Theory and History of Ontology (www.ontology.co) by Raul Corazzon | e-mail: rc@ontology.co

Selected bibliography on the Scientific Philosophy of Mario Bunge

Contents

This part of the section Ontologists of 19th and 20th centuries includes of the following pages:

Introduction

"The Treatise encompasses what the author takes to be the nucleus of contemporary philosophy, namely semantics (theories of meaning and truth), epistemology (theories of knowledge), metaphysics (general theories of the world), and ethics (theories of value and of right action). Social philosophy, political philosophy, legal philosophy, the philosophy of education, aesthetics, the philosophy of religion and other branches of philosophy have been excluded from the above quadrivium either because they have been absorbed by the sciences of man or because they may be regarded as applications of both fundamental philosophy and logic. Nor has logic been included in the Treatise although it is as much a part of philosophy as it is of mathematics. The reason for this exclusion is that logic has become a subject so technical that only mathematicians can hope to make original contributions to it. We have just borrowed whatever logic we use.
The philosophy expounded in the Treatise is systematic and, to some extent, also exact and scientific. That is, the philosophical theories formulated in these volumes are (a) formulated in certain exact (mathematical) languages and (b) hoped to be consistent with contemporary science.
Now a word of apology for attempting to build a system of basic philosophy. As we are supposed to live in the age of analysis, it may well be wondered whether there is any room left, except in the cemeteries of ideas, for philosophical syntheses. The author's opinion is that analysis, though necessary, is insufficient - except of course for destruction. The ultimate goal of theoretical research, be it in philosophy, science, or mathematics, is the construction of systems, i.e. theories. Moreover these theories should be articulated into systems rather than being disjoint, let alone mutually at odds.
Once we have got a system we may proceed to taking it apart. First the tree, then the sawdust. And having attained the sawdust stage we should move on to the next, namely the building of further systems. And this for three reasons : because the world itself is systemic, because no idea can become fully clear unless it is embedded in some system or other, and because sawdust philosophy is rather boring." (vol. I pp. V-VI)

From: Mario Bunge, *General Preface to the Treatise*, in: *Treatise on Basic Philosophy*, Dordrecht: Reidel 1974.

Main publications

1. Bunge, Mario. 1959. *Causality. The Place of the Causal Principle in Modern Science*. Cambridge: Harvard University Press.

   Third revised edition in 1979 with the title: *Causality and modern science* - New York, Dover Publications.
   From the preface to the first edition:
   "This is an essay on determinism, with special emphasis on causal determinism -- or causality, for short. To some, causation and determination -- and consequently causalism and determinism -- are synonymous. But to most people, determinism is a special, extreme form of causality -- and even a particularly displeasing one, for it is wrongly supposed to deny man the possibility of changing the course of events. I take sides with the minority that regards causal determinism as a special form of determinism, namely, that kind of theory that holds the unrestricted validity of the causal principle to the exclusion of every other principle of determination. The rational ground for regarding causality as a form of determinism, and not conversely, is that modern science employs many noncausal categories of determination or lawful production, such as statistical, structural, and dialectical, though they are often couched in causal language.
   In this book, the causal principle is neither entirely accepted nor altogether rejected. My aim has been to analyze the meaning of the law of causation, and to make a critical examination of the extreme claims that it applies without restriction (causalism), and that it is an outmoded fetish (acausalism). I have tried to do this by studying how the causal principle actually works in various departments of modern science. However, I hope I have succeeded in avoiding technicalities -- save in a few isolable passages. The book is, in fact, addressed to the general scientific and philosophic reader.
   The chief result of the above-mentioned examination is that the causal principle is neither a panacea nor a superstition, that the law of causation is a philosophical hypothesis employed in science and enjoying an approximate validity in certain fields, where it applies in competition with other principles of determination. a by-product of this analysis is a fresh examination of various topics in metascience, ranging from the status of mathematical objects to the nature and function of scientific law, explanation and prediction." (pp. V-VI).
   Index: Part I. A clarification of meaning. 1. Causation and determination, causalism and determinism; 2. Formulations of the causal principle; Part II. What causal determinism does not assert. 3. An examination of the empiricist critique of causality; 4. An examination of the romantic critique of causality; Part III. 5. What causal determinism assert. 5. The linearity of causation; 6. The unidirectionality of causation; 7. The externality of causation; 8. Causality and novelty; Part IV: The function of the causal principle in science. 9. Causality and rational knowledge; 10. Causality and scientific law; 11. Causality and scientific explanation; 12. Causality and scientific prediction; 13. The place of the causal principle in modern science; Bibliography; Index.

2. ———. 1959. *Metascientific Queries*. Springfield: Charles C. Thomas Publisher.

3. ———. 1960. "Levels: A Semantical Preliminary." *The Review of Metaphysics* no. 13:396-406.

4. ———. 1960. "The Place of Induction in Science." *Philosophy of Science* no. 27:262-270.

5. ———. 1961. "The Weight of Simplicity in the Construction and Assaying of Scientific Theories." *Philosophy of Science* no. 28:260-281.

6. ———. 1961. "Kinds and Criteria of Scientific Law." *Philosophy of Science* no. 28:260-281.

7. ———. 1961. "The Complexity of Simplicity." *Journal of Philosophy* no. 59:113-135.

8. ———. 1961. "Ethics as a Science." *Philosophy and Phenomenological Research* no. 22:139-152.

9. ———. 1961. "Analiticy Redefined." *Mind* no. 70:239-245.

10. ———. 1962. *Intuition and Science*. Englewood Cliffs: Prentice-Hall.

11. ———. 1962. "Causality: A Rejoinder." *Philosophy of Science* no. 29:306-317.

12. ———. 1963. *The Myth of Simplicity. Problems of Scientific Philosophy*. Englewood Cliffs: Prentice-Hall.

    From the Preface:
    "The aims of this book are two. First, to contribute to the elucidation of some key concepts of both philosophy and science, such as those of conceptual analysis, analyticity, truth, law, level, and simplicity. Second, to show the complexity, i.e., the richness, of those very concepts, thereby exploding the myth that simplicity is always either a fact or a desideratum of research. To the extent to which the book succeeds in attaining both goals it should discourage the concoction of naive, oversimplified pictures of knowledge.
    The method employed is a kind of philosophic procedure that may be called metascientific elucidation. This kind of clarification may be analytic or synthetic: it may consist either in the analysis or reduction of conceptual entities (concepts, propositions, theories), or in the construction of such entities. In either case, whether in the phase of analysis or in the phase of synthesis, I call this work metascientific if the objects of elucidation are relevant to science and if the task is performed in a way congenial to science and with the help of some of the tools of contemporary scientific philosophy, such as formal logic, semantics, and theory formalization.
    To the extent to which the ideas dealt with in this book are relevant to science and therefore of interest to both scientists and philosophers of science, and to the extent to which the analyses and syntheses proposed do take advantage of the tools of scientific philosophy, this is a work on metascientific elucidation." (p. V).
    Index: Preface; Acknowledgments; Part I. Analysis. 1. Metascientific elucidation; 2. Analyticity; 3. Levels; Part II. Simplicity and truth. 4. Logical simplicity; 5. Extralogical simplicity; 6. Simplicity and truth, 7. Simplicity in theory construction; 8. Partial truth; Part III. Scientific law. 9. Induction in science; 10. Kinds of criteria of scientific law; 11. Causality, chance, and law. 12. Laws of laws; Index.

13. ———. 1963. "A General Black Box Theory." *Philosophy of Science* no. 30:346-358.

14. ———, ed. 1964. *The Critical Approach to Science and Philosophy. Essays in Honor of Karl Popper*. New York: Free Press of Glencoe.

Revised edition in 1999 with the title: *Critical approaches to science & philosophy* - New Brunswick, Transaction Publishers (with a new introduction).

15. ———. 1965. "Physics and Reality." *Dialectica* no. 19:195-222.

16. ———. 1967. *Scientific Research I: The Search for System*. Berlin: Springer-Verlag.

Revised edition in 1998 with the title: *Philosophy of science: from problem to theory* - New Brunswick - Transaction Publishers

17. ———. 1967. *Scientific Research Ii: The Search of Truth*. Berlin: Springer-Verlag.

Revised edition published in 1998 with the title: *Philosophy of science: from explanation to justification* - New Brunswick - Transaction Publishers

18. ———. 1967. *Foundations of Physics*. Berlin: Springer-Verlag.

19. ———. 1967. "Physical Axiomatics." *Review of Modern Physics* no. 39:463-474.

20. ———. 1968. "The Maturation of Science." In *Problems in the Philosophy Osf Science*, edited by Imre, Lakatos and Alan, Musgrave, 120-137. Amsterdam: North-Holland.

21. ———. 1968. "The Nature of Science." In *Contemporary Philosophy. A Survey (Vol. Ii)*, edited by Raymond, Klibansky, 3-15. Firenze: La Nuova Italia.

22. ———. 1968. "Scientific Laws and Rules." In *Contemporary Philosophy. A Survey (Vol. Ii)*, edited by Raymond, Klibansky, 128-140. Firenze: La Nuova Italia.

23. ———. 1968. "Philosophy and Physics." In *Contemporary Philosophy. A Survey (Vol. Ii)*, edited by Raymond, Klibansky, 167-199. Firenze: La Nuova Italia.

24. ———. 1968. "Problems and Games in the Current Philosophy of Science." In *Proceedings of the Xivth International Congress of Philosophy (Vol. Ii)*, 566-574. Wien: Herder.

25. ———. 1968. "Conjunction, Succession, Determination and Causation." *Journal of Theoretical Physics* no. 1:299-315.

26. ———. 1968. "La Vérification Des Théories Scientifiques." In *Démonstration, Vérification, Justification: Éntretines De L'institut International De Philosophe. Liège, Septembre 1967.*, 145-159. Lovain-Paris: Éditions Nauwelaerts.

27. ———. 1968. "Les Concepts De Modèle." *L'Âge de la Science* no. 1:165-180.

28. ———. 1969. "Corrections to Foundations of Physics: Correct and Incorrect." *Synthese* no. 19:443-452.

29. ———. 1969. "The Metaphysics, Epistemology and Methodology of Levels." In *Hierarchical Structures*, edited by Law, Whyte Lancelot, G., Wilson Albert and Donna, Wilson, 17-28. New York: Elsevier.

Symposium held at Douglas Advanced Research Laboratories, Huntington Beach, Calif., Nov. 18-19, 1968.

30. ———. 1970. "Problems Concerning Intertheory Relations." In *Induction, Physics and Ethics. Proceedings and Discussions of the 1968 Salzburg Colloquium in the Philosophy of Science*, edited by Paul, Weingartner and Gerhard, Zecha, 285-315. Dordrect: Reidel.

31. ———. 1970. "Theory Meets Experience." In *Contemporary Philosophic Thought. (Vol. Ii)*, edited by Howard, Kiefer and Milton, Munitz, 138-165. Albany: State University of New York Press.

32. ———. 1971. *Problems in the Foundations of Physics*. Berlin: Springer-Verlag.

33. ———. 1971. "Conjunction, Succéssion, Détermination, Causalité." In *Les Théories De La Causalité*, edited by Jean, Piaget and Bunge, Mario, 112-132. Paris: Presses Universitaires de France.

34. ———. 1971. "Is Scientific Metaphysics Possible?"*Journal of Philosophy* no. 68:507-520.

35. ———. 1971. "Scientific Metaphysics: Addenda Et Corrigenda." *Journal of Philosophy* no. 68:876.

36. ———. 1971. "On Method in the Philosophy of Science." *Archives de Philosophie* no. 34:551-574.

37. ———. 1972. "A Program for the Semantics of Science." *Journal of Philosophical Logic* no. 1:317-328.

38. ———. 1973. *Philosophy of Physics*. Dordrecht: Reidel.

39. ———. 1973. *Method, Model and Matter*. Dordrecht: Reidel.

40. ———, ed. 1973. *Exact Philosophy. Problems, Tools and Goals*. Dordrecht: Reidel.

41. ———, ed. 1973. *The Methodological Unity of Science*. Dordrecht: Reidel.

Bertrand Russell Colloquium on exact philosophy (1972-193 Mc Gill University)

42. ———. 1973. "The Role of Forecast in Planning." *Theory and Decision* no. 3:207-221.

43. ———. 1974. *Treatise on Basic Philosophy. I: Sense and Reference*. Dordrecht: Reidel.

"This is a study of the concepts of reference, representation, sense, truth, and their kin. These semantic concepts are prominent in the following sample statements: 'The field tensor refers to the field', 'A field theory represents the field it refers to', 'The sense of the field tensor is sketched by the field equations', and 'Experiment indicates that the field theory is approximately true'. Ours is, then, a work in philosophical semantics and moreover one centered on the semantics of factual (natural or social) science rather than on the semantics of either pure mathematics or of the natural languages. The semantics of science is, in a nutshell, the study of the symbol-construct-fact triangle whenever the construct of interest belongs to science. Thus conceived our discipline is closer to epistemology than to mathematics, linguistics, or the philosophy of language. The central aim of this work is to constitute a semantics of science -- not any theory but one capable of bringing some clarity to certain burning issues in contemporary science, that can be settled neither by computation nor by measurement. To illustrate: What are the genuine referents of quantum mechanics or of the theory of evolution?, and Which is the best way to endow a mathematical formalism with a precise factual sense and a definite factual reference -- quite apart from questions of truth? A consequence of the restriction of our field of inquiry is that entire topics, such as the theory of quotation marks, the semantics of proper names, the paradoxes of self-reference, the norms of linguistic felicity, and even modal logic have been discarded as irrelevant to our concern. Likewise most model theoretic concepts, notably those of satisfaction, formal truth, and consequence, have been treated cursorily for not being directly relevant to factual science and for being in good hands anyway. We have focused our attention upon the semantic notions that are usually neglected or ill treated, mainly those of factual meaning and factual truth, and have tried to keep close to live science. The treatment of the various subjects is systematic or nearly so: every basic concept has been the object of a theory, and the various theories have been articulated into a single framework." pp. XI-XII.
Contents: Preface XI; Acknowledgements XIII; Special symbols XV; Introduction 1; 1. Designation 8; 2. Reference 32; 3. Representation 83; 4. Intension 115; 5. Gist and content 142; Bibliography 173; Index of names 181; Index of subjects 183-185.

44. ———. 1974. *Treatise on Basic Philosophy. Ii: Interpretation and Truth*. Dordrecht: Reidel.

"The present volume start with the problem of interpretation. Interpretation is construed as the assignment of constructs (e.g. predicates) to symbols. It can be purely mathematical, as when the dummy *x* is interpreted as an arbitrary natural number, or also factual, as when such a number is interpreted as the population of a town. Now, as we saw a while ago, predicated and propositions have both a sense and a reference -- and nothing else as far as meaning is concerned. These, then, are taken to be the meaning components. That is, the meaning of a construct is defined as the ordered couple constituted by its sense and its reference class. Once the meaning of a proposition has been established we can proceed to finding out its truth value -- provided it has one. If the proposition happens to be factual, i.e. to have factual referents, then it may be only partially true -- if true at all. Hence we must clarify the concept of partial truth of fact. This we do by building a theory that combines features of both the correspondence and the coherence theories of truth.

The remaining semantical notions, notably those of extension, vagueness, and definite description, are made to depend on the concepts of meaning and truth and are therefore treated towards the end of this work. The last chapter explores the relations between philosophical semantics and other branches of scholarship, in particular logic and metaphysics.
This volume, like its predecessor, has been conceived with a definite goal, namely that of producing a system of philosophical semantics capable of shedding some light on our knowledge of fact, whether ordinary or scientific. We leave the semantics of natural languages to linguists, psycholinguists and sociolinguists, and the semantics of logic and mathematics (i.e. model theory) to logicians and mathematicians. Our central concern has been, in other words, to clarify and systematize the notions of meaning and truth as they occur in relation to factual knowledge. For this reason our semantics borders on our epistemology." pp. Xi-XII. Contents: Preface XI; Special symbols XIII; 6. Interpretations 1; 7. Meaning 42; 8. Truth 81; 9. Offshoots 133; 10. Neighbors 166; Bibliography 198; index of names 206; Index of subjects 208-210.

45. ———. 1974. "The Relations of Logic and Semantics to Ontology." *Journal of Philosophical Logic* no. 3:195-219.

"Philosophers have argued untiringly, over many centuries, about the ties of logic with ontology. While some have followed Parmenides in identifying the two, others - particularly since Abelard - have asserted the ontological neutrality of logic and, finally, a third party has oscillated between those two extremes.
Unfortunately it has seldom been clear exactly what is meant by the 'ontological commitment' of logic: mere reference to extralogical objects, the presupposition of definite ontological theses, or the ontological interpretation of logical formulas? Nor has an adequate tool for investigating this problem - namely a full-fledged semantical theory - been available. (Recall that the only existing semantical theory proper, i.e. model theory, is not competent to handle this problem because it is solely concerned with the relations between an abstract theory and its models, as well as with the relations among the latter.) Much the same holds for semantics, though with a remarkable difference. If semantics presupposes logic, and the latter is ontologically committed, so must be semantics. But of course semantics could be tied to ontology even if logic were ontologically neutral. Therefore we need an independent investigation of the ontological commitment, if any, of semantics.
The purpose of this paper is to investigate the relations of logic and mathematics to ontology and to do it with the help of a theory of meaning. This theory has been sketched elsewhere (Bunge 1972, 1973) and will be fully expanded in a forthcoming book. We assign meanings to constructs, in particular predicates and propositions, and distinguish two meaning components : sense and reference. The sense of a construct *p* in a context **C** is the totality of logical relatives of *p* in **C**. If *p* belongs to a theoretical context then the sense of *p* is the collection of statements within the theory that either entail *p* or are entailed by *p*. And the reference class of a construct *p* is the totality of individuals "mentioned" (truthfully or not) by *p*. Finally the meaning of *p* is the ordered pair constituted by the sense of *p* and the reference of *p*. We shall apply these ideas to find out the meaning of the typical constructs of logic and semantics. But before doing so we must formulate those ideas somewhat more carefully. An before we tackle this task we must explain what we mean by a predicate and by a context."

46. ———. 1974. "The Concept of Social Structure." In *Developments in the Methodology of Social Science*, edited by Werner, Leinfllner and Eckehart, Köhler, 175-215. Dordrecht: Reidel.

47. ———. 1974. "Les Présupposés Et Les Produits Métaphysiques De La Science Et De La Technique Contemporaine." *Dialogue* no. 13:443-453.

48. ———. 1975. "A Critical Examination of Dialectics." In *Dialectics / Dialectique*, edited by Chaim, Perelman, 63-77. The Hague: Martinus Nijhoff.

Entretiens in Varna, 15-22 September 1973

49. ———. 1975. "Meaning in Science." *Poznan Studies in the Philosophy of the Sciences and Humanities* no. 1:56-64.

50. ———. 1976. "Possibility and Probability." In *Foundations of Probability Theory, Statistical Inference, and Statistical Theories of Science. Proceedings of an International Research Colloquium Held at the University of Western Ontario, London, Canada, 10-13 May, 1973*, edited by Leonard, Harper William and Alan, Hooker Clifford, 17-33. Dordrecht: Reidel.

51. ———. 1976. "The Relevance of Philosophy to Social Science." In *Basic Issues in the Philosophy of Science*, edited by William, Shea, 136-155. New York: Science History Publications.

52. ———. 1976. "El Ser No Tiene Sentido Y El Sentido No Tiene Ser: Notas Para Una Conceptologia." *Teorema* no. 6:201-212.

53. ———. 1977. *Treatise on Basic Philosophy. Iii: Ontology: The Furniture of the World*. Dordrecht: Reidel.

"This book and its companion, namely Volume 4 of our *Treatise,* concern the basic traits and patterns of the real world. Their joint title could well be *The Structure of Reality.* They constitute then a work in ontology, metaphysics, philosophical cosmology, or general theory of systems. Our work is in line with an old and noble if maligned tradition: that of the pre-Socratic philosophers, Aristotle, Thomas Aquinas, Descartes, Spinoza, Leibniz, Hobbes, Helvetius, d'Holbach, Lotze, Engels, Peirce, Russell, and Whitehead. But at the same time it departs from tradition in the matter of method. In fact our aim is to take the rich legacy of ontological problems and hints bequeathed us by traditional metaphysics, add to it the ontological presuppositions of contemporary scientific research, top it with new hypotheses compatible with the science of the day, and elaborate the whole with the help of some mathematical tools.
The end result of our research is, like that of many a metaphysical venture in the past, a conceptual system. It is hoped that this system will not be ridiculously at variance with reason and experience. It is intended moreover to be both exact and scientific: exact in the sense that the theories composing it have a definite mathematical structure, and scientific in that these theories be consistent with and moreover rather close to science - or rather the bulk of science. Furthermore, to the extent that we succeed in our attempt, science and ontology will emerge not as disjoint but as overlapping. The sciences are regional ontologies and ontology is general science. After all, every substantive scientific problem is a subproblem of the problem of ontology, to wit, *What is the world like?*
After a long period underground, talk about metaphysics has again become respectable. However, we shall not be talking at length about ontology except in the Introduction. We shall instead do ontology. In the process we shall attempt to

exhibit the mathematical structure of our concepts and we shall make the most of science. Being systematic our ontology may disappoint the historian. Being largely mathematical in form it will be pushed aside by the lover of grand verbal (but sometimes deep and fascinating) systems - not to speak of the lover of petty verbal matters. And being science-oriented it will fail to appeal to the friend of the esoteric. Indeed we shall be concerned with concrete objects such as atoms, fields, organisms, and societies. We shall abstain from talking about items that are neither concrete things nor properties, states or changes thereof. Any fictions entering our system will be devices useful in accounting for the structure of reality. (Constructs were dealt with in Volumes 1 and 2 of this work.)" pp. XIII-XIV.
Contents: Preface to *Ontology I* XIII; Acknowledgements XV; Special symbols XVI; Introduction 1; 1. Substance 26; 2. Assembly 39; 3. Thing 108; 4. Possibility 164; 5. Change 215; 6. Spacetime 276; 7. Concluding remarks 330; Bibliography 334; Index of names 344; Index of subjects 348-352.

54. ———. 1977. "A Theory of Properties and Kinds." *International Journal of General Systems* no. 3:183-190.

Co-author: Arturo Sangalli

55. ———. 1977. "The Gst Challenge to the Classical Philosophies of Science." *International Journal of General Systems* no. 4:29-37.

56. ———. 1977. "States and Events." In *Systems: Approaches, Theories and Applications*, edited by William, Hartnett, 71-95. Dordrecht: Reidel.

57. ———, ed. 1978. *La Sémantique Dans Les Sciences: Colloque De L'académie Internationale De Philosophie Des Sciences*. Paris: Beauchesne.

58. ———. 1978. "The Limits of Science." *Epistemologia* no. 1:11-32.

59. ———. 1979. *Treatise on Basic Philosophy. Iv: Ontology: A World of Systems*. Dordrecht: Reidel.

"This volume continues and concludes the task begun in Part 1, titled *The Furniture of the World* - namely the building of an exact and systematic ontology consistent with contemporary science. However, it can be read independently by anyone willing to take for granted the basic notions analyzed and systematized in the companion volume, namely those of substance, property, thing, possibility, change, space, and time.
The three main themes of this book are wholeness (or systemicity), variety, and change. These three notions are analyzed and systematized, and they occur in some of the main assumptions of our ontology. One of these hypotheses is that the universe is not a heap of things but a thing composed of interconnected things - i.e. a system. This supersystem is composed of subsystems of various kinds: physical, biological, social, etc. Only physical systems may be composed of things that are not themselves systems, such as elementary particles and field quanta. However, even nonsystems are components of some system or other, and every system but the universe is a subsystem of some system: there are no strays. Ours is, in sum, a world of interconnected systems. Moreover it is the only one.
Another postulate of this system of ontology is that concrete systems are not all alike except insofar as they are systems and therefore tractable with the help of a unifying systems-theoretic framework. There are different kinds of system and each

is characterized by its own peculiar properties and laws. Surely we sometimes succeed in accounting for the emergence and the history of a system in terms of its composition, environment, and structure. Nevertheless, explaining need not be explaining away: explained systems are not heaps, explained emergence is no mere resultant, and explained novelty is not old. Systemicity, emergence, and qualitative novelty and variety are as genuine as they are capable of being explained. Far from being incompatible with reason, wholeness and emergence can be understood.
A third major thesis of this work is that no system, except for the world as a whole, lasts forever. Systems get assembled, change, and break down. If natural, systems emerge as a result of self-assembly processes - often from debris of former systems. Even modest accretion processes can ensue in systems possessing emergent properties. Order can thus emerge from randomness, systems from physical precursors, living systems from nonliving ones, and so on. (Entropy need not increase in open systems.)
All three theses are by now common knowledge or nearly so. Now they - jointly with many others - have become part and parcel of a science oriented ontological system couched in a fairly exact language. Thus the novelty of this system resides sometimes in its components, and at other times in their organization." pp. XIII-XIV
Contents: Preface to *Ontology II* XIII; Acknowledgments XV; Special symbols XVI; 1. System 1; 2. Chemism 45; 3. Life 75; 4. Mind 124; 5. Society 186; 6. A systemic world 245; Appendix a. System models 253; Appendix B. Change models 273; Bibliography 292; Index of names 301; Index of subjects 305-308.

60. ———. 1979. "Philosophical Inputs and Outputs of Technology." In *The History and Philosophy of Technology*, edited by George, Bugliarello and Dean, Doner, 262-281. Urbana: University of Illinois Press.

61. ———. 1980. *The Mind-Body Problem: A Psychobiological Approach*. Oxford: Pergamon Press.

Index: Preface; 1. The mind-body problem; 2. The organ; 3. The functions, 4. Sensation and perception; 5. Behavior and motivation; 6. Memory and learning; 7. Thinking and knowing; 8. Consciousness and personality; 9. Sociality; 10. Conclusion: towards understanding mind; Epilogue: a behavioral approach by Donald O. Hebb; Glossary of technical terms; Bibliography; index of names; Index of subjects.
From the Introduction: "This book deals with one of the oldest, most intriguing, and most difficult of all the problems belonging in the intersection of science and philosophy, namely the so-called *mind-body problem.* This is the system of ancient questions about the nature of the mental and its relations to the bodily.
Here are some of the problems belonging to the mind-body problem circle. Are mind and body two separate entities? If so, how are they held together in the living organism? How do they get in touch in the beginning, how do they fly asunder at the end, and what becomes of the mind after the breakdown of the body? How do the two entities manage to function synchronically: what does it mean to say that mental states have neural correlates? Do these entities interact, and if so how? And which if any has the upper hand?
If, on the other hand, mind and body are not different entities, is the mind corporeal? Or is it the other way around, namely is the body a form of the mind? Or is each a manifestation of a single (neutral) underlying inaccessible substance? In either case: what is mind? A thing, a collection of states of a thing, a set of events in the thing-or nothing at all? And whatever it is, is it just physical or is it something more? And in the latter case -- i.e. if mind is emergent relative to the physical level can it be explained in a scientific manner or can it be described only in ordinary language?

The mind-body problem is notoriously a hard nut to crack -- surely even more so than the problem of matter -- so much so that some scientists and philosophers despair of it being soluble at all. We submit that the problem, though tough, is soluble, and shall outline a solution to it in this work. But before doing so we shall have to do some philosophical scouting and conceptual cleansing, because part of the problem is that it is usually formulated in inadequate terms -- namely in those of ordinary language. These are inadequate not only because ordinary language is imprecise and poor but also because the European languages are loaded with a preconceived solution to the problem, namely psychophysical dualism, or the doctrine that mind and body are separate entities." (pp. XIII-XIV).

62. ———. 1981. *Scientific Materialism*. Dordrecht: Reidel.

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63. ———. 1981. "Conceptual Existence." In *Transparencies : Philosophical Essays in Honor of J. Ferrater Mora*, edited by Priscilla, Cohn, 5-14. Atlantics Highlands: Humanities Press.

64. ———. 1982. "The Revival of Causality." In *Contemporary Philosophy: A New Survey (Vol. Ii)*, edited by Guttorm, Floistad, 133-155. The Hague: Martinus Nijhoff.

65. ———. 1983. *Treatise on Basic Philosophy. V: Epistemology and Methodology I: Exploring the World*. Dordrecht: Reidel.

"This volume is devoted to general epistemology and methodology; the next, to some epistemological and methodological problems arising in contemporary science and technology. Epistemology, or the theory of knowledge (French *gnoséologie,* German *Erkenntnistheorie),* is the field of research concerned with human knowledge in general-ordinary and scientific, intuitive and formal, pure and action-oriented. And methodology -- not to be mistaken for methodics, or a set of methods or techniques - -is the discipline that studies the principles of successful inquiry, whether in ordinary life, science, technology, or the humanities.
In this work epistemology is conceived as a merger of philosophy, psychology, and sociology: it describes and analyzes the various facets of human cognitive processes, whether successful or not, and whether or not they bear on everyday matters. Methodology too is descriptive and analytical, but in addition it is prescriptive or normative: it attempts to find out not only how people actually get to know but also how they ought to proceed in order to attain their cognitive goals. Thus both the epistemologist and the methodologist are supposed to describe and analyze experiment, but the methodologist is primarily interested in well designed experiment. In short, whereas epistemology is concerned with inquiry in general, the task of methodology is to find or perfect optimal inquiry strategies. (...)
This book continues an old tradition or, rather, a whole fan of traditions started in ancient Greece and India. But at the same time this work departs from tradition with regard to method. It is hoped that our inquiry into inquiry will be closer to the cognitive sciences and, in general, closer to contemporary research, than to obsolete

dogma. More particularly, we shall proceed as follows. We shall pick up the rich legacy of epistemological problems and hints (often optimistically called 'theories') bequeathed to us by the epistemological tradition. We shall enrich it with some of the problems and findings of contemporary scientific, technological and humanistic research, topping it with new hypotheses compatible with the science of the day-in particular neuroscience, psychology, and social science. And we shall elaborate and systematize the whole with the help of a few modest tools such as the concepts of set and function. However, in contradistinction with the former volumes in this *Treatise,* here we shall adopt a far more modest level of formalization. The result is a greater intelligibility-and length. (The formalizations have been put in parentheses and in the Appendices.)"
Contents: Preface to *Epistemology I & II* V; Acknowledgements XVII; Special symbols XIX; Introduction 1; Part I. Cognition and communication 19; 1. Cognition 21, 2. Knowledge 61; 3. Communication 97; Part II. Perceiving and thinking 127; 4. Perceiving 129; 5. Conceiving 159; 6. Inferring 199; Part III. Exploring and theorizing 231; 7. Exploring 233; 8. Conjecturing 286; 9. Systematizing 323; Appendices 377; 1. The power of mathematics in theory construction: a simple model of evolution 377; 2. The prose identifying the variables 380; Bibliography 383; Index of names 396; Index of subjects 401-403.

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"This is the sequel to *Epistemology I: Exploring the World.* In that work we studied cognition as a brain process, and communication as a social transaction. In particular, we studied perception and conception, the formation of propositions and proposals, exploration and systematization, discovery and invention. We regarded knowledge as an outcome of processes occurring in animals that learn by themselves and from one another. We took concepts and propositions, problems and proposals, to be equivalence classes of brain processes rather than ideal objects detached from brains and from society. However, we also stressed the need for studying such abstractions as well as the corresponding real processes.
In other words, we admitted that cognition ought to be studied both concretely (as a biopsychosocial process) and abstractly (with disregard for personal and social idiosyncrasies). We hoped in this way to favor the merger of the various hitherto separate approaches to the study of knowledge and knowledge-directed action: the neurophysiological and the psychological, the sociological and the historical, the epistemological and the methodological ones. After all, these various approaches have a single aim, namely to improve our understanding of the ways we get to know reality, and the ways knowledge can be utilized to alter reality.
In this volume we will study the ways theories and proposals (e.g. technological designs) are put to the test and used to understand or alter reality. We will stress the difference between belief and inquiry. We will study the kinds of knowledge and the ways human knowledge grows, declines, or alters course. We will distinguish basic science from applied science, and both from technology and ideology, and we will seek to demarcate genuine knowledge from bogus. We will analyze the two mechanisms for enhancing the cross-fertilization and the unity of the various branches of knowledge: reduction and integration. We will stipulate the conceptual and empirical conditions a proposition has to fulfill in order to be valued as (sufficiently) true, and a proposal to be regarded as (suitably) efficient. (We shall do so in the light of real cases drawn from contemporary research rather than in obedience to a priori philosophical principles.) We will analyze a number of important yet vague notions, such as those of truth and efficiency, background and framework, paradigm and revolution. And we will explore the possible limits to our exploration of the world, as well as the limitations of the classical philosophies of knowledge.

The upshot of our study is a descriptive and normative epistemology that cannot be compressed into a couple of slogans, although it combines some features of rationalism with others of empiricism. This synthesis may be called *scientific realism* because the criterion for adopting or rejecting any given thesis is its compatibility or incompatibility with the practice of research in contemporary science (basic or applied), technology, or the humanities. We find no use for a theory of knowledge, however exact or ingenious it may be, that is divorced from knowledge." pp. XI-XII
Contents: Preface to *Epistemology II* XI; Special symbols XIII; Part IV. Understanding and checking 1; 10. Understanding 3; 11. Producing evidence 59; 12. Evaluating 114; Part V. Variety and unity 155; 13. Epistemic change 157; 14. Kinds of knowledge 194; 15. Upshot 240; Appendices 272; 3. partial truth 272; 4. predictive power 276; 5. Formal structure of experiment 278; 6. Degree of confirmation of a theory 281; Bibliography 283; Index of names 291; Index of subjects 294-296.

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"This is a systematic study in the philosophy of science and technology, or PS & T for short. It struggles with some of the so-called Big Questions in and about contemporary S & T, i.e. questions supposed to be general, deep, hard, and still *sub judice.* Here is a random sample of such problematics. Is verbal psychotherapy scientific? Is political economy ideologically neutral? Are computers creative? What is the ontological status of machines? Is engineering just an application of basic science? What is language? Are there laws of history? Which are the driving forces of history? Which is the most fruitful approach to the study of mind? Are genes omnipotent? Are species collections or concrete systems? Do the earth sciences have laws of their own? Is chemistry nothing but a chapter of physics? Does contemporary cosmology confirm theology? Has the quantum theory refuted scientific realism? Is there a viable philosophy of mathematics? How are we to choose among alternative logics? What is the ontological status of concepts? These and other questions of interest to philosophy, as well as to science or technology, are tackled in this book from a viewpoint that is somewhat different from the dominant PS & T. An instant history of our discipline should help place our viewpoint. Modem PS & T began together with modern science and it was cultivated by scientists and philosophers until it became professionalized in the 1920s. At this time it took *a logical* turn: it was equated with the logical analysis and orderly reconstruction of scientific theories. Experimental and field work were deemed to be ancillary to theorizing, and technology was praised or deprecated, but hardly analyzed. Later on PS & T took *a linguistic* turn: only the languages of S & T seemed to matter. Facts, problems, theories, experiments, methods, designs and plans were overlooked. More recently, PS & T took *a historical* turn: everything was seen from a historical viewpoint. The logic, semantics, epistemology, ontology and ethics of S & T were declared subservient to its history or even irrelevant. Even more recently there have been attempts to force PS & T to take *a sociological* turn. Facts are said to be the creation of researchers, who would act only in response to social stimuli or inhibitors; there would be neither norms nor objective truth.

I believe the time has come for PS & T to take, or rather retake, a *philosophical* turn: to investigate the logical and semantical, epistemological and ontological, axiological and ethical problems raised by contemporary S & T, leaving the sociological and historical studies to social scientists. The time has also come to approach the problematics of PS & T in *a scientific* fashion, by paying close attention to current developments in S & T and checking philosophical hypotheses against the findings of S & T. At least this is the approach adopted in the present volume.
Although this book is part of an eight-volume treatise, it is self-contained: it can be read independently of the others. Moreover, each chapter can be read independently of the others. The book is addressed to philosophers, scientists, technologists, and culture watchers. It may be used as a textbook in a one year advanced course in PS & T. Each chapter may also be used in a course in the corresponding branch of PS & T.
To facilitate its use as a textbook, the present volume has been divided into two parts. Part I is devoted to the philosophy of the formal and physical sciences, whereas Part II covers the philosophy of the biological and social sciences as well as of the technologies." p. IX-X.
Contents: Preface to *Philosophy of science & technology* IX; Acknowledgements XI; Introduction 1; I. Formal science: from logic to mathematics 9; 1. Generalities 9; 2. Mathematics and reality 26; 3. Logic 40; 4. Pure and applied mathematics 75; 5. Foundations and philosophy 95; 6. Concluding remarks 121; II. Physical science: from physics to earth science 124; 1. Preliminaries 124; 2. Two classics 140; 3. Two relativities 155; 4. Quantons 165; 5. Chance 178; 6. Realism and classicism 191; 7. Chemistry 219; 8. Megaphysics 231; 9. Concluding remarks 241; Bibliography 243; Index of names 255; index of subjects 260-262.

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"This book is about values, morals, and human actions. It is also about axiology (the study of value systems), ethics (the study of moral codes), and action theory. It is concerned with both private and public values, morals, and actions. In particular, it seeks to uncover the roots and functions (biological and social) of valuation and morality. As well, it attempts to sketch a value system, a moral code and a general plan of action that may help us tackle the dreadful problems of our time.
(...)
The revival of value theory and ethics can be attested to by anyone who bothers to peruse the philosophical journals published in the course of the latest few years. This revival is particularly welcome at a time when philosophy as a whole is at a low ebb - so much so that some philosophers have proclaimed its death while others have taken leave of reason. But the current flourishing of ethics may be an indicator of the general crisis of modern civilization, for people do not usually reflect on problems about values and morals until they face them, and nowadays most of us face them daily by the dozen.
This is the last volume of my *Treatise on Basic Philosophy,* on which I started to work two decades ago. It is consistent with the previous volumes, in particular with the naturalistic, dynamicist, emergentist and systemist ontology, as well as with the realistic and ratioempiricist semantics and epistemology formulated therein. However, the present book may be read independently of its companions." p. XIV-XV.
Contents: Preface to *Ethics* XIII; Acknowledgements XV; Introduction 1; Part I. Values 11; 1. Roots of values 11; 2. Welfare 41; 3. Value theory 61; Part II. Morals 93; 4. Roots of morals 93; 5. Morality changes 133; 6. Some moral issues 158; Part III. Ethics 197; 7. Types of ethical theory 197; 8. Ethics et *alia* 243; 9. Metaethics 285; Part IV: Action theory 319; 10. Action 319; 11. Social philosophy 354; 12. Values and morals for a viable future 390; Bibliography 400; Index of names 416; Index of subjects 421-424.

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From the preface: "This book has been written for social scientists curious about philosophy, as well as for philosophers interested in social studies. As suggested by its title, it focuses on the philosophy involved in social studies -- albeit, usually in a tacit manner. I will argue that all social studies,
whether scientific or literary, are crammed with philosophical concepts, such as those of fact, system, process, theory, test, and truth. They also contain or presuppose some philosophical assumptions, such as that societies are (or are not) mere aggregates of individuals, that people can (or cannot) choose and act rationally, and that social facts can (or cannot) be studied scientifically.

Regrettably, most students of society rarely pause to examine the philosophical ideas they adopt. When they do, they often fall under the influence of philosophies that do not match the practice of contemporary social science research. Most of the philosophers who have paid attention to the philosophy in or about social science have held some or all of the following three theses: that there is a clear divide between the social and the natural sciences, there being no mixed or socio-natural sciences; that science and philosophy are mutually disjoint, so cannot learn from one another; that the philosophy of social science is the same as that of the natural sciences -- or else that the two are utterly disjoint. I will argue that all three, and many more received opinions, are false. I will examine some of the key philosophical ideas inherent in the social (and socio-natural) sciences, as well as some of the topical philosophical problems raised by them. Thus I will elucidate the ontological notions of event and causation, the semantic concepts of meaning and truth, the epistemological ideas of hypothesis and indicator, the axiological notions of value and utility, and the ethical concepts of right and duty, I will also wrestle with such classical controversies as individualism versus holism, rationalism versus empiricism, explanation versus understanding, and nomothetic versus idiographic science."
From the Introduction: "The *ontology* of social science examines the nature of society, the kinds of social process, the difference between law and rule, the roles of causation and chance, and the nature of planning. Hence it is concerned with questions such as: Are there social systems, or only aggregates of individuals? Are cultures systems of values and norms, or concrete social systems? What is a micro-macro link? What are the engines of history: the environment, biological factors, the economy, politics, culture, or all of these? Are there occasionally leaps in social evolution, or was Marshall right in inscribing the maxim *Natura non facit saltum* on the title page of his classic *Principles of Economics*? Is society a text to be deciphered by hermeneutics or semiotics? Is human history analogous to biological evolution?" (p. 7).

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From the Preface:
Index: Part I. Philosophical fundamentals. 1. Ontological fundamentals; 2. Semantical and logical fundamentals; 3. Epistemological fundamentals; Part II. Fundamental issues in biophilosophy; 4. Life; 5. Ecology; 6. Psychobiology; 7. Systematics; 8. Developmental biology; 9. Evolutionary theory;10. Teleology; 11. Concluding remarks; References; Name Index; Subject index.

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