge.

But before we do so, and in order to understand Bunge's mathematical fictionalism, it will be necessary to take a quick look at the history of non-Euclidean geometries, and the consequences that their development had for philosophy.

2] A Brief History of Non-Euclidean Geometries

In the fourth chapter of *After Finitude*, Meillassoux makes some scarce comments on the history of mathematics⁷; specifically, he refers to the development of non-Euclidean geometries during the nineteenth century, stating that "we are all familiar" with their history, and then he summarizes Lobachevsky's work. Although Meillassoux's target audience may be familiar with that history, it seems to us that it must be recounted here.

But before we present that history, it will be convenient to note that according to Meillassoux, philosophers have recently become modest, and even prudent, when discussing scientific issues⁸. It seems to us that this has been especially true after the Sokal affair. Unlike previous generations, today's continental philosophers have learned to be cautious about topics such as non-Euclidean geometries, Einstein's theories of special and general relativity, quantum physics and Gödel's theorems, among others.

⁶ *Ibid.*, p. 28.

⁷ *Ibid.*, p. 92.

⁸ *Ibid.*, p. 13.

This was never a problem for analytic philosophers. For example, Ernest Nagel and James Newman wrote a book on Gödel's proof⁹, and Thomas Kuhn wrote a book on quantum physics¹⁰. None of these authors have been criticized by Alan Sokal or Jean Bricmont for misusing scientific concepts. Kuhn has been criticized by Sokal and Bricmont in *Fashionable Nonsense* for fostering philosophical relativism, but not for misunderstanding physics¹¹. The point is that philosophers may be knowledgeable enough to write on topics such as Gödel's work and quantum physics without falling into charlatanry. That some philosophers do fall into charlatanry when discussing these topics does not mean that all of them do so. Of course, neither Sokal nor Bricmont claim the contrary. They specifically criticize a group of thinkers, those that they regard as post-modern intellectuals. But to step into that discussion exceeds the purposes of this article. We have only advanced these remarks in order to clearly state that we are fully aware of the perils surrounding the philosophical discussions of complicated scientific issues.

Thus, our presentation of the history of non-Euclidean geometries will follow Meillassoux's remark about modesty and prudence. In order to do so, we will use a well-known Argentine textbook on the philosophy of mathematics by Gregorio Klimovsky and Guillermo Boido, *Las desventuras del conocimiento matemático* ("The Misadventures of Mathematical Knowledge")¹². Klimovsky was a mathematician and philosopher of science who introduced set theory in Argentina. Boido was a physicist and historian of science, who wrote a popular history book on Galileo. A more detailed presentation of non-Euclidean geometries and their history can be found in Richard Trudeau's book, *The non-Euclidean revolution*¹³. Several quotes and definitions by philosophers and mathematicians of the past can also be found in Trudeau's book.

It will be necessary to begin by considering Euclid's *Elements*, which has certain similarities with Aristotle's way of conceiving axioms and theorems. For Aristotle, axioms are self-evident principles, which are undeniably true. From them, theorems can be

⁹ Nagel & Newman, *Gödel's Proof*, 1958.

¹⁰ Kuhn, *Black-Body Theory and the Quantum Discontinuity, 1894–1912*, 1987.

¹¹ Sokal & Bricmont, *Fashionable Nonsense*, 1998 [1997], p. 51.

¹² Klimovsky & Boido, *Las desventuras del conocimiento matemático*, 2005.

¹³ Trudeau, *The Non-Euclidean Revolution*, 2008 [1987].

deduced, and which are also undeniably true. Thus, he says in the *Posterior Analytics*:

That which is an indispensable antecedent to the acquisition of any knowledge I call an Axiom; for there are some principles of this kind, and “axiom” is the name generally applied to them¹⁴.

And later on, he highlights the self-evidence that characterizes axioms, when he says:

There are three elements in demonstrations: (1) the conclusion which is demonstrated, i. e., an essential attribute of some genus; (2) axioms or self-evident principles from which the proof proceeds; (3) the genus in question whose properties, i. e. essential attributes, are set forth by the demonstrations¹⁵.

Euclid’s postulates apparently were more or less similar to Aristotle’s axioms; that is, they were true statements which do not need to be demonstrated. Klimovsky and Boido say the following:

The statements that Euclid calls *postulates* are assumptions that we must accept without demonstration and that concern geometry itself. They are roughly equivalent to Aristotle’s axioms, although our geometer does not make any philosophical considerations about their evidence and merely asks the reader to accept them¹⁶.

This being so, let us examine the history of non-Euclidean geometries, which has its roots in the attempts to prove Euclid’s fifth postulate. These roots go far back to Antiquity. Philosophers like Posidonius and Geminus had the suspicion that the fifth postulate was not really a postulate, but a theorem. There were more or less solid reasons for this doubt. First of all, the grammatical expression of the fifth postulate is much more complicated and extensive than the other four. In its original formulation, it says nothing about parallels. Let us cite Euclid’s five postulates, in order to see how “strange” the fifth looks, at least from a grammatical point of view:

Let the following be postulated:

1. To draw a straight line from any point to any point.

¹⁴ Aristotle, *Aristotle’s Posterior Analytics*, 1901, p. 6.

¹⁵ *Ibid.*, p. 20.

¹⁶ Klimovsky & Boido, *Las desventuras del conocimiento matemático*, 2005, p. 78-79.

2. To produce a finite straight line continuously in a straight line.
3. To describe a circle with any center and distance.
4. That all right angles are equal to one another.
5. That, if a straight line falling on two straight lines make the interior angles on the same side less than two right angles, the two straight lines, if produced indefinitely, meet on that side on which are the angles less than the two right angles¹⁷.

The fifth postulate looked grammatically “strange” when one compared it to the other four. But this was not the only problem. If it was, then there would not be any other reasons, other than grammar, to suspect that this was a theorem. In other words, it would have been a postulate which was poorly written, but a postulate nonetheless. There was another source of doubt, more problematic than grammar. It was the fact that the fifth postulate was explicitly used only once in Euclid’s book. On the other hand, the first, second, third and fourth postulates are frequently used throughout the book, in order to deduce many different theorems. It seemed suspicious that there was a postulate whose only role was to deduce one specific theorem. In the words of Klimovsky and Boido:

It is striking that Euclid has placed among the postulates of his system one that is used explicitly only once, as if some aversion on the part of the author of the *Elements* lies behind it. We would say that everything happens as if in a certain religion we found a god of rain, another of fire, a third of the earth and a fourth of the sea, but also a god whose specific purpose is to cure a particular cold to a certain king. A divinity destined exclusively to that seems a bit excessive¹⁸.

This is why philosophers like Posidonius and Geminus suspected that the fifth “postulate” was a theorem, and they attempted to prove this. Even more so, they succeeded. They really did deduce the fifth postulate, therefore proving that it was a theorem. But there was a catch: they introduced an additional postulate in order to do this. Thus, Posidonius, whose work we know from the commentaries of Proclus, apparently proposed the following additional postulate:

¹⁷ Euclid, *The Thirteen Books of Euclid's Elements*, 1908, p. 154-55.

¹⁸ Klimovsky & Boido, *Las desventuras del conocimiento matemático*, 2005, p. 90.

Parallel straight lines are equidistant¹⁹.

Now this is much more concise and elegant than Euclid's formulation of the fifth postulate, as far as grammar is concerned. And with it, one can deduce Euclid's fifth "postulate" as a theorem. The problem is that the postulate that Posidonius introduces is actually equivalent to Euclid's. They say the same thing, even if this is not immediately evident. But it can be proved. If one takes the first four postulates of Euclid's *Elements*, together with the postulate that Posidonius introduces, it is possible to deduce, as a theorem, Euclid's fifth postulate. But the converse is also true. If one takes all of Euclid's postulates, then Posidonius' "postulate" can be deduced as a theorem. So Posidonius did not really prove that Euclid's fifth postulate was a theorem. In order to do so, he would have had to either deduce it using only the first four postulates of the *Elements*, or he would have had to introduce a new postulate which would not be logically equivalent to Euclid's fifth. He believed that he had succeeded in pursuing this second option, but later it was shown that this had not been the case. The other philosopher of that time, Geminus, had a similar experience.

At the beginning of the Middle Ages, Proclus summarized most of the earlier attempts at proving the fifth postulate. All of them had the same thing in common: they introduced an additional postulate, which was shown later to be equivalent to Euclid's fifth. Proclus himself attempted an additional proof. He did so by surreptitiously introducing a statement that is equivalent to Euclid's fifth postulate.

This kept going on and on during the Middle Ages and later during the Renaissance as well. At the same time, mathematics in general had been marching forward, especially in the works of Copernicus, Galileo, and later in Descartes. Mathematics, says Meillassoux, began to describe a "glacial world", one that was independent of human experience, and even of human existence:

It is this *glacial* world that is revealed to the moderns, a world in which there is no longer any up or down, centre or periphery, nor anything else that might make of it a world designed for humans. For the first time, the world manifests itself as capable of subsisting

¹⁹ Trudeau, *The Non-Euclidean Revolution*, 2008 [1987], p. 128.

without any of those aspects that constitute its concreteness for us²⁰.

Yet, the map of this glacial landscape would remain incomplete until Euclid's fifth postulate could finally be proven. It seemed like an almost impossible task, since there had been numerous attempts during the past centuries, and all of them had failed. By the 18th century, the situation was scandalous. While Kant claimed in a footnote to the *Critique of Pure Reason* that the lack of a solid proof for the existence of external things was "the scandal of philosophy"²¹, D'Alembert claimed in the *Essays on the Elements of Philosophy* that the problem of the parallel postulate was "the scandal of geometry"²². Euclid's fifth postulate came to be known as "the parallel postulate" because it could be written in a more elegant and concise way by using the notion of parallels. So, for example, it became customary to use the following equivalent formulation, which was popularized by John Playfair at the end of the 18th century:

Through a given point not on a given straight line, and not on that straight line produced, no more than one parallel straight line can be drawn²³.

According to Klimovsky and Boido, during the early decades of the 19th century, a small group of mathematicians:

[...] had the firm suspicion that the postulate of the parallels is unprovable from the previous four and that it is possible to obtain new conclusions, without finding any contradiction, admitting these four postulates and the *negation* of the fifth²⁴.

Among this group was Gauss. He developed a new geometry, a non-Euclidean one, but he did not publish his results immediately. Gauss did not publish his manuscripts because he feared that his colleagues would consider his work to be "the result of an insane lucubration, worthy of an eccentric"²⁵.

²⁰ Meillassoux, *After Finitude*, 2008 [2006], p. 115.

²¹ Kant, *Critique of Pure Reason*, 2000 [1781–1787], p. 121.

²² Le Lionnais, « Beauty in Mathematics », 2004, p. 133.

²³ Trudeau, *The Non-Euclidean Revolution*, 2008 [1987], p. 128.

²⁴ Klimovsky & Boido, *Las desventuras del conocimiento matemático*, 2005, p. 94.

²⁵ *Ibid.*, p. 95.

However, Gauss received a book from an old friend of his, a mathematician called Wolfgang Bolyai. It was a two-volume work on geometry. This treatise included an appendix written by his son, Johann Bolyai. In this appendix, Johann Bolyai had developed a non-Euclidean geometry by accepting Euclid's first four postulates and this additional one: "from a point exterior to a strait line there is more than one parallel that passes through that point". Previously, Johann had told his father that he had "created a universe out of nothing". When Gauss received this book, he wrote a letter to Wolfgang. He praised Johann's work, and felt relieved that other people had reached similar results by negating Euclid's fifth postulate. He now had more confidence in the idea that he was not a lone eccentric, but a serious researcher who, despite having produced a geometry which seemed "strange", had no logical errors. Gauss decided to encourage other mathematicians to investigate these possibilities. Yet the atmosphere of the time was rather uncertain, many mathematicians still felt that they could be making fools of themselves if they insisted too much on this issue. Johann Bolyai decided to stop publishing, in part due to the reason just mentioned, and in part because he felt that Gauss could rob him of his merits if the community of mathematicians were to fully accept the idea that it was possible, and legitimate, to develop non-Euclidean geometries.

Johann Bolyai was not entirely wrong in his suspicions. He was wrong to suppose that Gauss would try to steal his merit. But he was not wrong in supposing that the community of mathematicians would not accept the possibility of non-Euclidean geometries. This last point was to be corroborated when a third figure emerged on the scene, Nikolai Lobachevsky. He had developed a non-Euclidean geometry very similar to that of Bolyai, and he presented it in conferences and in publications. Lobachevsky had been urged by a friend of Gauss to publish these results; apparently because Lobachevsky himself felt rather uneasy about it, just like Gauss and Bolyai had felt. None of them were wrong on this point, because when the community of mathematicians started to pay attention to what they had written, they were accused of fabricating "caricatures of geometry" and even "morbid manifestations of geometry"²⁶.

What were the characteristics of these early non-Euclidean geometries? Why did they seem so "repugnant", or hard to accept?

²⁶ *Ibid.*, p. 94-96.

Neither Gauss, Bolyai nor Lobachevsky reached any contradictions by denying Euclid's fifth postulate. Instead, what they obtained was a series of "weird" theorems, which nonetheless were perfectly valid from a logical point of view. They were so "weird" that they defied intuition, and even common sense. For example, "the sum of the angles of a triangle is less than 180 degrees". Or they included statements like this one: "from a point exterior to a straight line, an infinite number of parallels pass through that point". As if this was not enough, another mathematician, Bernhard Riemann, developed a non-Euclidean geometry which claimed that "from a point exterior to a straight line, no parallels pass through that point". While Gauss, Bolyai and Lobachevsky developed different versions of what was later to be called "hyperbolic geometry", Riemann developed what would later be known as "elliptic geometry". It was Felix Klein who introduced these terms to describe the new geometries developed by his colleagues.

When the community of mathematicians began to pay sufficient attention to these new geometries, their initial rejection gave way to a more sophisticated way of resisting them. Instead of using terms like "caricature" and "morbid" to describe these geometries, the idea that began to gain acceptance was that these new geometries were perfectly logical, but that, unlike Euclid's, they did not refer to anything in the real world. In other words, it was claimed that Euclid's geometry is the only one that correctly describes physical space, while these other geometries do not describe anything. They were, in a sense, "imaginary", while Euclid's, on the other hand, was real.

Since that was supposedly the case, this gave way to the idea that those mathematicians who were working on non-Euclidean geometries were more or less wasting their time. Or, at best, they were simply entertaining themselves with a "game", as if they were inventing new rules for playing chess. Of course, one can invent any alternative rules for chess and have fun playing with those rules, no matter how bizarre they may be. But if one wanted to do serious research as a mathematician, then the efforts had to be made in the only geometry which was not purely imaginary, the only one that can describe physical space, that is, Euclidean geometry.

David Hilbert did not share the preceding opinion. For him, the invention of non-Euclidean geometries was not a waste of time. On

the contrary, he claimed that a sharp distinction must be drawn between the development of a purely formal system, on the one hand, and the task of finding applications for that formal system, on the other. In other words, one must distinguish between “pure” and “applied” mathematics. That a mathematical system, such as a non-Euclidean geometry, has no immediate applications in the real world, does not mean that there are no applications in principle. Because it could be the case that there are such applications, but that we have simply not found them yet. Thus, it is hastily and inadvisable to condemn research in pure mathematics just because it has no immediate applications.

Hilbert maintained that pure mathematics was the study of formal systems, and that the only thing that matters in these formal systems is their syntax. Applied mathematics, on the other hand, is the task of finding semantic interpretations of those formal systems. It is only at this point that semantics enters the scene; in purely formal systems, all that matters are their syntax. This distinction between pure and applied mathematics began to gain acceptance within the community of mathematicians, but there was still some reticence to the idea that non-Euclidean geometries could have a physical interpretation. They were too weird; their most basic statements went against common sense. The tide finally turned when Einstein described physical space in 1916 using an interpretation of Riemann’s elliptic geometry. This showed that non-Euclidean geometries could indeed have a relation to the real world, and that they could be used to describe physical space just as good, if not better, than Euclidean geometry.

Profound consequences ensued. Some of them were even quite disturbing. First of all, intuition and common sense were no longer a guarantee of what kind of mathematical research qualifies as “legitimate”. In other words, one cannot dismiss a work of mathematics simply because it runs contrary to intuition and common sense. Second, it was no longer clear that Euclidean geometry was the only “true” or “real” geometry, and it was not clear that there could even be such a thing, Euclidean or not. Instead, Hilbert’s distinction between pure and applied mathematics became the new cornerstone of mathematical research. All purely formal systems are equally legitimate; Euclid’s geometry is not “better” or “worse” than non-Euclidean geometries. As long as they are treated in a purely formal

way, all of them are on an equal footing. Regarding Hilbert's work, Klimovsky and Boido say the following:

Hilbert himself claimed that, while we are somehow obliged to use words from everyday language to speak *in* (or *within*) a formal axiomatic system, instead of "point", "line", and "plane" we could well use "table", "chair" and "beer glass" without altering in the least the system itself: "point" or "table", here, are mere empty labels without any meaning²⁷.

Shocking, isn't it? At least it was shocking to those mathematicians that still adhered to the Aristotelian notion that axioms must be "true" and "self-evident". What Hilbert showed was that an axiom does not necessarily have to be "true" or "self-evident" in the Aristotelian sense. Rather, it is a meaningless expression, composed of meaningless signs, which is arbitrarily formulated by the mathematician, in order to see what can be deduced from it. The theorems, which are deduced from the axioms, are no longer "true" either, as Aristotle thought. Instead, they are meaningless expressions, composed of meaningless signs, which are derived from the axioms simply by following a set of accepted, arbitrary rules. In this sense, a formal axiomatic system can be compared to a game of chess:

Actually, such a structure really looks like a logical game with some resemblance to chess. In chess we do not know exactly what we are referring to with the pieces (what we do know is how to move them), and no one in their right mind will believe that they are executing monarchical politics because they move the king, the queen and their pawns. Calling the pieces "king", "bishop" or "tower" is a tribute to tradition; in the same way, in a non-Euclidean geometry the words "point", "line", "plane", etc., have no meaning. Such a methodology is known as *formal axiomatic method*, or simply *axiomatic method*, and the game we have described in particular is an example of what is called a *formal axiomatic system*²⁸.

And later on, they say:

And if one were to ask here, from a purely theoretical, non-historical or practical point of view, which one of these is the legitimate chess,

²⁷ *Ibid.*, p. 106.

²⁸ *Ibid.*, p. 104.

the answer would be: they are all equally legitimate, once it is accepted, for each of them, their corresponding pieces, initial positions, rules, etc. The same applies to axiomatic systems. From a purely logical perspective, we can understand Euclid's geometry as a formal axiomatic system, since it has its vocabulary, the categories of that vocabulary, and it has its starting points, the axioms, and what is deduced from them, the theorems. Both the Euclidean geometry and the non-Euclidean geometries would be, on an equal level, formal axiomatic systems, that is, "games" that, as with the different variants of chess that we have mentioned, would have to be considered, all of them, perfectly legitimate²⁹.

Having said this, we are ready to examine Bunge's philosophy of mathematics, which draws upon the philosophical consequences of the history of non-Euclidean geometries.

3] Bunge's Philosophy of Mathematics

We saw that for Meillassoux, mathematical statements are ideal, but their referents are not. We also saw that Harman noticed an ambiguity in this seemingly unproblematic position. In Bunge's work, we find a solution to this ambiguity. He unequivocally states that numbers are not found in the Universe among objects such as rocks, trees and mountains. Numbers, according to him, are brain processes:

Although thinking of the number 3 is a brain process, hence one located in space-time, the number 3 is nowhere because it is a fiction existing by convention or fiat, and this pretense does not include the property of spatiotemporality. What holds for the number 3 holds for every other idea—concept, proposition, or theory. In every case we abstract from the neurophysiological properties of the concrete ideation process and come up with a construct that, by convention, has only conceptual or ideal properties³⁰.

According to Bunge, the number 3 is a fiction, and so is every other mathematical entity. There is more to be said, because not only does he consider mathematical entities to be fictional, he says that every concept, proposition and theory are fictional as well. He calls these "constructs", and they include even the most complex

²⁹ *Ibid.*, p. 115.

³⁰ Bunge, *Ontology II: A World of Systems*, 1979, p. 146.

scientific theories. So, for instance, a scientific theory about gravity is *not* gravity itself. For one thing, gravity is a fundamental force of nature, while a *theory* about gravity is not: it is a brain process. And brain processes are not fundamental forces of nature. So far, this is in agreement with Meillassoux's distinction between statements and their referents. But it seems that Meillassoux would be inclined to believe that an iron sphere, for example, is spherical in itself. It would be a sphere even if there was no one to look at it, since its spherical shape is understood here as a primary quality. Bunge would disagree:

Concrete objects (things) have no intrinsic conceptual properties, in particular no mathematical features. This last statement goes against the grain of objective idealism, from Plato through Hegel to Husserl, according to which all objects, in particular material things, have ideal features such as shape and number. What is true is that some of our ideas about the world, when detached from their factual reference, can be dealt with by mathematics. (For example, by analysis and abstraction we can extract the constructs "two" and "sphere" from the proposition "That iron sphere is composed of two halves".) In particular, mathematics helps us to study the (mathematical) form of substantial properties. In short, not the world but some of our ideas about the world are mathematical³¹.

Material things, therefore, do not have shapes, at least strictly speaking. We can, of course, talk about material things *as if* they had shapes, for example when we say that a certain iron object is spherical. But that object, in itself, is not spherical. This may seem hard to accept. Jean-Pierre Marquis, in his appraisal of Bunge's philosophy of mathematics, expresses his concern regarding the clarity of this point, and offers some comments on Bunge's example of the iron sphere:

I must admit that this is not entirely clear to me. Needless to say, the iron sphere is not, strictly speaking, a sphere in the mathematical sense. The sensory impression of the sphere presumably gives us an approximation of what a sphere in the strict sense would look like. One could perhaps say that we treat the iron sphere *as if* it were a sphere. But in order to do this, we already need to have the mathematical concept of sphere. The *mathematical concept* of

³¹ Bunge, *Ontology I: The Furniture of the World*, 1977, p. 118.

sphere is not in the iron sphere. The concept of sphere is given in a certain language, be it geometric, analytic or algebraic, thus in a certain context. It is, in Bunge's terminology, a *construct*³².

In order to clarify Bunge's example of the iron sphere, it will be useful to remember what happened to the concept of triangles during the development of non-Euclidean geometries in the nineteenth century. In Euclidean geometry, the sum of the angles of a triangle is equal to 180 degrees. For millennia, this seemed to be an absolute truth. However, in some non-Euclidean geometries it is possible to prove, without contradiction, that the sum of the angles of a triangle is greater than 180 degrees; this is the case of elliptic geometry. In others, such as hyperbolic geometry, the sum of the angles of a triangle can be less than 180 degrees. One cannot say that the triangles of Euclidean geometry are the "real" triangles and that the triangles of non-Euclidean geometries are "not real". What holds for triangles also holds, in general, for all other shapes: spheres, squares, rectangles, and so forth: there is no reason to believe that there is such a thing as a "real" sphere as characterized by this or that geometry, as opposed to other "non-real" spheres characterized by other geometries. The preceding point can be clarified further by considering some of Bunge's comments on cultural objects:

I submit that the same holds, *mutatis mutandis*, for all cultural objects. Thus, a sculpture that nobody looks at is just a chunk of matter—and so is a philosophical treatise that nobody reads. There is no immortality in cultural creations just because they can be externalized ("embodied") and catalogued³³.

Initially, one could argue that a certain sculpture is a chunk of matter that has a specific shape. But, just like the property of "being spherical" is not a primary quality of an iron sphere, neither is "having a specific shape" in the case of a sculpture that no one is looking at. Suppose we are considering a sculpture of a horse, or of Pegasus. The sculpture itself, without observers, would not look like a horse or Pegasus, because there would not be anyone looking at it. If this is so, then it would not only apply to cultural objects, but to natural ones as well. A waterfall would not look like a waterfall when nobody is looking at it, the Moon would not look round or spherical, on

³² Marquis, «Mario Bunge's Philosophy of Mathematics», 2012, p. 1574.

³³ Bunge, *Ontology II: A World of Systems*, 1979, p. 168-70.

the contrary, both of them would just be chunks of matter, without any visual appearance.

Bunge traces a distinction between attributes and properties. Attributes, according to him, are characteristics that we ascribe to things, but the things in question, by themselves, do not have those attributes. Properties, on the contrary, do belong to things in themselves, independently of human existence. Attributes are constructs, while properties are real. Thus, when we say that a sculpture looks like a horse, this is something that we are attributing to a chunk of matter. When we say that the sculpture in question is made of iron, this is a property of that chunk of matter itself. Iron has properties that are independent of our scientific hypothesis and theories, although we use the latter in order to understand the former. In this sense, “spherical” or “having a spherical shape” is not a property, it is an attribute. Attributes can be mathematical, but not properties. Whatever properties the object itself has, these are never mathematical.

4] Concluding Remarks

One of the most prominent features of French philosophy in the continental tradition is, from a historical perspective, its increasing association with mathematics. It was a prominent topic in the works of Gilles Deleuze, and even more so in those of Alain Badiou. Quentin Meillassoux's work is in line with that tradition, and our wager is that it could greatly benefit from Bunge's philosophy of mathematics. The rationale for this is that Bunge's approach provides an unequivocal solution to the ambiguity that Harman had recognized in Meillassoux's discussion of the “Pythagorean” thesis. Although Bunge advances some ideas which may seem difficult to accept, such as the idea that objects in themselves do not have geometric shapes, he nevertheless also provides reasons for doubting Meillassoux's claim that any property which can be mathematized can be construed as a primary quality. Numbers, algebraic structures, and other mathematical entities are not real objects nor properties of real objects, but useful fictions instead. They are brain processes, and by convention we feign that they have autonomous existence.

Acknowledgements

The author wishes to thank François Maurice for his reading of our manuscript, as well as his comments and corrections.

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Mario Bunge: Epistemology is Here to Stay

Ricardo J. Gómez¹

Abstract — The main claim of this study is that, contrary to Latour's view about the need to leave aside epistemology to deal with anything valuable about science, Mario Bunge has consistently built up a detailed and thorough epistemology. The argumentative strategy will be to show that (a) it is not true that we have never been modern, (b) epistemology is here to stay, and (c) Mario Bunge endorses a strong scientific realism, a brand of materialism, systemism and emergentism, including a moral dimension (there are objective values like, truth, peace and justice that deserve to be respected). Then, Bunge's realism rejects axiological neutrality making scientists responsible for their actions. Bunge has always been modern and keeps enriching his own views.

Résumé — Cette étude défend l'idée que, contrairement à l'opinion de Latour sur la nécessité de laisser de côté l'épistémologie pour traiter de tout ce qui a de la valeur pour la science, Mario Bunge a systématiquement construit une épistémologie détaillée et approfondie. La stratégie argumentative consistera à montrer (a) qu'il est faux que nous n'avons jamais été modernes (b) que l'épistémologie est là pour de bon et (c) que Mario Bunge soutient un réalisme scientifique fort, une version du matérialisme, du systémisme et de l'émergentisme, comportant une dimension morale (il existe des valeurs objectives comme la vérité, la paix et la justice qui méritent d'être étudiées). Ensuite, le réalisme de Bunge rejette la neutralité axiologique rendant les scientifiques responsables de leurs actions. Bunge a toujours été moderne et continue à enrichir ses propres positions.

1] Equivocity of the Term “Modernity”

Latour recognizes that “with the adjective *modern* a new regime is designated, an acceleration, a rupture, a revolution of time”². But

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² Latour, *Nunca fuimos modernos*, 2007 [1997], p. 27.

it always involves a contrast with an archaic and stable past. There is implicit a double asymmetry: an irregular break, and the presence of winners and losers. On the other hand, there are two types of practice. In one of them, hybrids are created, such as nature and culture. The second practice is “purification” where two ontological zones are created, that of humans and that of non-humans.

It is vital to recognize that, according to Latour, “while we consider these two practices separately, we are truly modern”³, but if we look at the purification and hybridization project “we are no longer totally modern”⁴.

The book has to try to show that as we always did the second, we have never been modern. With an additional paradox, the less hybrids are thought of, the more possible science becomes (but, as conceived by those who emphasize the separation-purification work).

With an addition: “nobody is really modern if he does not accept to distance God as much from the game of the laws of nature as those of the republic”⁵. The result of all this is that science corresponds to the representation of non-human, forbidden any appeal to politics, while the latter corresponds to the representation of citizens, but without relating them to what is produced by science⁶.

If we ask, with Latour, what there is, the answer is “hybrids” that through time are drawing skeins of politics, economics, technics, law, religion that multiply themselves.

Given a hybrid (a machine, an ozone hole, etc.), it is required to follow its march through history; the notion of “net” is Ariadne’s thread of all these mixed stories. The modern thinkers “break” the net into three parts, nature, politic and speeches. If this partition is not done, there is no separation between facts and their social context, but their inclusion-imbrication in each of the “moments” of the net.

³ *Ibid.*, p. 28.

⁴ *Ibid.*

⁵ *Ibid.*, p. 59.

⁶ This is a sort of a fairy tale about modernity. In the real world, it happened something totally different. On the one hand, distinguished scientists (Einstein, Darwin) and philosophers of science (Neurath, Putnam, Kitcher) acknowledge that ethical and political values might influence scientific activity. On the other hand, politicians have consistently used science for legitimating their decisions.

Latour also claims that against usual characterizations, “modernity has nothing to do with the invention of humanism, the irruption of the sciences, the laicization of society or the mechanization of the world”⁷.

We, for our part, believe that modernity has a lot to do with all of these, but that is not necessarily all. For example, Richard Westfall, a specialist in the history of modern science states that the move to modernity (in science, of course) is a step to scientific realism⁸. What is also a wild exaggeration is to deny the presence in modernity of humanism, mechanization, etc.

But there is more: “when we see them, i.e. the revolutions, in ‘network’ ... there is no way to build a history of radical rupture ... of misfortunes or irreversible sayings...”⁹. In other words, the modern concept of revolution is abandoned, in the scientific, political, etc. domains.

And, with it, all modern versions of progress disappear, with radical changes and progress towards the future. But, with the distorting addition introduced by Latour that “everything that happens is eliminated forever so that the moderns have the sensation of an irreversible arrow of time, of a capitalization, of a progress”¹⁰.

All this creative paraphernalia of an alternative version of modernity and what it is to be modern, culminates in claiming that “... what we are incapable of doing, now we know it, is really a revolution, be it in science, in technique, in politics, in philosophy”¹¹. This is, perhaps, the most monumental counterfactual ever perpetrated by any intellectual.

2] The Death Sentence for Epistemology

One is tempted to add that everything said by Latour is opposed to what we have learnt in the history of science courses, especially in courses of epistemology on positivism, popperianism, Tom Kuhn, Lakatos, and so on.

⁷ Latour, *Nunca fuimos modernos*, 2007 [1997], p. 62.

⁸ Westfall, *La construcción de la ciencia moderna*, 1980 [1977].

⁹ Latour, *Nunca fuimos modernos*, 2007 [1997], p. 79.

¹⁰ *Ibid.*, p. 104.

¹¹ *Ibid.*, p. 105.

What happens is precisely that Latour proposes that “it is necessary to return to anthropology capable of studying science overcoming the limits of the sociology of knowledge and, above all, of epistemology”¹². Observe, that by decree, Latour, has ruled out not only epistemology but the entire sociology of science, one of which, at one time, he himself defended.

The great problem that Latour faces is that the great scientists, from Aristotle to Einstein, visualize the development of sciences in terms much closer to those of the epistemology and philosophy of science than to Latour’s renewed anthropology that when dealing with famous cases in the history of science commits elementary interpretative mistakes. We will return to this when referring to the answer that Bunge would give to Latour’s interpretation of special relativity.

As it could not be otherwise, Latour explicitly reiterates that “we continue to believe in the sciences, but instead of taking them in their objectivity, their truth, their extraterritoriality, qualities that they never had but by the arbitrary recovery of epistemology...”¹³. That is to say that from Aristotle to Einstein, passing through the modern philosophers, all, while explicitly handling concepts such as truth, explanation, objectivity, etc., were wrong and they told us a story that we must replace by the hodgepodge of hybrids, networks, etc.

However, in that case, they cannot give an acceptable account of what the scientists are doing anytime they are attempting to reach the truth, to explain successfully, to predict with increasing accuracy, etc.

But the worst thing, from the perspective not only of the philosophy of science, but of the human pretension to understand, is that Latour’s version does not tell us everything or the most crucial thing to understand what scientists do in their practice leading to advance hypotheses and decide whether to accept them without reducing that process to negotiations decided by just power. That explains Latour’s failure for explaining paradigmatic scientific examples.

¹² *Ibid.*, p. 138.

¹³ *Ibid.*, p. 207.

2.1] Latour on Special Relativity

By way of example let us consider his version of the special theory of relativity¹⁴.

His central thesis is that the theory of relativity is “social from end to end.” This is because it is about (a) how events are measured in different inertial systems using observers on trains that move at great speed with respect to observers at a station, and (b) transport information without deformation from one human observer to another, so that the problems generated by the different location of the observers arise.

All these statements show that Latour has not the slightest idea of what Einstein holds. On the one hand, the presence of human observers is not an essential requirement for the theory. Einstein mentions them in the public version, but not in the 1905 work on special relativity, as mere rhetorical devices. The important things in 1905 are the laws of transformation that Einstein proposes with the important consequences about the relativity of spatial and temporal measurements, the constancy of the speed of light in inertial systems, the new law of addition of speeds, as well as the fundamental proposal that all the laws of physics (not only the mechanical ones) are invariant with respect to the inertial systems of reference. None of this is mentioned by Latour.

Instead, Latour states that “the book is about how we send an actor from one reference system to another. Instead of describing nature’s laws, it is a book of semiotics, which tries to understand how any narration is constructed.”¹⁵ Our answer is that Einstein can totally dispense with the actors, and that the laws of nature are a priority theme of the book which has nothing to do with semiotic recommendations such as narrative prescriptions.

Lamentably, Latour also invents a “third observer” (in addition to the observer in the train and in the station), that obviously Einstein never mentioned or assumed. Such a third observer “is the author or one of his representatives [telling the story of what happens with the other two observers] who tries to superimpose the observations sent by the other two”¹⁶. This is grotesque, because

¹⁴ Latour, «A Relativistic Account of Einstein’s Relativity», 1988, p. 3-44.

¹⁵ *Ibid.*, p. 9.

¹⁶ *Ibid.*, p. 11.

postulating the existence of a third observer who plays according to Latour the role of a privileged observer, is inconsistent with the very meaning of Einsteinian special relativity (where there is no inertial reference system of privileged observers).

According to Latour, special relativity is, like any scientific theory, a social construction. Why? Latour's response is chilling: the main observer is the third observer, since it is this one that allows "the control of the privileges to discipline docile bodies, as Foucault would say"¹⁷. Our final comment is, "Enough is enough".

This seems to be a paradigmatic example of what happens when scientific rationality is abandoned vociferously, as Latour does: the pretension of objectivity also disappears as well as the assumption that the empirical world is the reference to which we try to elucidate scientific hypotheses and theories. It is also gone that it makes sense to speak of true knowledge or pretense of being true about that world. It is left for later, the growing and almost indispensable relationship between such knowledge and its progress and the exponential growth of the incidence of technology in the life of human societies and their survival. As we will see, Latour's contribution, in this respect, is less praiseworthy because it is almost nonexistent.

However, what is affirmed is not to the detriment of the large crowd of commentators of his work. Among them, there are pragmatists postmodernists (although Latour rejects postmodernism), and Foucault¹⁸, and even followers of Heidegger and phenomenology¹⁹.

This forces us to ask ourselves who obviously criticizes his position. Undoubtedly scientific realist scientists and philosophers of science, and especially a distinguished contemporary representative of them, Mario Bunge, does it.

¹⁷ *Ibid.*, p. 15.

¹⁸ Foucault, *Power/Knowledge*, 1980.

¹⁹ Without identifying or even making them similar, postmodernism and social constructivism share some of their most fundamental notes. For example (a) their negative attitude about modernity, no matter that it is more extreme in Latour than in any postmodern philosopher, (b) the dismissal of the modern concepts of modernity like truth, progress, revolution, (c) the conservative attitude about the social consequences of the use of science and technology.

We have dealt with Bunge's strong critical rejection of Latour's social constructivism²⁰. We must now focus on what we consider to be his most important disagreements with the thesis that "we have never been modern."

3] Mario Bunge: The Counter-Figure to "We Have Never Been Modern"

Let us recall Kant's notes about the Enlightenment²¹, which are also cited by Latour, and that we believe are fully satisfied by the work and intellectual performance of Mario Bunge:

Daring to know, what involves daring to change, to think for itself without being founded on any authority and especially without reference to theological or divine entities.

In addition, the deep belief in scientific progress and that the latter is a promoter of social progress. Such progress is the result of the rational activity of humans in their cognitive approach to nature and social reality which makes it possible to put it at the service of humanity.

If we add to this the normative trilogy of the modern political revolution, i.e. freedom, equality and fraternity, we obtain the modern characterization of the human being as the architect of his own destiny and progress through the use of reason to know and dominate nature and achieve the rational organization of society.

If these notes are accepted, there is no doubt that Bunge does not abjure any of them, whereas Latour does it, insofar as, for example, he strongly criticizes rationality and progress through critical activity with the presence of revolutionary ruptures²².

There is no doubt: in terms of this characterization, Bunge is archetypally modern while Latour is not. They were also modern Galileo, Marx, Einstein, Planck, Bohr, and many others. Therefore, it is not true that we have never been modern. This strange thesis is the result of a characterization of modernity that would make possible such a wrong interpretation.

²⁰ Gómez, « Contra la mala ciencia y peor filosofía », 2000, p. 117-38.

²¹ Kant, *¿Qué es Ilustración?*, 1989 [1784].

²² See Cohen, *Revolution in Science*, 1987, for a careful analysis of the history of the idea of scientific revolution and how it was gradually transformed for encompassing political revolutions.

Someone can affirm that we are in the presence of two stories about us, one by Latour and the other by historians and philosophers of science. And both are conceived as defensible ones.

We are opposed to accept this escape route because, in our opinion, the former has as its ultimate objective to declare by decree the death of the philosophy of science. In other words, it would mean the end of a tradition that has accompanied humanity since its inception, precisely the one that makes possible criticism and the need to evolve (another notion rejected by Latour) through changes, those that culminated in science and technology as engines of human progress. In other words, the tradition that is to culminate in the scientific, political and social modernity.

Another general way of rejecting Latour's proposal about never being modern is by handling the obvious argument that he is accepting:

(P1) If we have been modern, then we believe that there are ruptures, i.e., revolutions in the scientific development, and that the notions of truth and objectivity play a crucial role in a sound version of that development.

(P2) However, there are not truly big ruptures (revolutionary breaks), and truth (as correspondence as well as objectivity) do not actually take place in a sound version of scientific development.

From (1) and (2), it follows that we have never been modern.

However, the problem is with (P2). It is hard to believe; it seems like a sort of a sudden by-product of Latour's imagination. But, according to him, we should believe it, because, as he explicitly affirms, the existence of revolutions, the role of truth in scientific research and the relevance of objectivity are just inventions of epistemology.

By a single stroke, Latour makes that those who like the great scientist, speak of revolutions, truth and objectivity, have taken part in a sort of imaginary concoction.

However, that sounds, at least, like insulting and unbelievable.

Someone might say that scientists make mistakes. Sure, but people like Latour, also. Then the question is who do we trust? In other words, who is more credible about science and its development: great physicists like Einstein or a master of distorting how important scientific theories are, like Latour?

Here we arrived at the ending point: Everyone interested in the issue should make a choice. I have already made mine: (P2) is blatantly false.

Have we ever been modern? No way!

Look at what follows about Mario Bunge.

3.1] Bungean Realism

As an example of the main core of that sort of realism, it is unavoidable to mention some of the fifteen characteristics that Bunge considers to be specific to scientific knowledge:

1. It is explanatory and predictive;
2. It is capable of progress. The modern scientist is a generator of problems, loves the truth, tries to prove new and uncertain, makes mistakes and learns from them;
3. It is useful and also represents social advances.

Bunge clarifies that technology consists of the treatment of practical problems through a scientific approach, which can also offer growth through the invention of new theories or research techniques.

More important than all of this is Bunge's strong attachment to the distinctive and separating note of the Medioevo from modernity; the key break is about the cognitive value of laws and scientific theories: they pass from mere predictive instruments to statements about the reality of the natural world²³.

Bunge, of course, is more modern than most of his colleagues in that regard because he defends a particular form of realism that has been characterized as "bungean realism", understood as a variety of scientific realism conceived by Bunge as a form of hyperrealism that goes hand in hand with the realistic ontological thesis, also being "materialist, systematic and emergentist"²⁴.

²³ Galileo is then the first representative of modern scientific realism. To defend heliocentrism (Copernicus) was not enough for becoming a modern scientist insofar as he was outspokenly an instrumentalist just as the medieval astronomers were.

²⁴ According to Bunge, scientific realism is one of the defining notes of the Scientific Revolution "... the scientific revolution was much more than a new view of science: it also included a new cosmovision, mechanicism, and a new gnoseology, scientific realism" (Bunge, *A la caza de la realidad*, 2012 [2006], p. 74).

Bunge affirms that the main assumption of materialism is that “all material things and only them, together with their properties and changes are real”²⁵. The systemic hypothesis can be stated as follows: all properties are given in packages, not isolated from each other. This implies that all entities are already systems, already current or potential constituents of systems, such as cells and genes. What is in reality is therefore a system or a component of such. Systemism is therefore a structural vision of something that in the case of systemic materialism is composed of matter.

Furthermore, as we will point out below, insofar as bungean realism is also valid for ethics and politics, it deals, for example, with “value packages, such as freedom, equality and fraternity, instead of isolated values”²⁶. This can be taken into account to criticize the neoliberalism that considers as a supreme value the free market, without discussing in detail the price that is paid in terms of equality and fraternity²⁷.

Being systemic, the bungean materialism is “emergentist”: “every system has properties that lack their constituents, starting with their composition”²⁸. The explicit corollary is “the existence of several levels of reality, each of which has emerged from preceding levels in the course of a process”²⁹.

Bunge also talks about seven aspects of such realism: ontological, gnoseological, semantic, methodological, axiological, moral and praxiological. The extension of realism to all those levels or dimensions is in itself a very rich novelty in contemporary realism.

Ontological realism affirms the existence of the world independently of the knowing subject in which things and facts are studied through “constructs” (data, hypothesis, models and theories). The existence of the outside world is “shown” by the presence of our errors, which makes explicit that there is something different from us and that it is not constructed. Everything we know of that world

²⁵ Bunge, *Memorias*, 2014, p. 56.

²⁶ *Ibid.*, p. 235.

²⁷ Milton Friedman’s view about the issue is the most honest recognition that any question about inequality and social justice (1967) should remain out of the sphere of economics. Consistently, the market (the Big Game) is beyond good and evil and no one is responsible for those who are the losers, i.e. the poor.

²⁸ Bunge, *Memorias*, 2014, p. 235.

²⁹ *Ibid.*

has an emergent property, against physicalism, which gives rise to a philosophy of mind and social philosophy.

Gnoseological realism presupposes the ontological as it states that reality is knowable, although it is an imperfect knowledge but always perfectible so that scientific hypotheses can be corrected to approximate the truth. The knowledge of the world is therefore always incomplete, indirect and fallible. Such realism is therefore not naive in that it does not deny the possible existence of errors in the act of knowing.

Moreover, the presence of metaphysical assumptions is unavoidable as well as that of auxiliary hypotheses to enable empirical testing.

Semantic realism holds that some propositions are about facts and not just about ideas, that some are approximate to the truth and that every approach is perfectible.

The strong thesis is that only those facts described by variables included in the laws of a theory are considered genuine references of that theory. For example, quantum mechanics does not refer to subjects of any kind because they do not appear in their laws, which makes the Copenhagen interpretations wrong.

While a correspondence theory of truth is assumed, truth values only emerge in the testing of the theory; there are therefore no inherent values of truth of a proposition because it can change with time.

Methodological realism assumes, on the one hand, that the scientific method consists of a general strategy of knowledge acquisition that involves experience, reason and imagination, on the other hand, the testing is global, affecting the whole theory. The explanation of regularities always requires, for being reliable, that it be through mechanisms.

3.2] Bungean Realism and Quantum Mechanics

These types of realism so far mentioned converge in Bunge's treatment of quantum mechanics. It is here that the novelty of Bungean realism, especially ontological and epistemological, appears explicitly. The formalism of quantum mechanics must be interpreted as being about very particular entities of nature that exist independently of the knowing subject. Bunge calls *quanton* such *sui*

generis entities³⁰. Their main characteristic is that they are fuzzy entities; this means that the physical world is not composed only of entities whose properties always have precise values. For example, the values of the electric charge can be defined at any moment with precision, but position, momentum and energy of the quantons are normally undefined (fuzzy) in the sense that their values are numerical ranges instead of unique numbers.

This specific character of the quantons differentiates Bunge's position from those that, according to him, such as Einstein's, are not truly realistic, since by holding that all entities in the world are always measurable, they could not cover the quantons. Einstein, according to Bunge, does not hold a realistic position but a classicist one because he believes that ultimately all entities are describable by classical or neoclassical theories.

In summary: Bunge believes that quantum mechanics describes a very special world (as opposed to the Copenhagen interpretation) composed of real entities unknown to classical physics whose states are described by state functions that they are not directly observable.

As a consequence, Bunge proposes a different version of the interpretation of, for example, the principle of indeterminacy of quantum mechanics. Bunge affirms that such a principle "relates the standard deviation of the position and momentum of a quantum in any arbitrary state and any moment of time"³¹. Note that for Bunge "the observer is not among the referents of quantum theory and the apparatus appears only when it is explicitly represented in the state function of the system"³².

Heisenberg's indeterminacy inequality expresses a nonclassical objective property of the quanton that "has nothing to do with measurements or mental states ... [emphasizing] that quantons are not punctual particles ... [and therefore] have no precise trajectories"³³. Therefore, what the principle does is to reveal a new mode of behavior in the orb.

³⁰ Bunge, *Epistemology III (1): Formal and Physical Sciences*, 1985, p. 171.

³¹ *Ibid.*, p. 181.

³² *Ibid.*, p. 191.

³³ *Ibid.*, p. 182. See, for example, Heisenberg, *Physics and Philosophy*, 1958.

Consistent with the above, Bunge argues that Bell's work, by showing that quantum mechanics violates Bell's inequalities, implies that no theory of local hidden variables can reproduce all the predictions of quantum mechanics. Bunge argues that Bell's work emphasizes that the objective of a theory of hidden variables of restoring realism failed, but that objective can be achieved without appealing to such variables. The realism left out of the scene is that which, like the EPR, assumes localism (distant things always behave independently of one another) and determinism.

But it does not allow us to conclude that the failure of Bell's inequalities in quantum mechanics has refuted the philosophical realism according to which the physical world exists without help from those who want to know it, against the interpretation of Heisenberg or Bohr that Bunge considered out of place to account for the epistemological status of quantum mechanics.

From the ontological point of view, Bunge believes that there is a kind of systemic holism (for example, given two quantons that are initially parts of a system, the state of each component is not only determined by local conditions but also by still belonging to a system). That is, physical separation implies spatial separation, but the converse is not true. Bunge, unlike classicists like Einstein, accepts distant correlations so if there are certain quantons being part of a system they always will be.

3.3] Axiological and Practical Realism

It assumes that there are "objective values", those rooted in biological and social needs. They are attackable and defensible in a rational way with the help of scientific knowledge. These values include health, knowledge, security and peace, among others. They are not absolute and tensions may arise between them. It is remarkable that Bunge affirms that axiological neutrality is not desirable or always possible since there are objective values worthy of being protected such as truth, justice and peace. Note that the values Bunge speaks of are not only epistemic.

Practical realism proposes that while there are medium-end pairs and there are objectively more efficient means to achieve certain ends, and as our actions may affect third parties, we have, therefore, to take into account the foreseeable consequences. Ergo, practical realism has to submit to a principle of responsibility.

To conclude: It is important to emphasize the strong character of this scientific realism, which encompasses much more than the cognitive dimension of human activity.

It should also be clarified that in philosophy of mathematics Bunge is not a realist of any kind but defends a moderated “fictionism”, while in aesthetics he considers realism a conservative position, and in politics as a form of “political cynicism” so that he rejects it openly.

Be aware that all these notes that characterize Bunge’s position, not only involve a strong attachment to the epistemological approach but, especially, that his notes of scientific realism and science are exactly opposite to those that Latour denies to modernity with which never, according to him, were we related: truth, change, progress, rationality, among others.

We cannot fail to mention, in this regard, that the Latourian elucidation of artifacts, those that have basically changed the ontology of the world in which we live and do science, is even more susceptible to being rejected by Mario Bunge.

3.4] A Short Remark About Technology and Human Responsibility

We believe it is important to highlight two aspects of the enormous differences in this respect between both authors. Mario Bunge, undoubtedly the philosopher who introduced the philosophy of technology in the Hispano-American world, believes that this philosophy consists of five fundamental components: techno-metaphysics, which deals with discussing the status of artifacts, techno-epistemology, which discusses the distinctive characteristics of technological knowledge, techno-axiology, occupied with the distinctive characteristics of the values present in the decisions related to the knowledge and use of artifacts, techno-ethics that discusses how to elucidate the positive character (good or not) of artifacts and their knowledge and use, and techno-praxiology, whose main theme is that of technological rationality. Of course, there has been different views about technology, from Aristotle through Marxism and neo-Marxism: the optimism of the majority of those who deal with

applied science; the pessimism of Ellul³⁴, and the contemporary versions such as Feenberg³⁵ and Winner³⁶.

Then, just as Latour rejects as irrelevant any discussion about the scope of the different philosophies of science, because all philosophy in this respect must be replaced by an anthropological-scientific approach, something analogous happens to the philosophy of technology. Hence any discussion about positions since Aristotle, Marxists and contemporary philosophers disappears in his work.

This, of course, does not prevent the philosophers of technology from eventually referring to Latour. Thus, Winner, from a philosophical stance with technological pessimistic tints, criticizes Latour's position on the social constructivism of technology. First, it highlights the imperialist pretension of Latour's approach because it aims to open the black box of technology throughout history to its current state³⁷.

Without considering the summary and critiques of Latour's position by Winner, it is essential to emphasize what he considers to be the most obvious defect of sociological constructivism: "an almost total disregard for the social consequences of technical choice"³⁸. That is, it neither took into account the quality of daily life that is generated by choice or decision, nor the distribution of power in society, the texture of human communities, social relations, etc. Winner also wonders what happens to groups that have no voice but are affected by the results of technological change and what happens to groups that have been deliberately excluded.

Winner is proposing, without saying it, that Latour's position is an obvious form of elitism. More than that: Winner stresses that by not taking into account the social consequences (consequences to change society and those that do not affect it socially), what is offered is an implicitly conservative version of society and politics. Latour's version, therefore, conceals as much as it reveals; for example, nothing is said about which groups "have been left out of the laboratory and which voices have been silenced." Nor is an

³⁴ Ellul, «The Technological Order», 1983.

³⁵ Feenberg, «Democratic Rationalization», 2014.

³⁶ Winner, «Do Artifacts Have Politics?», 2014.

³⁷ *Ibid.*

³⁸ Winner, «Social Constructivism», 2003, p. 237.

“evaluative stance,” or any kind of ethical or political principle, that helps people judging possibilities open by technologies.

That is to say, the sociological constructivism is agnostic about the evil-good that they accrue or accompany (linked to particular technological achievements). More briefly and emphatically: social constructivism does not have any stance about the relationship between technology and human welfare. It is actually morally and politically indifferent.

Latour’s social constructivism then looks as an academic point of view sanitized of any critical posture that might contribute to the critical discussion about the ethical, political and even ecological dimensions of technological choice.

Winner concludes that the box opened by Latour and other social constructivists is obviously empty.

Enough, again. Latour’s view is totally opposed to the fact of even posing the questions of an ethical and axiological dimension incapable in Bunge’s proposal and central to any modern position.

In addition, such failure in stressing that ethical and axiological dimension is in open opposition to the realizability of what Bunge calls “integral development”, the “statement that the thesis of authentic development and that benefits the people is not only economic, but also sanitary, cultural and political”³⁹. This idea “contradicted the two dominant currents of scientific policy: the economism defended by economists and the anti-science preached by both the economists and the right wingers of a new stamp”.

We cannot fail to mention a masterly statement by Bunge about the dominant neoliberal economics, the one about which Latour & Co. keep absolute silence: “standard economic theory is built on vague concepts, lacks empirical support, does not serve to face the crisis because it assumes that the economy is always in balance and disregards the suffering caused by poverty, inequality, unemployment and economic crises”⁴⁰. Otherwise, Bunge, the modern, deals with something that Latour disregards: Everything related to a more fortunate future of the people.

³⁹ Bunge, *A la caza de la realidad*, 2012 [2006], p. 316.

⁴⁰ *Ibid.*

4] Bungean Moral Realism: The Hard-Core of Epistemological Progress

Bunge strongly believes in the existence of epistemological progress. There is epistemological progress every time a certain epistemology allows a better understanding of the contemporary state of science (or of a certain science) also realizing that the corresponding scientific development is also progressive.

More clearly: A paradigmatic example of that progress is the obvious fact that in the last twenty years, at least, a thesis that reduces and impoverishes the complexity of scientific activity has been demystified. Until the nineties of the last century it was a kind of mortal sin to affirm that the scientific activity is loaded with both epistemic and non-epistemic values (peace, the well-being of a certain group, etc.). This was the consequence of the maintenance of two founding myths: the dichotomy of factual judgments/value judgments, and the inescapable identification of scientific objectivity with the evaluative neutrality of the scientific activity.

Today all this is past. Hallelujah: there is no such a dichotomy⁴¹ as evidenced in statements like “the Nazis were evil” in which there is an entanglement between the empirical and evaluative content of it. But, as Bunge will argue, while it is possible to consider that certain values are objective, the presence of them in a research process does not color it with any subjectivity. The point is, even as Bob Nozick⁴², not precisely a scientific realist, stated years ago, that science is objective because of the values it is infused with.

Mario Bunge has in this regard a solid defense of such objectivity and a clear elucidation of why the unavoidable presence of values of all kinds in all contexts, even in the context of justification, does not necessarily imply the absence of objectivity; everything depends on what values and how they intervene.

Bunge proposes that “objectivity should not be confused with neutrality regarding values”⁴³, because, for example, the search for certain values (such as welfare, peace and security) is preferable to

⁴¹ See, for example, Putnam, *The Collapse of the Fact/Value Dichotomy and Other Essays*, 2002.

⁴² Nozick, *Anarchy, State, and Utopia*, 1975.

⁴³ Bunge, *A la caza de la realidad*, 2012 [2006], p. 62.

that of others. Such objectivity is constitutive of scientific realism since the modern scientific revolution.

It is even deeper, because certain values are objective “because they are rooted in biological and social needs”⁴⁴. Therefore, instead of arguing that the fact/value dichotomy leads to the naturalistic fallacy, Bunge and the moral realists “consider the fact/value an over-naturalist or irrationalist fallacy”⁴⁵. Such objectivity makes it possible for these objective values to be discussed on scientific grounds.

Therefore, statements containing objective, even moral, values can be considered as true or false. To do this, they must always be put in context: “from a situational perspective ... lying, stealing and helping others without expecting a reward are moral facts; and the norms and counter-norms associated with these facts are true because they conform to the supreme moral principle: enjoy life and help others live lives worthy of being enjoyed”⁴⁶. The quote says it all: moral realism assumes the existence of moral facts and, therefore, moral truths.

The main example that Bunge uses is more than revealing: “Poverty is a moral fact, not just a social fact, because it involves unnecessary suffering and degradation” and “the creation of work is a moral fact not only an economic fact, because it satisfies the right to work”⁴⁷.

Nothing therefore prevents that such moral facts in which every society is involved can be studied with the help, not only of factual truths, but also moral ones.

Without a doubt this constitutes an enormous epistemological progress, involving a different moral treatment of the considered facts, with respect, for example, to the neoliberal proposals of Hayek⁴⁸ and Friedman⁴⁹. Faced with the lack of human compassion in all of Hayek’s work proposals on economics and vociferated in

⁴⁴ *Ibid.*, p. 363.

⁴⁵ *Ibid.*, p. 364.

⁴⁶ *Ibid.*, p. 365.

⁴⁷ *Ibid.*

⁴⁸ Hayek, *Studies in Philosophy, Politics and Economics*, 1967.

⁴⁹ Friedman, *Capitalism and Freedom*, 1967.

Friedman's work, Bunge would never negotiate such virtue, human companionship, when seriously analyzing facts involving it⁵⁰.

All this seems to be not only epistemological but also moral progress according to Bungean realism.

Not all truths are true in any context. Moral truths are not, because they "ultimately concern rights and obligations and since they are related to a culture and its moral code ... therefore, they are contextual"⁵¹. In our Western context, "it is good for us to do good works, unless one has been educated in the harsh school of orthodox economics, for which selfishness is the supreme virtue"⁵². That is, on the one hand, moral truths are contextual, on the other hand, there is an enormous distance from Friedman and neoliberal views about the relationship between economics and ethics to Bunge's revival of the relevance of ethics when dealing with economic issues.

Besides, having a clear view of the contextuality of moral truths requires perceiving that "all moral imperatives can be expressed in the indicative way. The imperative 'you will not kill' can be translated as 'killing is bad'". This translation "designates a proposition that is true in every moral code that affirms the right of persons to life and is false in every code that does not admit such a right"⁵³.

The most obvious consequence is the possibility of empirical testing of moral standards. This is possible in three complementary ways: coherence or compatibility with higher-level principles, compatibility (with the best common knowledge, scientific or technological available), and contribution to individual or social well-being⁵⁴. Like the scientific truths, they are perfectible, "what discards the possibility of a perennial ethic, modeled for perfect humans who live in a perfect society"⁵⁵.

⁵⁰ The most explicit examples of Friedman's extremism about ethics and economics show up in his most quoted book, *Capitalism and Freedom*.

⁵¹ Bunge, *A la caza de la realidad*, 2012 [2006], p. 368.

⁵² *Ibid.*, p. 369.

⁵³ *Ibid.*, p. 371.

⁵⁴ *Ibid.*, p. 372-73.

⁵⁵ *Ibid.*, p. 374.

As a consequence, ethical theories can be tested in a similar way to scientific theories, i.e. “agreement with the relevant facts and compatibility with other theories”⁵⁶.

Bunge himself allows us to end this section with what we started with: the categorical denial of the fact/value dichotomy in contemporary epistemology: “In short, there are facts and moral truths. The former are part of the fabric of reality and the moral truths are interwoven with other factual truths”⁵⁷.

To conclude: there is no stronger and more welcome version than the bungean one of the entanglements between science and ethics, especially in a scientific realist view.

5] Moral Realism as a Critical Foundation of the Theory of Rational Choice

It is known that such theory constitutes the unavoidable principle of orthodox economics and neoliberalism. It is the one that cannot be abdicated even though it is falsified by the empirical activity of human beings and by agents in the market. According to this principle, to act rationally is to try to maximize the achievement of the goal, and therefore, in the capitalist market, this means acting efficiently in order to maximize profit.

On the problems cited by Bunge that this principle has it should be emphasized that (a) real-life actors are very rarely free as assumed in the theory discussed, (b) they are constrained by social and moral norms. Therefore, you should not aim to maximize efficiency because you will sacrifice other values, such as welfare and environmental protection. Similarly, before the praise of supposed benefits of the globalization of the free market, it is necessary to discuss how to “correct or compensate for the growing imbalances it produces”⁵⁸.

There are deep theoretical problems underlying what Bunge says. The theory of rational choice assumed by neoclassicism and neoliberalism takes for granted that we choose, decide and act according to the objective order of our preferences. However, we could establish, in principle, the objective order of preferences of an

⁵⁶ *Ibid.*, p. 375.

⁵⁷ *Ibid.*, p. 377.

⁵⁸ *Ibid.*, p. 379.

individual, but there is no dependable way of establishing interpersonal utility comparisons, because the levels of desire are totally subjective. We could not establish how much more utility would obtain a consumer of a given good than another consumer of the same good. We could also not measure in a dependable way the utility differences for a single individual; for example, statements like “we achieve three units more of utility from a pear than from a peach” are not dependable.

Therefore, it cannot use Bentham⁵⁹ utilitarian formula that considered a certain result as the best for all the society if it is the greatest sum of utility of all the members of that society (because this assumes that it is possible to measure the utility for each individual). Accordingly, the maximum of utility cannot be used as a normative principle.

Pareto’s criterion came to the rescue: a result A is Pareto-superior to a result B, if at least an individual in the society prefers A to B, whereas no one prefers B to A. Moreover, a result for which there is no other result that would be Pareto-superior is called “Pareto optimum”⁶⁰. However, this merely apparent solution is irrelevant because people’s preferences are not linearly ordered. The standard solution is to use the Kaldor-Hicks criterion⁶¹. According to it, a result A is Pareto-superior to a result B if those who are better in the situation A could compensate those who would be better in the situation B, and yet would have a net benefit. As a matter of fact, this criterion favors always those results that involve a bigger quantity to distribute, although some members of the society receive less than in another situation where it would be less to distribute. Besides, the criterion emphasizes the potential distribution over the actual one; the winner “could” compensate the loser but this does not mean that she should be committed to do it.

Most importantly is to stress the fact that all this is, then, ethically neutral and innocuous with respect to the obligation of dealing with the inequalities. In other words, all this terminological paraphernalia is metrically insufficient, because it makes neoclassical and neoliberal economics ambivalent with respect to elementary

⁵⁹ Bentham, *A Fragment on Government*, 1776.

⁶⁰ Pareto, *Manual of Political Economy*, 1906.

⁶¹ Kaldor, «Welfare Propositions of Economics and Interpersonal Comparisons of Utility», 1939, Hicks, «The Foundations of Welfare Economics», 1939.

problems of inequality. If it could be decided to distribute half a million dollars of a rich person for inoculation of poor kids and improve their health, society would be better in this situation than if the distribution would not have been made; but, according to the same neoclassical theory, the millionaire would suffer a certain loss, a loss of utility. There is no way of comparing with any metric, according to all the neoclassical frame adopted by neoliberalism, the loss of utility suffered by the millionaire with the one won by those who were inoculated. But that ambivalence is a political and ethical disaster, because, as a consequence, in the real practice the final decision is taken by those with more power. In the most vital issues, from a social point of view, the assumed scientific rigor disappears and is replaced by voluntarism or by barbarianism.

The worst outcome is that any question of equality and social justice is out of the domain of economics, and is not related at all with the evaluation of the behavior of the market and its results.

Therefore, the market is beyond good and evil, and is not responsible—truly speaking no one is—of those who are annoyed by the market results. More precisely, the market is beyond any moral judgment.

And that, and precisely that, is a moral disaster that Bunge's recent views on moral realism outspokenly denounces and makes him call to overcome neoclassical and neoliberal economics.

There is much more, such as linking realism and scientism to materialism, obtaining the triad that Bunge calls scientific hylorealism.

However, it is the same empirical reality and its complexity approached by such hylorealism that invites us to be fair with the reader and to stop supposing to have shown convincingly the unique character of Mario Bunge as a philosopher of science for (a) his respect of the reality of which science is made, (b) its detailed and always updated analysis of it, (c) its defense of the possibility of knowing it as it is and, especially, (d) its indisputable achievement of a global version that does not leave out the ethical dimension constitutive of human reason.

And this makes him different, much more so when in the twentieth century two fatal reductionisms had been consummated: first, of philosophy of science to epistemology and second, of the latter to

the logic of scientific research thus impoverishing both the reality addressed and its critical study.

Bunge is a living example of the rejection of those reductionisms. And mainly, of another even more damaging reduction: that of human reason to theoretical reason. That means that Bunge has not left out the rational discussion of our choices and their consequences. In other words, what modernity called practical reason is back in the domain of science and its philosophy.

Acknowledgements

I appreciate the excellent comments of the proofreader that allowed a clearer and more rigorous final version of this paper.

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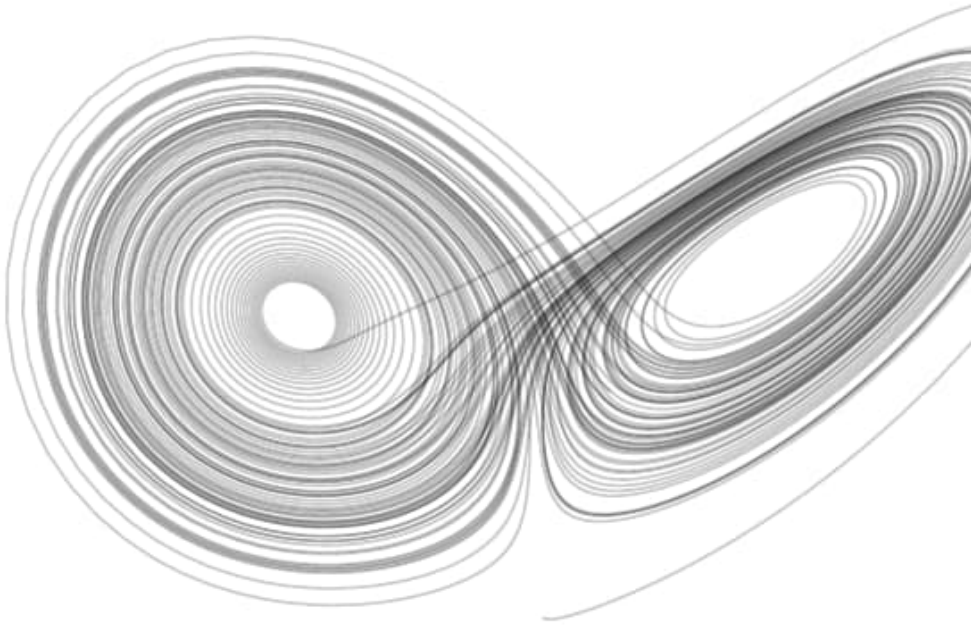
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3

Reflections and Testimonies



Criticism: Destructive and Constructive

Mario Bunge¹

Abstract — In the scientific communities most criticisms are constructive, while they are destructive in the humanistic circles. Indeed, scientists circulate their drafts among colleagues and students, hoping to elicit their comments and suggestions before submitting their work to publication. In contrast, philosophers and political thinkers attack their rivals, without sparing arguments *ad hominem* or even insults. The reason for this difference is that scientists are after the truth, whereas most humanists fight for more or less noble causes, from swelling their own curricula to joining crusades for or against rationality, realism, justice, or what have you.

Résumé — Chez les scientifiques, la plupart des critiques sont constructives, alors qu'elles sont destructrices chez les humanistes. En effet, les scientifiques font circuler leurs brouillons entre collègues et étudiants, dans l'espoir de recueillir leurs commentaires et suggestions avant de soumettre leurs travaux à la publication. En revanche, les philosophes et les penseurs politiques attaquent leurs rivaux à coup d'arguments *ad hominem* et d'insultes. La raison de cette différence est que les scientifiques recherchent la vérité, alors que la plupart des humanistes se battent pour des causes plus ou moins nobles, allant de la promotion de leur propre programme à la participation à des croisades pour ou contre la rationalité, le réalisme, la justice ou autre.

In the scientific communities most criticisms are constructive, while they are destructive in the humanistic circles. Indeed, scientists circulate their drafts among colleagues and students, hoping to elicit their comments and suggestions before submitting their work to publication. In contrast, philosophers and political thinkers attack their rivals, without sparing arguments *ad hominem* or even insults.

The reason for this difference is that scientists are after the truth, whereas most humanists fight for more or less noble causes, from swelling their own curricula to joining crusades for or against rationality, realism, justice, or what have you. An extreme case is Einstein's criticism of the subjectivist philosophy of Ernst Mach,

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whose work in experimental physics Einstein respected and lauded. Another exemplar is Lenin's criticism of the idealist physicists of his time, whom he called "lackeys of the bourgeoisie". He felt no respect for his targets because he did not understand their contributions to science.

Around 1950 I regarded myself as a student of Marxism and was ready to face the establishment's philosophy of science, which was operationist—in summary, "time is what clocks measure". I was duly provoked by the talk that Leo Rosenfeld—Bohr's lapdog—gave at the Sao Paulo Institute of Theoretical Physics in 1951, where I was spending a semester as David Bohm's postdoc student. Rosenfeld was an easy target, for he went as far as to claim that locomotives worked because their machinists shared the principles of thermodynamics. I wrote a critical paper that the *British Journal for the Philosophy of Science* published on the recommendation of Karl Popper².

However, I was dissatisfied with the job of gravediggers: I wished to grapple with philosophical problems. To fulfill this task I bought an elegant notebook with straw covers, to be filled exclusively with my thoughts on philosophical problems. I waited in vain for inspiration. The philosophical works of the classics of Marxism had prepared me for destructive criticism, not for working on fresh problems. I had not realized yet that philosophical schools are essentially barren.

Inspiration struck only in about 1966, while teaching the two relativities at the University of Delaware. There I axiomatized both theories and advised a couple of students, who wrote a paper each. Shortly thereafter I conceived of the research project that would keep me busy during the next few years. This was to construct an objective alternative to the standard or Copenhagen interpretation of quantum mechanics, a theory that I had taught in both my native Argentina and in the USA.

The completion of this task led me to propose an enrichment of conventional axiomatics, consisting in accompanying every mathematical postulate with a semantical assumption. For example, an axiom of the form "X is a Hermitian operator" would be paired with

² «Strife about Complementarity (I)», 1955 and «Strife about Complementarity (II)», 1955.

“X represents the energy of an arbitrary quanton (quantum-mechanical entity).” I call *dual axiomatics* this enriched version of conventional axiomatics, and claim that it avoids philosophical grafts and clarifies a number of obscure points in the ordinary or heuristic formulations. For example, it becomes clear that all the references to observers in the theorems are illegitimate because they do not occur in the axioms, and that the geometric coordinates individuate points in space, not particle positions.

My student and coworker Andrés Kálnay, as well as the Nobel Prize winner Willis Lamb adhered to my reconstruction of quantum mechanics. Lamb wished me to join him in a research project, but he caught me when I was immersed in the philosophy of social science. My project in quantum theory was continued by Héctor Vucetich and his students at my alma mater, the University of La Plata, in particular Gustavo Romero and Santiago Pérez Bergliaffa. In short, I realized that the most effective criticism is the one accompanied by a suitable substitute. The end result of that decade of work are my books *Foundations of Physics* and *Scientific Research*, both published by Springer in 1967³.

My next essays in constructive criticism were my works in the philosophy of mind⁴ and on political philosophy⁵. I criticized psycho-neural dualism as a barren pseudoscience, and parliamentary democracy as a partial and therefore ineffective political regime. I tried to show that cognitive neuroscience delivers all that had been attained by brainless psychology and then some. I also argued that the shortcomings of parliamentary democracy are corrected by expanding it into integral democracy, not by rejecting it the way the Marxist-Leninists had done.

My brief passage in 1951 through a Peronist jail for political dissidents had persuaded me that civil liberties, though insufficient, are necessary for an acceptable quality of life. Integral democracy seems to include the merits of both political democracy and genuine socialism. But I still have no clue as to how to effect a peaceful transition from political to integral democracy.

³ *Foundations of Physics*, 1967, *Scientific Research I*, 1967, *Scientific Research II*, 1967.

⁴ *The Mind-Body Problem*, 1980.

⁵ *Political Philosophy*, 2009.

In sum, destructive criticism is occasionally necessary but it does not beget new ideas and it satisfies our hunting instinct but not our need for creative and peaceful cooperation. The progress of science, technology and the humanities calls for invention and constructive criticism, that is, criticism in the service of progress, not of political power.

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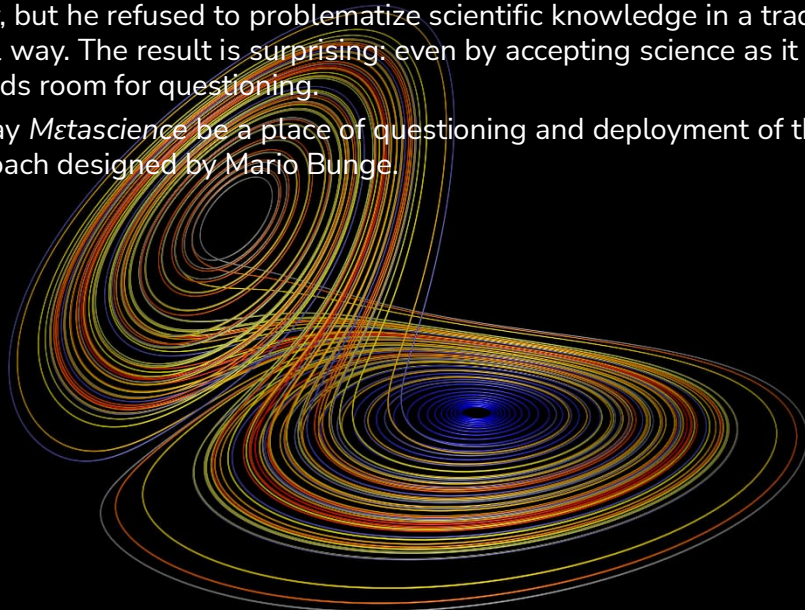
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This inaugural issue of the journal *Metascience* is also a special issue since it pays tribute to **Mario Bunge (1919-2020)** to highlight his contribution to knowledge and our filiation with his thought. Mario Bunge's project is part of the humanist and scientific tradition of the Enlightenment. At the end of his intellectual journey, he wrote more than 150 books and 540 articles or chapters, including translations into several languages. The work covers almost all branches of philosophy, from ontology to ethics, semantics, epistemology, methodology, praxeology and axiology, as well as a large number of scientific disciplines, ranging from physics to sociology, chemistry, biology and psychology. Without a doubt, Bunge's magnum opus is the *Treatise on Basic Philosophy* in nine volumes (1974-1989).

The six contributions gathered here come from authors from different backgrounds. Like Bunge's project, they are neither part of the analytic or continental movement in philosophy. The reader will find studies on the Bungean system, applications of Bungean thought, reflections and testimonies, and metascientific contributions.

From the point of view of metascience as theorized in these pages, Bunge is the last of the philosophers and the first metascientific. He kept from philosophy the idea of a complete system that would integrate semantics, ontology, epistemology, ethics, axiology and praxeology, but he refused to problematize scientific knowledge in a traditional way. The result is surprising: even by accepting science as it is, he finds room for questioning.

May *Metascience* be a place of questioning and deployment of the approach designed by Mario Bunge.



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