THE IMPLEMENTATION OF AXIOMATIC METHOD IN POLITICAL SCIENCE: A JUSTIFICATION

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ABSTRACT

After several decades of empirical research, the goal of having a scientific theory of politics has not been reached. The reason for this situation, as presented in this dissertation, is that the methodology adopted was only one stage of the scientific method. Reacting against more traditional approaches, Political Science has adopted the standard of objectivity and value-free research as being the essential components of method. This approach has, in fact, provided a justification for the existence of inductive forms of knowledge at the expense of deductive and axiomatic theorizing.

A more complete conception of the scientific method is presented as an alternative standard. It postulates that modern science rests on an axiomatic - rather than empirical - conception of method. The new approach defines science as the application of deductive logic to the discovery of underlying dynamisms. This perspective should enable us to complement the limits of the inductive approach with a more fundamental method of theory building. It should also enable us to present theoretical statements which are predictive - the hallmark of a mature science.

RÉSUMÉ

Après plusieurs décades de recherches empiriques, l'objectif d'atteindre une théorie scientifique n'a pas été atteint. La raison de cette situation, telle que démontrée dans cette dissertation, a été que la méthode adoptée n'était qu'une étape de la méthode scientifique. En réaction aux approches traditionnelles, la science politique a adopté les étalons de l'objectivité et de la neutralité comme constituant l'essence de la méthode scientifique. Cette approche a, en fait, fourni une justification pour des formes inductives de connaissance au détriment d'une théorisation déductive et axiomatique.

Une conception plus complète de la méthode scientifique est présentée comme modèle de rechange. Elle postule que la science moderne repose sur une conception axiomatique - plutôt qu'empirique - de la méthode. Cette nouvelle approche définit la science comme étant l'application de la logique déductive à la découverte de dynamismes sous-jacents à la réalité directement observable. Cette perspective devrait nous permettre de compenser les limites de l'approche inductive par une méthode théorique plus fondamentale. Elle devrait nous permettre de prédire par déduction logique - ce qui est la marque d'une science axiomatisée.

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To Margaret Flannigan my most sincere appreciation for typing this and her patience in helping me find the time to put it together.

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PREFACE

The need for precise and coherent knowledge has led the social sciences to adopt the methods of the scientific disciplines. Although this new approach has resulted in abandoning the traditional pursuit of knowledge, the expected development of scientific certainties and testable laws has not occurred. The empirical method has led only to an accumulation of data. In our quest for a scientific method, we have neglected to study the complex structure of modern science, instead we have adopted by convention an incomplete conception of method that has failed to provide an adequate theoretical foundation for political science and for the other social sciences as well.

New methods cannot make political science become more scientific if they are half-applied. To equate science with factual analysis is to forget the procedure used in science to transform facts into theoretical constructs.

The usual definition reflects a confusion between a pragmatic form of knowledge and the global scientific procedure. Political scientists think only of science as the method of observation followed by theories that are generalizations of those previous observations. The methodological independence of theory and the logical processes involved prior to observation have not been properly asserted.

Modern science is not only a "natural science," its method is not only strictly empirical and is above all not only inductive. What political scientists overlook in emphasizing the empirical approach to the neglect of all else is that the scientific method has passed beyond empirical common sense a long time ago when the first axiomatic definition of reality was proposed in theoretical physics.

Today, what we call "natural sciences" are usually axiomatic sciences, their methods are based more on logical axioms than on facts - the facts being there as post-theoretical corroborations of the axiomatic constructs.

Unfortunately, very few scientists and philosophers of science have concerned themselves with these questions. The first explanations of the axiomatic method appeared at the end of the 19th century in the works of Hertz and Boltzmann, followed later by the reflections of Einstein. As a rule this theory of science has not been successful in academic circles outside theoretical physics.

INTRODUCTION

The present dissertation has one central aim and two subordinate ones. The central aim is the introduction of a method of axiomatic theorizing in political science as a complement to the inductive empirical approach. The two subordinate ones are first, a demonstration of the method developed in modern theoretical physics and second, an examplification of the type of explanation that would result in the discipline from the implementation of the axiomatic method.

The need for precise and coherent knowledge has led social sciences to adopt the methods of scientific discipline. Consequently, the Behavioural movement in the social sciences has been instrumental in describing numerous relationships among social variables. The movement, however, has never reached the level of theory-formulation and admittedly political science has remained at a pre-paradigmatic stage of inquiry. The reason for this as it will be argued in this disseration is that part of the scientific method has been forgotten. The difficulties generated by an empirical explanation of reality must be dealt with by a complementary method of interpretation that has escaped the attention of social scientists.

The problems faced by contemporary Behaviouralism are similar to those faced by physics at the end of the 19th century. At that time, it came to be recognized that certain problems were created by the method of inductive analysis itself. The main critiques were that the limits could not take into account the relativity of contexts of observation, the multiplicity of causes acting on a single occurrence or the varying patterns of secondary factors present within observed structures. The method could not predict unexpected occurrences on the basis of generalization of observations. These epistemological limits of the method took a long time to be clearly established within the new science of theoretical physics and, outside this specialized field, these limits have remained virtually unknown. It is not surprising therefore that the method developed in modern theoretical physics also remains unknown. Few physicists and philosophers of science have ever compared the epistemology and method of theoretical physics to those of mainstream physics. It has always been taken for granted that they were identical. This is not absolutely true however. Many differences do exist and anybody interested in method should be able to account for them.

Theoretical physics is introducing numerous distinctions in the scientific method. It proposes that models be established on logic rather than on sensate categories, it proposes that two types of scientific explanation are possible for any phenomenon - an empirical one linking the phenomenon to surrounding variables and a fundamental one attributing a "why" to the observed relationships. It proposes accordingly that several superimposed layers of causality do exist simultaneously and that rules of correspondence can be established between the different theories explaining the same phenomenon. It finally proposes that science be based on formalized reference systems rather than on common sense.

These developments are superior to those that have been worked out within the present methodological debate in the discipline. By comparison the exhortation to "go back to the facts" or to clarify definitions or to pay more attention to values and worldviews are far less structural and much less likely to lead to any breakthroughs. Part of the resistance of social scientists towards theoretical physics stems from the conception that human liberty is unamenable to rigid scientific laws. Quantum mechanics shows however that indeterminacy is a built-in feature of the world that can be dealt with in an axiomatic model of reality. The opposition between social sciences and physics has been exaggerated.

The work which follows attempts to deal with the questions of modern theory and methodology in political science from the standpoint of an analytic conception of the social and political reality. It involves a new type of theory that differs markedly from most of what is called theory in political science.

The work that follows is divided into six chapters.

Chapter I consists of a definition of the problem of method in science. It proposes that science is made up of two mutually exclusive but complementary methods: empirical and axiomatic.

Chapter II reviews the complex process that led to the discovery of axiomatic method in theoretical physics. The evolution of Einstein's concept of method is taken as an illustration of this process.

Chapter III summarizes the basic components and concepts of axiomatic method in science and shows how they differ from a standard conception of method.

Chapter IV presents arguments in support of the implementation of axiomatic method in political science and describes the conceptual scheme within which this implementation could become possible.

Chapter V reviews some past and present attempts at implementing axiomatic theorizing in the social sciences. Reasons for their relative failure will be proposed.

Chapter VI shows how game theory could be used as a tool for the creation of an axiomatic science of politics.

In concluding, a review of the main characteristics of axiomatic method will be made and the consequences of implementing this type of approach in Political Science will be evaluated.

CHAPTER I

THE CONCEPTION OF SCIENCE IN MODERN PHYSICS: STATING THE CASE

A) The Problem

There is no such thing yet as a science of science. Opinions, essays, reflections and analyses on the subject come from a wide variety of intellectual "milieus" and it is somewhat difficult to assess the relative importance of historical studies, epistemological conceptions, ideological critiques, logical analyses and philosophies of science that are available at the moment. Methodological debates have become integral components of most scientific disciplines during the past two decades and probably nobody would agree for sure on a final standard in the face of such controversial evidence. All these controversies have, however, been instrumental in the spread of certain concepts like "paradigms," "verifiability," "and relativity of knowledge" which would make science more or less dependent on the type of approach to problems selected by a single scientist or a group of scientists. In a sense the present dissertation is a continuation of this actual trend since it is also based on the assumption that the type of science one has depends on the paradigm to which he refers. However, this dissertation constitutes also a break from this trend since it brings a second argument into the debate, an argument that is apparently not expected: there are only two paradigms in science, not multitudes. Science is in perpetual motion between an empirical paradigm that provides the procedure for factual investigation and an analytic paradigm that redefines reality in terms of abstract structures and processes within which the observable facts receive a deductive explanation. Of course this backward and forward motion applies in principle to a great number of objects of study but that does not constitute as many paradigms -- in all cases the change consists of the transition from an empirical conception to an analytical model. This change is not arbitrary either, it rather follows very consistently an implicit logic that will be described in the following chapters.

Such a change occurred at the end of the 19th century with the creation of modern theoretical physics. Few scientists and even fewer philosophers of science have analyzed the scientific revolution that happened then. The revolution was not the result of a change in method which remains empirical by definition, it was a change in the scientific epistemology. Theoretical physics has rejected many of the mainstream empirical postulates in order to replace them by abstract models of reality. Unfortunately, it is very difficult to explain this change within the present-day mainstream conception of an empirical science.

In his classical work on Explanation in the Sciences, Emile Meyerson wrote more than half a century ago: "True science, the only one that we know, is in no way, and in none of its parts in accordance with the positivist scheme."[1] At this point in the disseration, there

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[1]Emile Meyerson, De l'explication dans les sciences, Paris, P.U.F., 1921, p. 31.

will be no undertaking to show that the analytic theory of knowledge corresponds more exactly than empiricism to the vast logical universe disclosed by modern theoretical physics. Instead, and in a summary fashion, a general sketch of this scheme is proposed. This scheme should permit researchers to estimate the worth of a theory of knowledge that has remained largely misunderstood, partly as a result of the neglect of modern critiques of science.

1) Theories of Knowledge Following Recent Breakthroughs in Physics

Strange hints on the dual nature of reality came with the discoveries of relativity and quantum mechanics. Both theories expressed constants that could not be explained easily within the classical view of nature. In 1925, a young French physicist (Louis de Broglie) suggested that phenomena involving the interplay of matter and radiation could best be understood by regarding electrons not as individual particles but as systems of waves. Shortly after Schrödinger, a Viennese physicist developed the same idea in coherent mathematical form, evolving a system that explained quantum phenomena by attributing specific wave functions to protons and electrons. Subsequent experiments showed that not only electrons but whole atoms and even molecules were producing wave patterns when diffracted by a crystal surface, and that their wave lengths were exactly what de Broglie and Schrödinger had forecast.

And so all the basic units of matter shed gradually their substance. The old-fashioned electron was reduced to an undulating charge of electrical energy, the atom to a system of superimposed waves. One could only conclude that all matter is made of waves, that the concept of matter is not absolutely necessary. Eventually the "waves of matter" become "waves of probability" where the concepts of matter and wave become equivalent.

Another shock to the classical view of nature came with the impossibility of adding high velocities in the theory on relativity. In this theory, the velocity of light is unaffected either by the motion of the source or the motion of the receiver. Even if we imagined an observer racing toward a coming light at a speed 100,000 miles a second, the principle of the constancy of the velocity of light tells us that the observer will still meet the speed of the oncoming light beam at 186,284 miles a second, no more, no less. The dilemma presented by this situation involves an irreconcilable conflict between the principle of the constancy of the velocity of light and the principle of the addition of velocities. Even the stern logic of mathematics could not solve the enigma. Einstein concluded that a new law of nature had to be found to enable the scientist to explain the relations between moving systems in such a way as to understand the paradox. Eventually the principle of relativity was discovered by him making time, speed and matter structurally interdependent. The point to consider, however, is that relativity itself cannot be explained empirically. It is not sure whether or not relativity could be quantified as such. Also, it remains very difficult to figure out why clocks would slow down at velocities close to that of light or why a yardstick would shrink to about half its length. Eventually these types of problems were to affect the definition of science's epistemology.

To face these problems, three theories of knowledge offer logical positions.

The mainstream position in science is the empirical one. Most modern phycisists consider it rather naïve to speculate about the true nature of anything. They are positivists or logical empiricists who contend that a scientist can do no more than report his observations. Theoretical physics is accepted as a heuristic device only, not as a worldview. While quantum physics define with great accuracy the mathematical relationships governing the basic units of radiation and matter, it does not matter if it does so at the expense of our definition of the true nature of both. If one experiment reveals that science is made up of particles and another shows that it is made up of waves, both results will be accepted as complementary and not as contradictory. The empiricist does not think that mathematical laws themselves have to be explained. In the abstract language of mathematics he can describe how things behave though he does not know -- or need to know -- what they are. Science is the accumulation of mathematical constants of the relations between things, not an investigation into the nature of things. In this view mathematics are only a heuristic device, they do not reveal more about the world than the constant they express.

In this theory of knowledge, science is limited to a procedure for research and investigation. The relations between facts are linear in character and follow a pattern of action-reaction that can be quantified. Facts are considered as self-evident and questions related to the inner structure of facts are not even considered. Science is basically inductive and consists of generalizations of observed relations between facts.

Another theory of knowledge is the one supported by the logical-positivist tradition in philosophy of science. It considers science as a set of formal statements made on reality. The different conditions for protecting objectivity during investigation, the logic of the statement and the deductive procedures for testing the theories constitute the objects-of-study of the analyses. The problem with this approach is that it limits its investigation to the empirical method and has very little concern with theoretical physics epistemology. However, the problems of theoretical physics being more of an epistemological nature and having more to do with the redefinition of reality than with method, this theory of knowledge is not very helpful.

The axiomatic theory of knowledge is revolutionary. It is a theory that has never been explicitly presented as a standard for science, instead we find bits and pieces of it in the writings of some theoretical physicists such as Einstein and Planck. It postulates the following points:

- reality is made of successive layers of causality: empirical, structural and dynamic;
- substance is superseded by logical structure, facts become symptoms of the structure and causality becomes purely formal;

- to each layer corresponds a different type of scientific explanation for the same problem, for example, classical mechanics, statistical mechanics and quantum mechanics are theories corresponding to successive layers of causality;
- the empirical layer is the easiest to observe and analyze but it is also the least interesting because it changes too much, facts are too accidental to provide a sound basis for science;
- the other layers of reality cannot be perceived directly, they are more or less abstract dynamisms concealed among the facts, to discover them requires a theoretical approach more than an empirical one. For example, relativity cannot be seen, it is essentially a conception -- but at the same time it does not mean that it does not exist also.

These points are in full contradiction with common sense notions. This is normal. The science of the underlying structures which really took off with the advent of modern theoretical physics cannot possibly be understood within the limits of the empirical theory of knowledge.

2) The Two Methods in Science

Science does not deal only with facts. It is also concerned with the logical properties of those facts. Geometrical and structural properties are of interest. These logical properties do not exist if we separate them from the facts yet they cannot be discovered by inductive analysis. The axiomatic method postulates the existence of abstract causes, of ideal patterns and logical structures present among observable facts.

Empirical science relies on inductive method. It does not search for the ultimate logic of reality. Empirical categories are concrete, they represent patterns of visible factors surrounding an occurrence, they do not correspond to the invariant logic of reality which is of a different nature. The structure is made up of necessary laws. Facts are by-products of the logical structure and the essential cause of their interaction is to be sought in this structure. Facts form a syndrome within which an intrinsic rational element is to be found beyond the pattern reported by objective analysis. This rational element will provide for a rational why to the observed relationships (or empirical laws).

Therefore there are two levels of scientific explanation that are complementary but that differ as to what makes for an "explanans" of the situation. Inductive analysis explains by virtue of visible factors surrounding an occurrence, it is unable however to uncover the intelligible network of necessary relations present in their object of study. Empirical analysis describes stable factual relationships but does not explain them as the consequence of irreductible causes. Empirical science is a genuine science since it discovers exact relations but it is not the only science possible as long as the essential causality that makes these patterns possible is not revealed. It does not reach a level of formal-rational explanation which would give a definitive explanation to observed facts as a necessary consequence of an invariant cause.

Empirical method does not make a distinction between empirical and structural causality. It looks for converging factors within a specific case and does not try to explain this convergence by a necessary property of reality. If there was no such underlying property the visible contingent causes would remain a purely accidential combination of factors. Circumstantial factors are precisely bound together by the presence of an underlying logical pattern.*

An empirical science has much difficulty in establishing general theories because the circumstantial factors it describes retain an accidental character up to a certain degree. Patterns of factors are by definition changing patterns and as long as a law explaining these changes is not discovered an empirical science remains approximative. An empirical science is valid to the extent that the factors it observes are more or less stabilized by the underlying structure. But this stability is assumed by the method, it is not analyzed. Empirical categories are always relative. By comparison an axiomatic science (example: theoretical physics) deals directly with the logical network existing among facts. The aim of the method is to go beyond the visible facts in order to discover an inner core of necessary connections (a pattern). This underlying logic is not directly observable: its structure must be represented by a special type of model, the axiomatic model. The model will be a hypothesis of an intelligible pattern present in the facts. The observed facts become the effects of this underlying structure. This underlying structure will explain the movements of the visible structure as a consequence of its necessary principles.

The laws of the underlying structure differ from the laws of the visible structure however. They are made up of necessary formal-logical relations. The degree of conceptualization required to

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*Without internal connections all facts would be constantly permuted at random. In modern physics facts are not glued together by substance but by logical properties.

understand them is very different from empirical conceptions. For example, dilatation of gas will be explained by the kinetic theory, the movement of planets described by astronomy will be explained by the concepts of astrophysics. The nature of axiomatic concepts differs from the nature of empirical concepts. The structural concept is more than the development of an empirical concept - it is deduced from a rational model instead of being abstracted from inductive analysis.

In the social sciences, the axiomatic method, its components, assumptions and process of operation constitute still a largely uncharted area. The explanation of social, economic and political events as the result of an underlying logical network is still largely an unknown possibility. Certain new theories such as game theory and more recently catastrophe theory recognize the possibility of explaining events as the result of a binding logic but for the moment these tools are still used within a strict empirical perspective of ordering visible data - the possibility of generalizing these conceptual schemes into full axiomatic theories has not been properly evaluated.

3) The Positivist Theory of Knowledge Stands in Contradiction to Modern Science Practice

The amount of literature on the analytic interpretation of science is extremely limited.[2] Actual works available in the fields

[2]Elements pertaining to the analytic perspective are to be found mostly in the writings of theoretical physicists. Almost no philosophers of science have addressed themselves to this problem. Those who did were European scholars more interested in purely philosophical problems concerning knowledge than in science as such.

of methodology and philosophy of science are remarkably silent about this possible conception of science. Even popular authors like Thomas S. Kuhn and Karl Popper fail to make a distinction between empirical and axiomatic epistemology. Their theories on science are too vague to take into account the complicated changes in method that have occurred in modern science and specially in theoretical physics. In fact their works, despite an appearance of novelty, do not challenge an empirical conception of science. There exists, it is true, a vast amount of literature on theoretical physics that includes philosophical reflections on method, but this literature usually tinkers with highly specific problems the nature of which escapes a general discussion on method. Finally, some "general" philosophers of science like Gaston Bachelard[3] and F.S.C. Northrop[4] have indeed made the distinction between empirical and analytic epistemologies but in a rather vague manner not wholly consistent with our discussion.

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[3]Gaston Bachelard, Le nouvel esprit scientifique (Paris: Presses Universitaires de France, 1934). His thesis is that empiricism is a form of "phenomenalism" that remains at the surface of things. This form of knowledge would be typical of the methods used in the classical sciences of botany, astronomy, anatomy, etc., etc. Their aim is description rather than theory building. Theory building constitutes the last "stage" of science and involves the utilization of abstract logic to express hidden as well as visible relations. In order to attain the level of theory formulation, the researcher must reject many empirical concepts which were taken for granted by the phenomenalist type of science in order to replace them by axiomatic postulates.

[4]F.S.C. Northrop, The Logic of the Sciences and the Humanities (New York: McMillan & Co., 1947). Northrop postulates that modern science is not based on an empirical epistemology but on an axiomatic one. Unfortunately, he confuses axiomatics with the hypothetico-deductive method and fails to assert the complex prerequisites of the new method.

One of the few accessible works establishing a clear distinction between the two epistemologies is Mario Bunge's philosophy of physics.[5] Bunge's analysis is almost unique. In the absence of other works concurring with or challenging this enterprise, it will be summarized in an attempt to constitute a conceptual framework. The basic argument consists of the idea that physicists have a false idea of what they are doing, their own conception of science stands in contradiction with their scientific practice:

> "The typical physicist of our time has discarded the worn out dogmatic systems -- which were half untestable and half false, and largely strerile anyhow -- only to adopt uncritically an alternative set of philosophical tenets. This home-spun philosophy, extremely popular in the physical profession since the dawn of our century, goes by the name of **operationism.** It holds that a symbol, such as an equation, has a physical meaning only to the extent to which it concerns some possible human operation. Which entails that the whole of physics is about operations, chiefly measurements and computations, rather than about nature."[6]

Bunge argues that science is not necessarily a descriptive enterprise since theories add conceptual elements that may not be included in the research procedure. The discovery of theoretical models that will provide for a "why" to the observed relations cannot be reduced to a purely descriptive conceptual enterprise. Bunge therefore rejects the empirical conception of science and articulates his own view along

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[5]Mario Bunge, Philosophy of physics (Boston, Dordrecht-Holland, 1973).

[6]Page 1. Operationism is a variant form of logical-empiricism where the constituents of a statement include operational as well as semantic concepts. Operational concepts are not necessarily theoretical however; they tend to reduce scientific statements to descriptions.

three main proposals: (1) science transcends inductive analysis; (2) science is not limited to the discovery of stable relationships; (3) science is not based on definitions. He rejects what he calls "the standard philosophy of physics."

a) Science is More Than Inductive Analysis

The contemporary physicist, he argues, "no matter how sophisticated and critical he may be on technical matters, usually espouses dogmatically what may be called the Credo of Innocent Physicist."[7] The main dogmas of this Credo are:

> " (I) Observation is the source and the concern of physical knowledge.
> (II) Nothing is real unless it can become part of human experience.
> (III) The hypotheses and theories of physics are but condensed experience, i.e., inductive syntheses of experiential items.
> (IV) Physical theories are not created but discovered: they can be discerned in sets of empirical data, such as laboratory tables. Speculation and invention play hardly any role in physics."[8]

Bunge agrees that observation does supply some rudimentary knowledge. But knowledge always goes beyond observation since it postulates the existence of unobservable (or at least not directly observable) entities such as the inner model of a solid body or waves. Physics goes even farther since it creates ideas that cannot be extracted from experience such as the concept of meson and the law of

[7] Ibid., p. 2.

[8] Ibid., p. 2.

inertia.[9] In other words, science defines facts according to abstract concepts and also deals with non-observable variables. Inductive knowledge stops at the appearance of things, it correlates phenomena with phenomena while omitting that these phenomena constitute only the symptoms of things to be studied. The empiricist limits the concept of reality to the resulting aspect of reality.

Like Newton, he limits science to measure without seeking a qualification for this measure. A mathematical constant would be a final judgment on any object of study. To Bunge, this is not acceptable -- even mathematical laws must themselves be explained by a theory that transcends them. The neglect of a causality behind phenomena is a characteristic of the empirical approach. For Bunge, all theories contain concepts that are removed from immediate experiment, they transcend experiment rather than summarizing it.[10] Therefore theories have nothing to do with inductive syntheses:

> "Axiom IV is really a consequence of Axiom III: if theories are inductive syntheses then they are not created but are formed by agglomerating empirical particulars, much in the same way as a cloud is formed by the aggregation of water droplets. The falsity of this thesis follows from the falsity of Postulate III, but it can be exhibited independently by recalling that every theory contains concepts that do not occur in the data employed in checking it. Thus continuum mechanics employs the concept

[9] Ibid., p. 3.

[10] Ibid., p. ~~5.~~ In fact concepts suggest new observations and experiments. Theories are as important (even more important) than observations since they determine the type of observation needed rather than be dependent upon it.

of inner stress; but, since this concept is unobservable, it does not figure in the data used to support or to undermine any particular hypothesis concerning the definite form of the stress tensor."[11]

If science was limited to description of visible things, there would be no need for theory. More than that, induction is a process that lacks a criterion of truth (facts are accidentally related, not essentially related). This lack of a criterion leads to conflictual models based on identical facts. The famous controversy over the problem of the relativity of knowledge[12] deals in fact with a problem that does not concern science: it is the phenomenal knowledge only which is relative to different contexts and cultures[13] not the scientific knowledge which transends data with logical theories. As Bunge goes on to say,[14] theories are not photographs nor worldviews, they are symbolic models of the logical structure of reality. H_2O, for example, stands for the logical structure of water, not for its empirical properties (cold, hot, clear, polluted, etc.). Therefore scientific theories are not inductive syntheses. Inductive analysis is a form of knowledge limited to information on phenomenal characteristics, no more, no less. It is a superficial form of knowledge.*

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[11] Ibid., p. 6.

[12] Eugen F. Miller, "Positivism, Historicism and Political Inquiry," American Political Science Review, (September 1972), p. 862.

[13] See: Karl Mannheim, Ideology and Utopia, (London, Routledge and Kegan Paul, 1954).

[14] Ibid., p. 6.

*Few people remember the errors and limitations of Aristotle's physics - a genuinely empirical science.

b) Science is Not Limited to the Discovery of Stable Relationships

According to Bunge the postulates referring to theorizing in the standard philosophy of physics are not valid. These postulates are:

> " (V) The goal of hypothesising and theorising is to systematise a part of the growing fund of human experience and to forecast possible new experiences. In no case should one try to explain reality. Least of all should we attempt to grasp essentials.
> (VI) The hypotheses and theories that include nonobservational concepts, such as those of electron and field, have no physical content: they are merely mathematical bridges among actual or possible observations. Those transempirical concepts, then, do not refer to real yet imperceptible objects but are just auxiliaries devoid of reference.
> (VII) The hypothesis and theories of physics are not more or less true, or adequate; since they correspond to no independently existing items, they are only more or less simple and effective ways of systematising and enriching our experience rather than components of a picture of the world."[15]

Scientific theories are not aimed at making convenient typologies for factual knowledge. Science goes deeper than the ordinary data. Deep explanations require that we postulate the existence of mechanisms that escape perception most of the time (except for the macrophysical and properly mechanical ones).[16] Many scientific theories are nonphenomenological and refer to abstract entities that cannot be seen nor "visualized" with the help of imagination.

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[15] Ibid., p. 2.

[16] Ibid., p. 7. Bunge, however, does not detail systematically the different layers of the scientific reality -- he simply proposes a distinction between "deep" and phenomenological theories.

Science has abandoned inductive knowledge as a standard method because visible relations constitute only the syndrome layer of reality. Any visible relationship is either accidental (facts are changing all the time) or stable -- in which case it should be explained by the existence of an underlying structure. The mathematical expression of a visible relationship (an empirical law) is not enough for science: the phenomenal law remains to be explained by a superior law that goes beyond relations and regularities to reach the essence of things. Beyond empirical properties, there are formal properties in science, such as mass and charge[17] which originate several other properties -- but these properties are those of underlying patterns which may differ from the phenomenal sequence of things. Science is closer to X-Ray radiography than to empirical description, the logical skeleton sustaining things is the real target. This is why Bunge rejects Axion VI of the standard philosophy of physics which postulates that trans-empirical concepts are nothing more than mathematical (or logical) bridges among observations:

> "Axiom VI is common to conventionalism, pragmatism and operationism (which may be regarded as the philosophy of science of pragmatism). If adopted, most of the referents of physical theory are dropped and we are left with empty calculi. For, what characterises a physical theory by contrast to a purely mathematical one, is that the former concerns -- whether rightly or wrongly -- physical systems. If a theory is not about a class of physical systems, then it does not qualify as a physical theory. Hence the sixth dogma is semantically false. It is psychologically false as well, for if theories were nothing but data grinding machines, nobody would bother to build them."[18]

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[17] Ibid., p. 7.

[18] Ibid., p. 7.

Empirical theories and models are typological in character. They are portraits of certain stable processes and nothing else. The usual confusion between mathematical physics and theoretical physics is typical of empiricism: theoretical physics does not limit its uses of mathematics to establish direct relations between facts (this is only one aspect of the question), mathematics also express complex properties that cannot be understood from an empiricial perspective: relativity makes little sense out of a non-Euclidean universe (but such a universe cannot be seen even if it is there). Therefore Axion VIII which makes theories similar to technical tools is also to be rejected: the logical reality modern science is talking about is "true" in itself and the goal of theories is the discovery of this immanent pattern, not the pragmatic ordering of data.[19]

c) Science is not Based on Definitions

A third group of empirical postulates would make science based on definitions. Such a view seems logical but in fact it is not. Here are these postulates:

> " (VIII) Every important concept has to be defined. Consequently every well-organised discourse has to start by defining the key terms.
>
> (IX) What assigns meaning is definition: an undefined symbol has no physical meaning and therefore can occur in physics only as a mathematical auxiliary.

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[19] Ibid., p. 8.

> (X) A symbol acquires a physical meaning through an operational definition. Whatever is not defined in terms of possible empirical operations is physically meaningless and should therefore be discarded.[20]

According to Bunge the demand "that every concept should be defined to begin with, is flatly absurd."[21] In logic, since concepts are made of other concepts, some of them must remain undefined and serve as a basis for understanding. In science there is a great role played by basic undefined concepts which serve to ground a theory. Thus "concepts like mass and force are primitive (undefined) in Newtonian mechanics.[22] Theories do not start with definitions but with undefined concepts that will be glued to logical and mathematical concepts in order to form a theory. They are essential, others are not.[23]

The role of primitive concepts (undefined axioms) is to define the other concepts of a theory. Basic concepts are not defined semantically (by connotative and denotative descriptive statements), they are defined by a whole theory. These concepts are not operational definitions and involve more than measure:

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[20] Ibid., p. 2.

[21] Ibid., p. 9.

[22] Ibid., p. 9.

[23] Bunge does not review the logical and semantic limits of empirical concepts. He simply states that empirical definitions are not the basis of a theory.

"Besides, the numerical value of a magnitude or physical quantity is only one constituent of it. For example the concept of electric field is, mathematically speaking, a function and therefore it has three ingredients: two sets (the domain and the range of the function) and the precise correspondence between them. A set of measured values is only a sample of the range of the function. Unless one has a fairly well-rounded idea of the whole thing one would not even know how to go about taking such a sample. That is, far from assigning meanings, measurement presupposes them."[24]

Modern science is then axiomatic. In modern theories no phenomenological meaning whatsoever is attributed to the primitive notions. These notions are simple terms whose whole significance consists of being used according to some or other particular formal conventions. Sciences based on definitions are therefore not axiomatic. Pure science consists of the invention of an alogrithm set up in such a way that the judgments about its subject correspond to judgments of experience in a purely abstract operationalization of the parameters. The content of the theory becomes an idea rather than a summary of facts.

B) Political Science

1) Empiricism

In the analytic perspective, the crisis of political science is to be seen as the crisis of scientific theorizing. We must leave the surface of immediate content and search deeper for the underlying premises of the theories. It is not only what the theories say but what they

[24] Ibid., p. 10.

assume that becomes the main interest. An axiomatic criticism aims at the roots of existing theories - philosophical, conceptual and ideological presuppositions and implications rather than at actual propositions.

Therefore the new perspective constitutes a variant of the "methodological debate." Instead of being interested in the ideological position of Behaviouralism, we want to stress the point that the method followed by Behaviouralism is not a complete one. The analytic approach offers a solution to political science: not so much in terms of a change of paradigm but in terms of a change of method. The methodological debate exists because the empirical method is not strong enough to impose its conclusions. An advanced scientific method should render the present methodological debate obsolete.

Today, the scientifically inclined political scientists still conceive theory as a precise copy of observations rather than as the discovery of the logic at work within these observed events. Within this approach, theory is still conceived in an archaic manner germane to nineteenth century physics as can be seen in this excerpt from an article by Eugene F. Miller:

> "It is true that logical positivists moved toward a more liberal criterion of meaningfulness which could accommodate the fact that theoretical physics makes extensive use of concepts which do not refer to anything directly observable. As Carnap pointed out in this later period, 'the prodigious growth of physics since the last century depended essentially upon the possibility of referring to unobservable entities like atoms and fields.' Accordingly, Carnap developed the view that theories must be tested indirectly by linking theoretical concepts to observable things by 'correspondence rules.'

> Carnap's later view is possibly liberal enough to sanction metaphorical references to 'nonobservables' in the human sciences, but not all empiricists would be this generous. Brodbeck, for example, grants that references to invisible entities cannot be eliminated from atomic physics, but she denies that social scientists are warranted in introducing similar concepts. In this respect, social science is like classical Newtonian theory: all of its concepts refer to what can be observed, namely, to the 'observed behavior' of individuals or groups. Social scientists should not 'hunger after the complexity of the invisible,' because the phenomena they study are not of 'atomic or subatomic dimensions.' Thus the notion of 'model' appropriate to these nonobservable entities has 'no intelligible meaning in social science.'"[25]

The idea that the cause of human events may refer to abstract properties of society has not yet entered the awareness of political scientists. However, the standard view is incorrect. Facts do not constitute the basis of the scientific pyramid, axioms do. Hypotheses are not scientific-binding statements; they are guesses about the possibilities in the abstract world, and these guesses are certainly completely formed by formal logic. But science is hypothesis-testing: tests are based on empirical reality but facts are defined conceptually by the axioms -- so there is nowhere in science such a problem as a narrow selection of facts. Science is based on theoretical abstractions about reality, it is not based on self-evident facts capable of supporting a scientific blueprint by simple observation, we cannot see thermodynamics, nor charmisma, nor power.

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[25]Eugene F. Miller, "Metaphor and Political Knowledge," American Political Science Review 73, (1979), p. 164.

The pragmatic consequences of this lack of concern for the nature of social reality is that Behaviouralism cannot produce any theoretical explanation that could be refutable on logical grounds. The Behavioural approach is only cumulating data on the characteristics of politics - but it has not been proven so far that these visible characteristics were something else other than secondary attributes of politics. Behaviouralism is combining method with phenomenal appearance: the empirical world is only the result of an internal dynamism, it is not an entity in itself and a science that limits itself to the study of the facts is only a science of appearances, not a fundamental science based on logic.

2) Implementing the Analytic Method in Political Science: An Alternative Approach

Political Science should become a discipline like geometry, and concerned with the dynamisms of political life in separation from any content. Political axiomatics should succeed in building a formalized and integrated theory of politics where the whole of social and political life could be deduced from a body of necessary logical laws.

> "The forces of ordinary intellectual discourse, therefore, drive political studies towards the deductive mode of analysis. Some may find that prospect of a discipline dominated by such reasoning distasteful because deduction is closely prescribed

by a large number of rules. These rules, are however, helpful rather than handicapping because they set out the conditions that must be fulfilled most precisely, and free the analyst from the pursuit of many dead ends. They concentrate the mind wonderfully, rather than dispersing its energies across a wide range of marginal considerations. The question is who is to be master - analyst or subject-matter? (...)

What is particularly important about the arguments used here is that they rely on general considerations which are or ought to be accepted by the proponents of all traditions within political studies. For instance, though behaviouralism is often contrasted with traditional social and political theory, the latter has equally been affected by the same logical problems. New paradigms have had to be developed in the study of the history of ideas, and the same pattern of argument has produced a movement towards deductive reasoning in analytical political theory. Thus the same pressures are found in the work of those who are often the leading anti-behaviouralists; it is likely that both traditional and modern approaches will end at the same place if they are both using the same map.

The study of politics will continue to experience crises until it finds a mode of analysis of its own. This will not occur until it adopts methods which are based on the exploitation of the properties of deductive reasoning."[26]

The implementation of this method in Political Science faces considerable opposition: science is still conceived to be exclusively empirical and too rigid to fit the relative indeterminancy of human problems. Eugene Meehan has well summarized this point of view:

"The need for a clear and unambiguous definition of knowledge, for a set of criteria that can be used to determine the status of propositions, is classic. Reasoned argument or explanation is not possible until the standards of evidence have been defined and agreed. A good part of the polemic over

[26] J. Stanyer, "Irresistable Forces: The Pressures for a Science of Politics," Political Studies, 24(3), 1976, p. 252.

methodology in political science can be traced to fundamental disagreement about epistemological requirements, and many of the distinctions that can be drawn between political science and physical science may be attributed in large measure to epistemic differences. If the political scientist could simply adopt the epistemological standards of the physicist for his own, a great many troublesome problems of technique, method, and research strategy would disappear, and it has sometimes been suggested that this be done. Unfortunately, or perhaps fortunately, this solution to our problems will not do; a political scientist restricted by the strict epistemological standards of the physicist could not perform the tasks of his own discipline."[27]

Many political scientists maintain the distinction between the physical sciences with their search for abstract universal laws and the more concrete cultural disciplines which deal with unique more or less extended circumstantial events, seeking to present them in a descpritive manner, rather than abstractly. This accepted practice simply rejects the possibility of having a real science of politics based on general laws and exact theories in order to limit itself to the unoriginal description of problems and institutions. This unnecessary limitation is self-defeating, surely the uniqueness of events and the particular problems of human freedom do not make general causal explanations impossible. The great political scientist Harold Lasswell was a spokesman for such a possibility:

"Facts, to Lasswell, were to be regarded as data for hypotheses, and in his introduction to 'Power and Society' he expressed devotion to 'pure causal analysis'. Theorising in politics was not to be confused with metaphysical speculation in terms of abstractions hopelessly removed from empirical observation and control. He accepted the 'straightforward empirical view'

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[27]E. Meehan, The Theory and Method of Political Analysis (Homewood, Ill.: Dorsey Press, 1965), p. 169.

(Lasswell's assessment) of two such widely separated books as Machiavelli's 'Discourses' and Michel's 'Political Parties'. But he for himself would aim at broader generalisations than either. For good or ill, the assessment that Lasswell, like Merriam, is to be understood primarily for the conviction which they helped to spread that the study of politics is important and can be scientific after the manner of the natural sciences is certainly justified."[28]

In an advanced science of politics, the events should be the result of abstract laws totally independent of human will. Politics should be reducible to exact laws of social and political dynamisms to be discovered by the method of logical-axiomatic deduction. In an advanced science, the method is deductive: an event is explained by showing that it can be deduced from an established axiomatic model of a hidden dynamism. Such deduction from the existence of an abstract law offers a causal explanation (the explicandum) to a set of facts that are rigidly determined. A less advanced science of politics is only probabilistic - deductive: it provides only for circumstantial explanation of the event and includes tendency statements.

The axiomatic theory is neither empirical nor is it a set of models that can be correlated with the facts. Here, the theory is an abstract and symbolic construction of a hidden dynamism. This type of theory offers conceptual, rather than empirical generalizations. The theory must also include some theorems that relate the theory to observable facts. This type of theory is an hierarchical construction

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[28]H.V. Wiseman, Politics the Master Science (London: Routledge & Kegan Paul, 1969), p. 53.

based on universal axioms (postulates) which are not deducible from any other statements in the theory. Its theorems are logical derivations of the original axioms is best expressed by a conventional set of symbols (as in chemistry for example) or by mathematical equations. The knowledge expressed by an advanced science stands in real contradiction with the results of empirical analysis. James S. Coleman describes the way the axiomatic theory of gravity might not have been devised, had Galileo gone about his task in the way most data-analyzing social scientists do:

> "A simple example will illustrate some of the difficulties which might arise by this kind of 'brick-by-brick' approach to theory. Suppose that early mechanics had developed by the use of regression equations. Suppose, specifically, that an investigation had been carried out relating the length of time a body had fallen through air and the velocity it attained. The relation in mechanics is that the velocity attained is equal to the acceleration due to gravity times the time the object has fallen, or
>
> $$v = gt$$
>
> where g is the acceleration due to gravity. Now if there had been numerous investigations involving different-sized bodies, different velocities, and bodies with differing densities, the investigators would have ended with numerous pairs of observations (v_i, t_i), which they would locate on a scatter diagram in order to find the line of best fit. But in every case, and especially for high velocities (i.e., objects which fell a great distance) and low-density objects (i.e., feathers), the observed velocity would fall considerably below that which the theoretical equation predicts. The resulting regression equation might have ended up including other variables, such as mass or density of the object; and there would have been indications that at high velocities the relation of velocity to time was not even linear. The reason, of course, would be air resistance, which has different effects as a function of the density of the object, its shape, its velocity, and other things. The regression equation would of course have been empirically correct, but it wouldn't have corresponded to the simple velocity-time relation which served as the basis for Galileo's remarkable contribution to the science of mechanics.

They might even have served to confound the issue, by bringing in too soon a factor - i.e., air resistance - which was irrelevant to the fundamentals of mechanics."[29]

One way of distinguishing an advanced science from a pre-science is that the former includes a generally agreed-upon body of axioms from which most of its theories can be deduced. Political Science does not possess such a body of axioms. Lacking this base for deduction, a source of deductive theory could possibly be found in a well-established theory from another field.

3) Three Theoretical Stages in the Development of Political Science

a) The Black Box View of Political Science

We think that empirical political science is a "black box" type of science according to a world-known classification made by Mario Bunge.[30] This means that the Behavioural school of thought is undertaking only a description of the functioning of the constituted political system and political behaviour. It explicitly states this goal and the lack of interest in the mechanism-producing society. The "black box" type of science is cumulative. It considers the world as a coherent system of causes and effects which is relatively static in terms of structure and which can be understood completely through a finite amount

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[29] J.S. Coleman, Introduction to Mathematic Sociology (New York: The Free Press, 1964), pp. 100-101.

[30] Angela Botez, "Models of the development of science", Revue roumaine de sciences sociales, Vol. 22, No. 1, (1978), p. 17.

of information to be completed in due time. The process of cognition is seen as a passive recording of reality, be it material or ideal, as a reflection of existing properties and relations of the object. Methodologically, this conception emphasizes the empirical, taxonomic knowledge and aims at offering detailed descriptive statements and a unitary and more or less stable scientific language. Theories are reductionist and are based essentially on induction. Facts are prior to theory and select the valid theory out of cumulated evidence.

The cumulative view ignores the genesis of the political facts in analytical terms and concentrates exclusively on the resulting visible structure as the cause of politics. It denies the possibility of scientific progress through logical imagination. When it does consider scientific discovery, it defines it as the extension of former knowledge in new combinations, stressing in this way the continuity and stability of scientific knowledge. Regarding the development of mental structures, they are viewed from an observational perspective aiming at a fixed description of events. The development of science is limited, since it consists only of the discovery of a pre-existing finite truth. Secondary theories will be integrated to the previous ones in order to deal with the ultimate invariable factors. The trends supporting this conception of science are, generally speaking, the empirical philosophies of science: the Vienna circle and logical positivism.

Since this type of political science refers only to the actual organization of the political factors and not to their dynamics, not to the mechanisms producing them, behavioural conceptions can be regarded as the descriptive stage of the research in science. As such, the accuracy of the research method constitutes an essential prerequisite for the next stage of science.

What is faulty in the black box science is not research objectivity but the analysis that is limited to the static structure of behaviour ruling out diachrony, the genetic construction of the structure and the internal dynamics of the structure as valid sources for scientific theories.

b) The Grey Box Interlude of Thomas S. Kuhn

The "grey box" type of science consists more or less of the black box approach plus an affirmation of the importance of the role of imagination in science. The role of constructive reason is the basis on which theories are built - theories that can then select the relevant facts. According to this view, the dynamics of science consists of cognitive mutations called paradigms. Science becomes a point of view, and the changes in these points of view cannot be predicted in advance. Science is a succession of scientific revolutions in which the existing paradigms are replaced by others, linguistically incompatible, incommensurable and inappropriate. It acknowledges and probably exaggerates the influence of socio-historical conditions on scientific development. The method is much less accurate than the black box approach but gains enormously in scope. It is a stage where interesting questions are asked about reality. But the method is remarkably weak in its definition of correspondence between theories and facts. The theories are extremely relativistic since opposing theories can be based on the same facts.

The grey box approach does not measure up to its own standards because it does not propose a change of method but only a change in the conception of science. Science is in fact no more a method but simply a worldview. At this point science cannot be differentiated from ideology which also defines a worldview and selects the fact to prove it. The value of the grey box approach lies in its emphasis on the importance of theories to understand the world but the specific method that could permit the building of genuine theories is completely mistaken for free imagination.

c) The Translucid Box Approach

The last approach in science is reached when the specific method for scientific theorizing is discovered. This method consists essentially of the translation of the empirical facts into analytical categories that can be permuted according to the rules of mathematics. In this approach, the problems linked with the task of defining the facts in a clear manner are over since the facts become simple coordinates within a mathematical model of the universe. However, the building of a model that would serve as an axiomatic foundation to theories is immensely difficult since the parameters of the interaction of facts cannot be derived from observation - only from logic. The model then is a gigantic logical puzzle that tries to link all the observable facts of the world according to simple common denominators.

At this stage, the conception of reality ceases to be logical-positivist and becomes somewhat Hegelian in nature: the world becomes the distorted embodiment of a principle that transcends it - in Hegelianism this principle is called the "spirit," in modern science it is called - at least by Einstein - an axiomatic mathematical principle. Logical models of the universe replace the observable universe as a source of theorizing - if the model is valid, then the laws derived from it will be confirmed later by experimental scientists. At this stage the empirical reality is not rejected, it is simply translated into logical hypotheses amenable to mathematical deductions. Mathematics at this stage are not measures of statistics but algebraic equations expressing hypothetical abstract attributes of the observable world. The world is no longer material but purely mathematical. The observable world remains absolutely essential for testing the axiomatic theories but it is no more absolutely necessary as a direct source for theorizing. The axiomatic method frees itself so to speak from the vernacular-pedestrian-task of judging the immediate reality in order to take off in the "sky" of abstract theorizing. This flight into pure thinking has, however, nothing to do with metaphysics because the axiomatic researcher subordinates his task to a reference system that serves as a rule of logic. The goal is to decipher the logical structure of the world, not to observe empirical regularities.

CHAPTER II

THE NEW METHOD IN THEORETICAL PHYSICS

A) The Evolution of Method

The evolution of method in science - and more precisely in contemporary theoretical physics - has led to an epistemological revolution that must be taken into account in a discussion on the development of method in political science. This epistemological transformation is of an interest larger than physics because it reveals for the first time the logical imperatives for the scientific method. Before these contemporary developments, method has usually been assimilated to common sense and it is the great merit of the new approach to have discovered that any further improvements in the development of science requires that the empirical epistemology must be replaced by an axiomatic reference system. The arguments for this transition can be listed as follows:

- Infinite regression in the chain of factual causes must stop at some basic cause justifying the process of causality.
- Infinite regression in terms defining other terms must also stop at some primitive terms justifying all terms.
- Primitive causal relations cannot be observed. They form a pre-order of the observed reality.
- Primitive causal relations are therefore to be understood in terms of abstract operationalism couched in an axiomatic language.
- The transition from observational terms to axiomatic terms is an immensely difficult process.

1) **The Axiomatic Method**

The axiomatic method was invented by Newton when he furnished a mathematical theory of planetary motion, obtaining thereby his law of gravitation. It differed from the previous one in that it was mathematical and speculative. Up to now, physics is the only one of the sciences to which mathematical procedure has been applied with complete success. The incentives which prompted the new method are the following: in the prior method, facts were defined and their relations were grossly established. But the relations discovered by the occurrence of a phenomenon in different contexts were the most obvious ones, the more hidden or more complex relations were simply overlooked. At this point came the question: could these additional relations be revealed by connecting more facts together or by connecting them with a different method? Political science has apparently made the error of opting for the first approach while modern physics has opted for the second possibility.

To proceed beyond the empirical stage, researchers are compelled, however, to introduce assumptions of a more or less speculative nature. These assumptions are too complicated to be reduced by commonplace reasoning which eventually lead to the replacement of simple human objectivity by an axiomatic logic amenable to mathematical formulation. With this new approach the scientific reference system is no longer based on human perception, it is based on a rule of formal logic.

With formal logic replacing common sense, formerly unsuspected relations are revealed, and additional laws are derived. These logical (or mathematical) laws are no longer called "empirical" for they differ entirely in their mode of derivation from the laws that may have been established in the preceding stages. Newton's law of gravitation is an illustration of a law obtained through the medium of mathematics. The theories developed so far in physics as a result of the application of the axiomatic theorizing are usually called "theories of mathematical physics" or more briefly "theoretical physics". The theory of relativity and the quantum theory are of this type. The role played by mathematics in these new theories is not to express an empirical regularity as it is mistakenly assumed, it is instead the explanation of an invariant deviation from an expected regularity by linking mathematically this observed deviation with a built-in abstract dynamism: the theory of relativity is the clearest example of this mode of reasoning.[1]

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[1]There are two positions on the meaning of mathematical theories in physics. The first position (empirical) rejects all attempts that would make mathematical relations the expression of an underlying abstract universe: "The whole of our physical knowledge is based on measurement....The physical world consists, so to speak, of groups of measures resting on an obscure foundation that is outside the realm of physics....The whole object of the exact sciences consists of pointer-readings and similar indications. We cannot at this point enter into an examination of what can be classified as 'similar indications'; observing the approximate coincidence of a needle with a division on a scale can, in a general way, be extended to include every sort of coincidence or, according to the customary expression used in the language of relativity, an intersection of lines of the universe. This is the essential point: even though we would appear to have very definite conceptions of the objects of the external world, these conceptions form no part of the realm of exact science and are in no way confirmed by it.

An illustration of formal logic replacing common sense theorizing can be easily conceived in the following example: if we push a well-greased wagon on a track and let it go, it will stop at one point -- the empiricist will establish a correlation between the force applied on the wagon and the distance covered on the track; it will be an empirical law.

The axiomatic analyst will have a different idea of the problem: he will remark that there is no reason why the cartwheel should stop at any moment, it should logically follow a permanent straight line unless an unseen resistance is at work affecting the movement. He will therefore build a mathematical model of the inertial forces causing the act of stopping. In the first case an empirical regularity is established, in the second case a fundamental cause is reached.

(Continued from p. 35)
Before exact science can begin to handle the problem, it must replace them with quantities representing the results of physical measurements." A.S. Eddington, The Nature of the Physical World (Cambridge, University Press, 1929), pp. 252-253.
The second position (analytic) recommends that the abstract properties and patterns of the universe be considered as real even if they are hard to conceptualize. Wave mechanics, for example, is more than a set of mathematical symbols. It is more than a symbolic representation of probability. Even if no imaginable spatio-temporal representation, no physical image of those waves is itself possible and even if it were impossible to define them as a result of certain sequences of operations of physical measurements, it is not necessary to conclude to their non-existence. Theoretical physics includes many such abstract concepts that transcend their immediate mathematical utility. More is gained by postulating the real existence of abstract patterns than maintaining that these concepts are pure mathematical symbols.

1) At One Point the Axiomatic Method Must Replace the Empirical Method

As we have said already, science develops by methodological stages. The first stage is the empricial one in which careful observations and descriptions are generalized in tendency statements. However, this inductive method has severe limits that came to be understood little by little over time in some disciplines. Empirical concepts are vague, despite their pretense to the contrary, they are influenced by subjective interpretations and above all they lack a substantive logic that could justify how many and which categories of facts are needed to build scientific theories. Facts are not really self-evident and in their search for a better understanding, scientists came to realize that meaning is imposed upon the facts by the theory itself.*

Following from this observation on the preconception of facts, the next stage in science is essentially a debate over paradigms. The provisional solution to the vagueness problem is that a conceptual framework will bring together all the empirical observations in an attempt to provide them for a meaning.

The problem, however, is to determine a method by which a model can be chosen: if the world is a sea of inchoate phenomena to which a meaning is given by placating a model on it, how will you ever know that the meaning given by your model is valid? You can make as many arbitary models as you want with such a method since the definition of the facts (in the absence of the existence of absolute objective self-evident

*Facts result from a sensate description or an analytic construct.

facts) remains largely arbitrary. Even if a common model is singled out for practical purposes by a community of scholars, it does not mean that this convention is scientific.

Since the facts are defined by the models themselves it becomes impossible to decide between different models explaining the same facts with different concepts. The solution cannot be a return to factual verification due to the limited degree of precision of the facts and due to our ignorance of the number of facts that must be cumulated in order to establish a universal generalization under the form of a scientific law (not to mention the immense problem of the variations of empirical relationships in different contexts and in different time-spans, a problem big enough to cancel by itself any prospect of having an empirical science at all). This stalemate was solved in physics in different works and especially in the writings, speeches and correspondence of Albert Einstein. Einstein proposed a change in the focus and in the content of the scientific models that proved to be the only possible solution. First, he understood that the models were not linking facts together but were in fact expressing logical properties of the universe that were partly independent of the observed facts and second he found that the only possible convention that could decide between different models of the universe was not an arbitary convention (paradigm) but was formal logic. This new epistemology prepared by the works of Heinrich Hertz and Ludwig Boltzmann was a true scientific revolution.[2]

This shift in the focus and in the contents of the models will then permit a new type of scientific verification. It will no longer correlate a definition with a fact in a loosely descriptive manner but will explain the occurrence of an event as the necessary indicator of the existence of a hidden abstract pattern at work among the facts. With the new method, a theory will be verified if a predicted specific event will occur among all the observed phenomena - if this specific event does occur and gives credence to a logical theorem derived from an axiomatic model, then the implied variable inferred in the model will be believed to exist.

B) The Transition to an Axiomatic Science in Physics

The gradual replacement of empiricism in physics was largely due to the introduction of concepts that had little or no empirical

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[2] Present-day paradigms in theoretical physics are based on pure logic. "The theory of relativity constitutes, on the whole, the crowning of the old macroscopic physics, while, on the contrary, the Quantum Theory arose out of the study of the corpuscular and atomic world": Louis de Broglie, "Relativité et Quanta," Revue de Métaphysique et Morale, (July-September 1933). In these few very suggestive pages M. Louis de Broglie recalls how the Theory of Relativity and the Quantum Theory had to confront each other as a result of their having grown up from different axiomatics.

equivalents. Following the thesis of James CLerk Maxwell on electromagnetism, the scientific community changed radically its conception of reality for a subtler one. This change is well reported by Albert Einstein:

> "Neglecting the important individual results which Clerk Maxwell's life-work produced in important departments of physics, and concentrating on the changes wrought by him in our conception of the nature of physical reality, we may say this:-- Before Clerk Maxwell people conceived of physical reality -- in so far as it is supposed to represent events in nature -- as material points, whose changes consist exclusively of motions, which are subject to partial differential equations. After Maxwell they conceived physical reality as represented by continuous fields, not mechanically explicable, which are subject to partial differential equations. This change in the conception of reality is the most profound and fruitful one that has come to physics since Newton; but it has at the same time to be admitted that the program has by no means been completely carried out yet. The successful systems of physics which have been evolved since rather represent compromises between these two schemes, which for that very reason bear a provisional, logically incomplete character, although they may have achieved great advances in certain particulars."[3]

This change prompted certain philosophers of science to question the value of the empirical epistemology <u>since the new theories were pointing at the existence of relationships that could be understood from a purely conceptual point of view but that could not be observed as such.</u> The debate that ensued on the nature of reality came gradually to be monopolized by Ernst Mach and Albert Einstein. The problem was: is physical reality abstract or empirical?

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[3]A. Einstein, <u>Essays in science</u> (N.Y., Philosophical Library, 1934), p. 44.

1) Ernst Mach

Mach's philosophy is considerable and cannot possibly be reviewed here. We will rather concentrate on the essential part of his scientific epistemology.

Mach was a physicist, a physiologist and also a psychologist and his philosophy arose from the wish to find a solid perspective to which he could hew in any research, one that could provide a common denominator to all fields of science from the field of physics to that of physiology and psychology. He reached such a perspective by going back to that which is given before all scientific research: namely the world of sensations. The argument was that all our knowledge concerning the external world relied only on sensations. Mach held that we can and must take these sensations and complex of sensations to be the sole content (Gegenstande) of knowledge, and, therefore, that there is no need to assume the existence of an objective world hidden behind the sensations. With that, the existence of the world in itself is removed as an unjustified and unnecessary problem. Physical objects are after all nothing else than more or less invariant patterns of sensations. We cannot see any substance, we perceive and hear only colours, sounds, heat, pressure, etc. To infer from these sensations that the world is a substance is a dead-end deduction that is irrelevant to science. The world is empty and there exists nothing other than sensations and their connections. Mach also defined the sensations as the "elements".

According to Mach, the new worldview developed after Maxwell's theories was not really in contradiction with the common sense view of the objective world since this view was largely the result of an improper understanding of the process of human thinking. Scientific knowledge of the world consists, according to Mach, in nothing else than the simplest possible description of the connections between the sensations, and it has its only aim in the intellectual mastery of those facts by means of the least possible effort of thought. This aim is reached by means of a more and more complete accommodation of thoughts to the sensations and the accommodation of the thoughts to one another. This is the formulation by Mach of his famous "principle of the economy of thought". Mach had correctly pointed out that "If all the individual facts - all the individual phenomena, knowledge of which we desire - were immediately accessible to us, science would never have arisen".[4] For Mach, science is the totality of the mental relations between different data of experiment. For Mach scientific theories were nothing else than mental techniques serving to bridge the gaps in our sensations, they did not refer to the existence of anything in particular and therefore the field-theories in physics did not refer to the existence of a non-phenomenal world behind the sensate world but were only heuristic devices.

For Mach any statement about the existence of any world was a metaphysical concept since we cannot experiment whole worlds but only

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[4]E. Mach, Conservation of Energy (N.Y., Dover Publ. 1947), p. 54.

isolated sensations. From a logical point of view he maintained that the explanations of the phenomena with the easy hypothesis of the existence of a world determining them were a loss of time since the properties ascribed to this world had no theoretical significance. To say, for example, that bodies attract each other in nature as a consequence of an inner disposition for attraction does not explain why this disposition exists after all. To say that "ether" must exist because light could not travel in a void does not tell us anything about the inner structure of "ether". Mach's phenomenalistic positivism proved to be an undeniable and irresistible weapon for the critical reevaluation of classical physics eliminating all the false explanations derived from the existence of unprovable world properties. Mach was the first philospher to correctly criticize the metaphysical aspect of empiricism. Therefore, the aim of science "is not to produce bold hypotheses as to the essence of matter, or to explain the movement of a body from that of molecules, but to present equations which, free from hypotheses, are as far as possible true and quantitatively correct correspondents of the phenomenal work, careless of the essence of things and forces".[5]

But the phenomenalistic positivism of Mach, even if it had demonstrated successfully the metaphysical character of many empirical assumptions had failed to give a convincing explanation of the chasm created in the new theories between the observed world and the

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[5]G. Holton, "Where is Reality? The Answers of Einstein," in Science and Synthesis, N.Y., Berlin, Springer-Verlag (1971), p. 63.

theoretical world. To assert that the world does not really exist (or at least that its existence does not concern science) and that theories are artificial subjective links between disparate sensory experiments seemed to many scientists to be a too easy evacuation of the problem of reality in science. After all, Mach's "sensations" had themselves a metaphysical character all of their own - how could Mach be so sure that his cinema-like form of knowledge was projecting the total picture of the world or that our understanding of the film was correct?

2. Einstein's Critique of Mach

Mach's early influence on Einstein had been enormous and had contributed to the implicit epistemology found in the special theory of relativity of 1905 - a theory which again was in contradiction with the phenomenal perception of the world. For a time it seemed that Einstein was satisfied with the idea that the elasticity of time and space according to motion included in his theory was little else than a free speculation linking paradoxical observations on the speed of light. Like Mach he believed that the opposition between theoretical relativity and the perception of a stable three-dimensional world was a false problem.

The Machist component of the 1905 paper showed up convincingly in two respects. First, by Einstein's insistence that the fundamental categories of physics had to be defined with the aid of an epistemological analysis rather than being taken at face value with an empirical description. Second, by his belief that reality consisted of disparate "events" perceived by senses.*

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*A. Einstein, Zur Elektrodynamik bewegter Korper, Annalen der Physik, 17, 1905, p. 891-921. The article proposes a discussion of some concepts in an abstract operationalist manner.

Einstein really believed at that time that all scientific concepts and statements rested solely in isolated experiments (Einzerlerlebnisse) to which the concepts referred.

This phenomenalistic epistemology was well summarized by R.S. Cohen:

> "[The phenomenalist program] suggested that nature was to be conceived as a set of disconnected atomic facts, that the flux of sensations can be analyzed into individual observation-protocols ... The phenomena with which science deals are assumed to be isolated sensations or single observations. The relations among the given phenomena were subjective matters of efficient but arbitrary ordering of the data; hypothetical entities and their relations were viewed as fictions or as shorthand; and the monadic character of atomic sensations was assumed a priori but made empirically plausible by a program of reductive definition of scientific concepts in terms of individual reports."[6]

However, two intellectual events will gradually lead Einstein to a rejection of Machian phenomenalism and its replacement by a coherent epistemology that will decisively solve the problem of the gap between the new theoretical world of physics and the visible world.

The first blow came from Ernst Mach himself when he finally rejected the theory of relativity. The reasons for this rejection are numerous but the central argument made by Mach was that Einstein's theory was based a priori on an unprovable view of the world rather than on sense-impressions. For Mach, Einstein was not a phenomenal empiricist,

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[6] R.S. Cohen, "Dialectical materialism and Carnap's logical empiricism," in The Philosophy of Rudolf Carnap, P.A. Schlipp, ed., La Salle, Ill. (1963), p. 136.

he was something new, something that had nothing to do with phenomenalism.

What had made the relativity theory work was not its avowed recognition of the importance of the phenomenalist epistemology but rather the unexpected affirmations made by Einstein concerning the constancy of light velocity and the relativity in all branches of physics, two postulates for which there could not be any direct confirmation at all. Einstein did not understand at once that his theory was in itself a rejection of the implicit principle of description latent in all the works of Mach. For Mach the theorizing process was nothing else than a quasi-descriptive patchwork between two separate observations, but now Einstein was apparently linking two separate unprovable assumptions. For Mach there was no possible way a scientist could transcend the factuality of the world even if this factuality was more chaotic than the homogenous substance defined by the traditional empiricists. Implicit in Mach's theory was the underlying assumption that categories had still to be abstracted from experiments. Mach was a sophisticated empiricist, he understood brilliantly that the existence of the world was a useless conception leading to pseudo-explanations by the attribution of ad hoc properties to this world, but he did not understand that a theoretical enterprise linking disparate phenomena can precisely do only that: redefining a reality linking the two observed phenomena. In Mach's theory the world is subjective instead of being objective as in empiricism - and if Mach can explain the opposition between the theoretical world and the observable world as a false problem resulting from the more complex apparatus developed by science to link more phenomena together, he would not understand that the relationships between facts should postulate the existence of intervening components. In other words, the relationship did not really exist, it was only a mental systematic illusion made necessary by the limits of one human perception.

Einstein would one day turn this conception upside down by stating that only the relationships exist and that the observed events are only particular (and usually misleading) aspects of these abstract relations. But before elaborating and justifying this anti-phenomenalistic epistemology, Einstein struggled hard to remain in the Machian tradition:

> "I am anxious to draw attention to the fact that this theory is not speculative in origin; it owes its invention entirely to the desire to make physical theory fit observed fact as well as possible. We have here no revolutionary act but the natural continuation of a line that can be traced through centuries. The abandonment of certain notions connected with space, time and motion, hitherto treated as fundamentals, must not be regarded as arbitrary, but only as conditioned by observed facts."[7]

The gradual erosion of Einstein's confidence in Mach's approach came when he finally realized that there was very little in this approach concerning causality. Like the empiricists before, Mach had limited science to a description of the world where causality was nothing else than an infinite chain of actions and reactions between all the elements.

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[7] Einstein, A. "On the theory of realtivity," in Ideas and Opinions, (N.Y. Crown Publishers, 1954), p. 246.

But such a type of causality cannot explain all the observed events and the excuse that the events are disconnected due to our limited capacities for perception is a rather feeble one. This question is particularly important since the gap observed between the theoretical view of the world in contemporary physics and its visible counterpart may precisely refer to the existence of a new type of causality that cannot be included in the observed phenomena.

If we return to Einstein's 1905 paper on relativity theory[8] it is evident that he has an instrumentalist view of the concepts of space and time. For him time is not a substance but is a judgment bearing on the simultaneity of two events - if the train arrives at seven o'clock, what is really meant is that the pointing of the small hand of a clock to seven and the arrival of the train are simultaneous events.

For Einstein, however, the time of an event by itself has no operational meaning whatsoever, it has only a phenomenal meaning because our consciousness registers the simultaneity of the events but the cause of the simultaneity can only be given by attributing a supplementary explanation to what constitutes in fact the intersection of two particular world lines, say that of the train and that of the clock.

Starting from this problem two kinds of explanation are possible. The first one would be empirical and would describe all the circumstances of this particular observation including the point of departure and speed of the train and making sure that the clock was near

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[8] A. Einstein, Sidelights on Relativity (London, Methuen, 1922), p. 8.

the train and working properly at the time of the arrival. A graphic could then be made showing the numbers of metres travelled per second at the time of the arrival in the direction of the clock. The ultimate explanation of the experiment would be that the distance travelled by the train was proportional to the distance travelled by the long hand on the clock for any sequence of movement determined for the experiment.

The second type of explanation would be theoretical and would attempt to relate the two events by an absolute link rather than by circumstantial evidence, the empirical evidences are implicitly based on the unproved postulate that the world is homogeneously the same everywhere which would render two separate measures (seconds and metres) absolutely related. Einstein proved exactly the contrary, that not only the circumstances of the occurrence of an event were accidental in all cases but that time itself would ultimately vary according to acceleration.

A clock placed aboard the train would register time more slowly than the clock at the train station due to its acceleration. What Einstein really demonstrated was that the perceived world of absolute space and time does not exist and that no empirical coordinates will ever be able to do anything more than a metaphor of the occurrence of two events. The principle invoked by Einstein is that empiricism and phenomenalism are defining their parameters starting from the illusion of the existence of a homogeneous world (but such a world cannot be proven logically). Causality therefore is purely accidental in empiricism and phenomenalism and cannot ascribe in an event. Circumstantial explanations are baby talk since the observations may change arbitrarily with changing conditions of observation. Mach was not able to take a solid stand on the problem of causality, in fact his approach if carried to the extreme would have fallen in a meaningless description. In the absence of a logical reference system his method cannot lead to a definitive explanation of causality.

The fact is that common sense is far from being a satisfactory basis of scientific thinking. The mathematical and physical sciences demand the most uncommon kind of thinking imaginable. No scientific discovery was ever made by the application of common sense. It took the great boldness of Einstein's scientific imagination to perceive that the two postulates on which the special theory of relativity is based are logically contradictory only if we accept Newton's axioms of an absolute space and an absolute time. The two postulates that Einstein enunciated were not made up in order to impress his colleagues with some startling paradoxes. They were distilled by a careful analysis from a large number of well-established physical measurements. But if we accept these two postulates, Newton's absolute space and absolute time have to be abandoned.

To the same end, Einstein also reminded his readers frequently of the fatal error that had been made for so long in thinking that the basis of Euclidean geometry was logically necessary; this error was caused by forgetting the empirical base and hence the limited experiential context within which all concepts are fashioned. A similar illusion was the great obstacle to formulating the Special Relativity Theory, namely, that there exists a universal time applicable to all events in space as a whole, a concept of time long held to be an a priori given, necessary conception, seemingly independent from our sense experiment. This error was caused by forgetting that the notion of time itself arises initially in our everyday experiment by watching sequences of events happening at one locality, rather than in all of space.

More and more Einstein came to undersand that the scientific categories could not be abstracted from sense experiment due to the built-in contingency of the observed events. Not only events were relative to changing contexts and also dependent on all the hazards of perceptual distortion and subjective misinterpretations but their mechanical relation to each other was no explanation at all but simply a description of accidental facts. The last but decisive argument is that empirical causality cannot explain the paradoxes observed in nature: add one speed of light to an object moving at the speed of light and you obtain only the initial speed - this paradox is outside the reach of empricism and phenomenalism. Einstein therefore abandoned (like Mach) the concept of empirical reality as an unwarranted judgment on the world. But instead of justifying knowledge as a descriptive link between visible facts, he rather correctly pointed out that the real world was an abstract systematic substructure upon which the visible phenomena were forming a highly distorted mirror. Therefore a new solution was found to explain the opposition between the visible world and the new scientific theories: these new theories were revealing the real world which is on a plane beyond sense-experience. However, we have indirect evidence of the presence of this abstract world by the occcurrence of certain specific events observable in the material world. In a sense empiricism and phenomenalism were analyzing only the surface of things, ignoring completely the inner dynamisms of reality. Reality for Einstein is not commensurable with the visible world. Thus, the laws of science may be said to be also built into the event-world as the underguiding structure "governing" the pattern of events. Einstein elaborated his epistemology well after his main discoveries had been made. It was only in 1933 that a firm commitment to his new epistemology was made:

> "We are concerned with the eternal antithesis between the two inseparable components of our knowledge, the empirical and the rational, in our department... The structure of the system is the work of reason; the empirical contents and their mutual relations must find their representation in the conclusions of the theory. In the possibility of such a representation lies the sole value and justification of the whole system, and especially the concepts and fundamental principles which underlie it. Apart from that, these latter are free inventions of the human intellect, which cannot be justified either by the nature of that intellect or in any other fashion a priori. 'The fundamental concepts and postulates of physics were not in the logical sense inventions of the human mind but could be deduced from experience by 'abstraction' - that is to say, by logical means. A clear recognition of the erroneousness of this notion really only came with the general theory of relativity.' 'Nature is the realization of the simplest conceivable mathematical ideas. I am convinced that we can discover by means of purely mathematical constructions the concepts and the laws connecting with each other, which furnished the key to the understanding of natural phenomena. Experience may suggest the appropriate mathematical concepts, but they most certainly cannot be deduced from it. Experience remains, of course, the sole criterion of physical utility of a mathematical construction. But the creative principle resides in mathematics. In a certain sense, therefore, I hold it true that pure thought can grasp reality, as the ancients dreamed.'"[9]

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[9]A. Einstein, "On the method of theoretical physics" in Ideas and Opinions, p. 270-276.

Einstein from then on believed that Mach's theory of knowledge "on the account of the relative closeness of the concepts used to experience" did not suffice, and that one must go "beyond this phenomenological point of view" to achieve a theory whose basis is further removed from direct experiment but is much more logical in character.

Since 1909, there were signs of a gradual hardening of Einstein against the epistemological priority of experiment, not to speak of sensory experiment. More and more clearly Einstein put the logical consistency of thematic conceptions higher in importance than the empirical experiments and again and again he proved to be right.

Finally Einstein completely rejected the phenomenalistic epistemology. His rejection can be summed up in the following points:

- Mach did not understand the speculative character of theories, that scientific discovery is incommensurable with observation.
- Mach did not pay any attention to the logical structure of theories, for him theories had no value in themselves.
- Mach was completely wrong when he proposed that sensations were the ultimate reality, that they were the building blocks of the real world --this would have led to the rejection of the idea of physical reality.

3) Reality According to Einstein

Mach's program by itself was an insufficient attempt to explain the differences between the empirical and the theoretical images of the world. What Einstein had done was first to adopt Mach's doctrine (that we know only disparate experiments of reality), and then he turned it upside down - <u>these isolated observations were not caused by the limits</u>

of human perception but by an abstract substructure determining the structure and function of the phenomenal surface.

Einstein was led to the conception of an objective, "real" world behind the phenomena to which our senses are exposed. Of course the same choice was made by Galileo, Newton, Planck, etc. It will be important for our analysis to remember that Planck, (Einstein's earliest patron in scientific circles, and who by 1913 succeeded in persuading his German colleagues to invite Einstein to the Kaiser-Wilhelm-Gesellschaft in Berlin), was indeed at that time the only scientifically prominent opponent of Mach, and had just written his famous attack, Die Einheit des physikalischen Weltbildes (1909). Far from accepting Mach's view that, as he put it, "nothing is real except the perceptions, and all natural science is ultimately an economic adaptation of our ideas to our perceptions", Planck held that a basic aim is "the finding of a fixed world independent of the variation of time and people" or, more generally, "the complete liberation of the physical picture from the individuality of the separate intellects".

By 1931, in the essay "Maxwell's Influence on the Evolution of the Idea of Physical Reality",[10] Einstein could start with the words: "The belief in an external world independent of the perceiving subject is the basis of all natural science". Again and again, in the period beginning with his work on the general relativity theory, Einstein

[10] A. Einstein, Essays in Science, p. 12.

insisted that between experiment and reason, as well as between the world of sensory perception and the objective world, there are logically unbridgeable chasms. The efficacy of reason to grasp reality was characterized later by Einstein by the word "miraculous". Even the very terminology in these statements would have been anathema to Mach.

Indeed, all other evidence points to the conclusion that Einstein's work on general relativity theory was crucial in his epistemological development. As he wrote later (Physics and Reality, 1936): "The first aim of the general theory of relativity was the preliminary version which, while not meeting the requirements for constituting a closed system, could be connected in as simple a manner as possible with 'directly observed facts'." But the aim could not be achieved. In "Notes on the Origin of the General Relativity Theory",[11] Einstein reported: "I soon saw that the inclusion of non-linear transformation, as the principle of equivalence demanded, was inevitably fatal to the simple physical interpretation of the coordinates, - that is, that it could no longer be required that coordinate differences should signify direct results of measurement with ideal scales or clocks. I was much bothered by this piece of knowledge ..." - just as Mach must have been. "The solution of the above mentioned dilemma [from 1912 on] was therefore as follows: a physical significance attaches not to the differentials of the coordinates, but only to the Riemannian metric corresponding to them".[12]

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[11] A. Einstein, Ideas and Opinions, p. 288.

[12] Ibid., p. 289.

In fact Einstein had completely rejected empiricism and he was resisting attempts made by friends and other scientists to make him comply with the empirical method. He repeatedly responded that the facts cannot lead to any deductive theory and at most were the symptoms that could lead to the intuition of a general principle underlying them. In 1952 he wrote:

> "It appears that you do not take the four-dimensionality of reality, but that instead you take the present to be the only reality. What you call 'world' is in physical terminology 'spacelike section' for which the relativity theory - already the special theory - denies objective reality."[13]

In the end, Einstein came back full circle to a view which many (and perhaps he himself) thought he had eliminated from physics in the basic 1905 paper on relativity theory: there exists an external, objective, physical reality which we may hope to grasp - not directly empirically or logically or with fullest certainty, but at least by an intuitive leap, one that is only guided by experiment with the totality of sensible "facts"; events happen in a "real world", of which the spacetime world of sensory experiment, and even the world of multidimensional continua, are useful metaphors, but no more than that.

In an unpublished fragment which apparently was intended as an additional critical reply to one of the essays in the book, Albert Einstein, Philosopher-Scientist (1949),* Einstein returned once more - and quite scathingly - to deal with the opposition to this view.

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[13] G. Holton, Where is Reality? The Answers of Einstein, p. 68.

*Schilpp, Paul, editor, Albert Einstein, Philosopher and Scientist (Evanston, Ill., the Library of Living Philosophies, 1949).

And now, his words indicate explicitly and with clarity that the change that had begun half a century earlier in his epistemology was now complete. Perhaps even without consciously remembering the words of Planck's attack on Mach cited earlier - that a basic aim of science is "the complete liberation of the physical world picture from the individuality of creative intellects" - Einstein refers to a "basic axiom" in his own thinking: "the postulation of a 'real world,' which so-to-speak liberates the 'world' of the thinking and experiencing subject. The extreme positivists think that they can do without it; this seems to me to be an illusion, if they are not willing to renounce thought itself".

Einstein's final epistemological message was that the world of mere experiment must be subjugated and transformed by fundamental thought so general that it may be cosmological in character.

Einstein had become a staunch anti-positivist but he was not the only one to reflect on this methodological transformation, the appearance of theoretical physics in the second half of the nineteenth century eventually led the physicists to make a sharp distinction between the empirical (or phenomenal) world and the real world that cannot be perceived directly but that can be deduced conceptually from the occurrence of certain phenomenal patterns. In his autobiography, Max Planck writes:

> "The real world exists behind the explorable world. The world we see, the world of phenomena, is only a limited approximation of the real world. In fact the "real" reality is not located spatially behind the empirical reality but is embodied in it. The inner core of the empirical world is ANOTHER world made up of absolute logical relations.

> Even if they are interrelated the two worlds are independent and cannot be united by human thinking. The gap between them will always be immense in our minds. This gap is so dissonant that we always try to erase it - usually by denying the existence of an abstract world at the core of matter. However, the empirical knowledge derived from this attitude will never enter the realm of the real reality because the phenomena we see are only superficial appearances. The real reality is so complex and so remote from our usual experiences that we will possibly never really understand it. The new reality is not the basis of science but rather its goal."[14]

To simplify the program we could say that empiricism is a three-dimensional model of the world (a homogeneous space-time stage supporting simple mechanical interaction) while contemporary science is a four-dimensional model where the fourth dimension is an abstract determinism that governs the relations within the first three dimensions.

The transition to modern science is the product of a mental revolution in the conception of the real world. In contemporary science the two elements that defined reality in positivism are disocciated. Reality is two things: it is what is perceived objectively and it is also a rule of logic that is not included in the observed phenomena. These two elements were compounded and taken for granted in the empiricist epistemology under the assumption of objectivity but in modern science they are dissociated methodologically - objectivity in modern science is attained only at the cost of replacing the observable reality by formal logical models.

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[14] M. Planck, Autobiographie scientifique (Paris, Albin Michel, 1960), p. 145-151.

Sensate objectivity is from now on the great obstacle in the pursuit of scientific reality. Concrete cases are no longer synonymous of objective cases - the reality of modern science places the emphasis on conceptual objectivity and rejects empirical objectivity as being vague, impressionistic and superficial.

This rupture in the positivist epistemology was consecrated so to speak by the theory of relativity. This theory rejects the popular perception of the world as being made up of finite space and time.

For Einstein the future of method in physics was highly dependent on the pursuit of theoretical reasoning:

> "Si donc il est vrai que la base axiomatique de la physique théorique ne peut être obtenue par une inférence à partir de l'expérience, mais doit être une libre invention, avons-nous le droit d'espérer que nous trouverons la bonne voie? Bien plus: est-ce que cette bonne voie existe réellement, ailleurs que dans notre imagination? Avons-nous le droit d'espérer que l'expérience va nous guider comme il faut lorsqu'il existe des théories (comme la mécanique classique) qui s'accordent avec l'expérience dans une très large mesure, même si elles ne vont pas jusqu'au fond du sujet? A quoi je réponds avec une parfaite assurance qu'il y a, à mon avis, la bonne voie et, de plus qu'il est en notre pouvoir de la trouver. Notre expérience jusqu'à ce jour nous justifie dans notre certitude que l'idéal de la simplicité mathématique est réalisé dans la nature. Je suis convaincu que la construction purement mathématique nous permet de découvrir les concepts et les lois qui les relient, lesquels nous donnent la clef pour comprendre les phénomenes de la nature. L'expérience peut, bien entendu, nous guider dans notre choix des concepts mathématiques à utiliser; mais il n'est pas possible qu'elle soit la source d'où ils découlent. Si elle demeure, assurément, l'unique critère de l'utilité, pour la physique, d'une construction mathématique, c'est dans les mathématiques que réside le principe vraiment créateur. En un certain sens, donc, je tiens pour vrai que la pensée pure est compétente pour comprendre le réel, ainsi que les Anciens l'avaient rêvé."[15]

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[15] R. Blanché, La méthode experimentale et la philosophie physique (Paris, A. Colin, 1965), p. 271-273.

C) Albert Einstein's Methodology

Einstein never wrote a treatise on method but judging by his publications and letters a very coherent program emerges. His interest in method went far beyond personal curiosity for he believed that epistemological development and scientific breakthroughs were interdependent. Epistemology outside research was empty speculation to him - but science without epistemology was bound to remain a fixed dogma, it was a permanent process rendered necessary by the rapid change of the scientific foundations. Einstein was somewhat sceptical of any philosophy of science that was made outside the scientific research process - he believed that epistemology should be built by the scientists themselves - because they were the ones who knew what the problems were.[16]

Outside his basic scientific exposes, Einstein wrote many articles, lectures, books and countless letters to other scientists with respect to different scientific problems, chief among them being those dealing with epistemology. His epistemological framework consists of the definition of three interdependent but different abstract operations that go far beyond the simple accumulation of data so central to the empirical method.

1) The Starting Point: A Speculative Jump

Einstein placed emphasis on the sequence of steps in doing science, in making a discovery or formulating a theory, rather than

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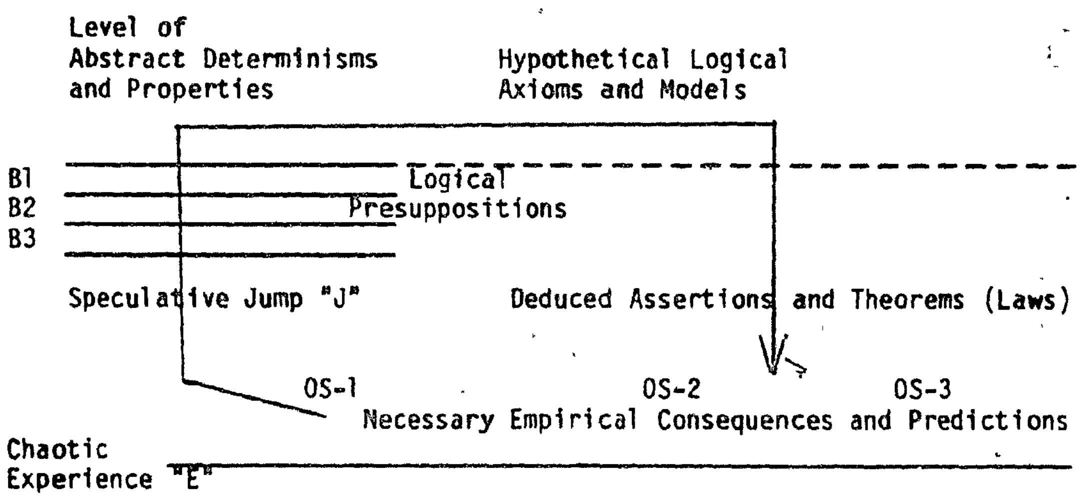
[16] A. Einstein, Ideas and Opinions, p. 290.

reformulating the results later on to make them acceptable to publishers of scientific journals or philosophers interested in the justification of proposed theories.

His approach is a model for thinking and for the integration of extremely complex relationships. Although he never bothered to illustrate it explicitly. Empiricism for Einstein rested on the unproved assumption that the visible phenomena were the ultimate reality. This primitive assertion is the equivalent of the rejection of the possibility of theorising in Einstein's model because the empiricist believed he did not need a method to think but only a method to observe. In fact the empiricist holds thinking in suspicion for he believes that the construction of models hampers him in the observation of the "hard facts". For Einstein the empirical method was an absolute waste of time since the variables are always contingent and non-amenable to essential invariant relationships. Einstein always believed that empiricism was a pointless evaluation of reality.

Einstein's model for thinking can be schematized in a diagram:*



* Reproduced from Einstein's historical letter to Solovine in 1952.

In this model (also labelled the EJASE cycle) thinking starts with experiments that are given to us. However, these experiments are chaotic, accidental, circumstantial and contingent to the ad hoc interaction of countless factors - simply to correlate these events empirically is not at all an explanation but constitutes only a catalogue - to render the chaos intelligible, a unified system of thought must relate all these events as the consequence of an absolute invariant ultimate relationship. This system will become a scientific theory if it can handle all the observed facts starting from a single logical principle.

Science is not the correlation of experiments among themselves as believed by empiricists, it is the correlation of the experiments with a theoretic structure - meaning a set of propositions embodying the totality of their own parameters without additional references to ad hoc factors involved in the problem.

Sense experiment will then provide for a pragmatic validation of the theory - the theory will be retained if it handles fact usefully and it will be abandoned if its deductions do not coincide with events. A theory can never be verified as such due to an essential gap between the world of theory and the world of events, verification is the result of interpretation - more than exact measure. The term "exact science" was another empirical misunderstanding of reality according to Einstein.

Understanding for Einstein is a deductive process - this type of deduction should not be confused, however, with the misconceived notion of an empirical deduction. For Einstein deduction is never empirical (empirical deductions being only generalizations of partial observations), deduction is axiomatic - starting from a set of abstract principles. The discovery of these principles constitutes the real aim of science, an aim not too easily understandable since Einstein postulates that these principles cannot be inferred from the empirical experiment.

In his diagram, the passage from experiments (E) to a set of axiomatic postulates (A) designated an arrow (J) that stands for speculative jump. This notion is central in the Einsteinian method and can be characterized by the following elements:

- This jump is not logical but intuitive and made with the help of pure imagination and pre-scientific thoughts.
- This jump builds a model of a suspected hidden relationship linking the observed events together.
- This relationship is not empirical but abstract, the model is not a sort of trans-observational language but a logical speculation.
- The speculative jump is essentially guesswork that tries to rebuild the real image of the world concealed within the chaos of human experiment.
- The image of the world thus obtained is a synthetical conjecture of postulate and principles from which the observed event can be deduced as a particular case of an all-encompassing principle.

If the model is correct then the observed facts will be understood as being the necessary functions of a structure larger than the immediate observed circumstances. This inclusion of the empirical world in a larger abstract world made up of systematic dynamical relationships is really the crux of the matter - the only difference at this point between the philosopher and the scientist being that the latter provides for an exact measure of his theoretical world while the philosopher can offer arbitrary conceptions only. The ability to measure the abstract reality with the combination of mathematical logic and imagined operational postulates (axioms) permits for the first time in history of mankind the deciphering of reality within reality. Not only does this method permit the handling of many more facts than the empirical method but it can also predict the occurrence of future events as necessary consequences of the abstract structure of the world. This new type of prediction is infinitely superior to the tendency statements and the random probabilities of the empirical method.

To put it more simply the real order of the world cannot be observed, but since it really exists, the argument goes thus: the events of the world are not necessary one to the other (all the facts of the world are contingent),* therefore it is useless to link them together for the sake of creating an image of the world because this image would contain no necessary causality - what should be done is to imagine abstract properties, the relations of which would explain the world we see as an epiphenomenon. But to do this an empirical clue must serve as an occasion for the speculative jump, an empirical phenomenon must serve as an indicator of the present of a hidden factor at work. This factor will be a symptom or even a syndrome of the hidden reality. Einstein still defines this syndrome in Machian language: "certain repeatedly occurring complexes of sense impressions".

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[17] A. Einstein, Ideas and Opinions, p. 291.

*Contingency means immediate proximity but also accidentality. Facts are permutable - they are not essential.

The speculative jump will consist of connecting this syndrome with an imagined axiomatic concept. This concept will at first be completely arbitrary but will gradually be processed through the next step of the process of theorizing. An example of this is Newton attributing the concept of gravity to the symptom of falling apples.

The new concepts have nothing to do with positivism. The concept of gravity defines a logical property from which the fall of objects is only one possible consequence - gravity is a principle not an observational category (it is true that modern theories are far more easily differentiated from the visible world than previous physical theories - but the difference also exists in the previous ones, even if it is less apparent).

The speculative jump is the starting point of the theory. Without it, no logical principles can be inferred from empirical experiment; this speculative process is also an implicit negation of common sense explanations that usually attribute an effect to a contingent immediate cause or to a metaphysical property.

2) The Development of the Hypothesis

To return to Einstein's schema, the next step will be that from A, by a logical path particular assertions (S) are deduced. This step is made up of vigorous analytical thinking. "Logical thinking is necessarily deductive".[18] From the axioms, necessary consequences and

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[18] Ibid., p. 307.

predictions are made. In his special theory of relativity the constancy of the velocity of light was an axiom from which followed necessarily the transformation equations for space and time coordinates describing a rule governing the relativity of simultaneity, the so-called length contraction and time dilation effects. The consequences of the theory were really innumerable ranging from countless new perspectives in the problems of physics to the use of nuclear energy. Starting from the paradox of the non-additionality of the speed of light he derived the empirically inconceivable (but rather commonplace from an axiomatic point of view) proposition of the relativity of time and space according to speed.

The axioms must be reduced to their simplest logical formulations. Each element in the theory must be rendered irreducible and must have an absolute single role in the hypothetical model. Axiomatic theories are absolutely denotational and must not include even the possibility of a connotational statement. This is why modern scientific equations are cast into a mathematical language that leaves no doubt as to the exact meaning of the elements present in the model. The only important criterion of the theory is logical consistency.

After the elaboration of the deductions in the form of theorems comes the process of verification. Contrary to the current views over falsificationalism held by Karl Popper, Einstein believed that the process of verification is not of a logical nature, theories do not coincide so easily with facts. In his model, the global relationships of (A) to (E) or between the axioms and experiment is difficult to understand and even if the relations between (S) and (E) or between theorems and the occurrence of specific events is easy to realize by the presence or the absence of the predicted factor, it does not mean that the theory is necessarily proven because the whole structure of conjectures, postulations and deductions may be wrong while still leading to positively testable theorems. The phlogiston theory is the best example of this type of error in the history of modern science.

The process of verification of the theory is not absolute. According to Einstein we should better talk of a reference to the facts rather than a verification on the facts for two reasons, first because the verification involves a conceptual interpretation of the facts and second because the experimental facts are usually far from evident: misinterpretation of the data - especially if it consists of minute details - is frequent.

Instead of the dogma of verification, Einstein proposes two criteria for the criticism of a scientific theory.

3) External Validation

The first test is what Einstein called the criterion of "external validation"' and it is "concerned with the validation [Bewährung] of the theoretical foundations by means of the material of experiment [Erfahrungsmaterial] lying at hand".[19] The criterion is simply this: "The theory must not contradict empirical fact".[20]

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[19] P. Schlipp, ed., Albert Einstein: Philosopher Scientist (Evanston, Ill., The Library of Living Philosophers, 1949), p. 22.

[20] Ibid., p. 21.

Note that this is a principle of disconfirmation or of falsification, and hence much more sophisticated than any injunction to seek "confirmation" by empirical test. It is more generous, because in the absence of disconfirmation one can hold on to the theory - "Once a theoretical idea has been acquired, one does well to hold fast to it until it leads to an untenable conclusion"[21] and it is also a sharper demarcation criterion because the presence of believable disconfirmations soon discredits a theory, whereas a continued absence of verification merely delays the final decision.

4) Inner Perfection

Einstein's second criterion was frankly stated in his Autobiographical Notes: "The second point of view is not concerned with the relation to the material of observation but with the premises of the theory itself, with what may briefly but vaguely be characterized as the 'naturalness' or 'logical simplicity' of the premises of the basic concepts and of the relations between these which are taken as a basis".*

Einstein considers as very destructive the inclusion of any empirical assumption to increase the relevance of the theory. Artificial additional assumptions must be avoided since they constitute a false articulation of the theory with the facts. A simple theory is hard to build due to the chaos of possibilities from which exact axioms must be chosen.

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[21]P. Schlipp, Albert Einstein: Philosopher Scientist, p. 23.

*"Autobiographical Notes" in Albert Einstein, Philosopher and Scientist, pp. 3-98.

The theory does not stop with an attempted verification but in fact is a kind of cycle that must be repeated each time the correspondence between the concepts and the empirical predictions is not perfect - each cycle clarifying a little more the empirical symptoms and readjusting the logical properties of the axioms. The theory can also be developed exclusively by methods of logical deduction with little attempt at verification but ultimately sense data must play a role of control. When the theory is finished it is presented like a textbook pedagogic scheme which is characterized by a rearrangement to bring out an axiomatic structure and to hide all traces of the speculative phase that motivated and characterized the theory in its early stage. This presentation format leads to the false belief that the axiom system was induced; and from the latter predictions are deduced which experimental demonstration is provided: this format of writing scientific papers is a distortion.[22]

In this brief review of Einstein's conception of method, it becomes evident that once the principle of the presence of a logical world within the empirical world as its essential causation is accepted the real task of science consists of unveiling this inner world with the aid of imagination and logic.

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[22] The commonly agreed-upon structure of writing scientific papers for publication which makes it seem that the gathering of data and induction from them formed the beginning of scientific work, has prompted P.B. Medawar to call the scientific paper a "fraud" and a "travesty of nature of scientific thought" in P.B. Medawar, "Is the Scientific Paper a fraud?" The Listener (1963), p. 377-378.

But the speculative jump from the observed data to a body of logical principles cannot be accomplished in a void or by magic because even if these principles cannot be abstracted from experiment, they must at least correspond to some meaning.

This element will be provided by a framework of preconceptions and presuppositions. These schemes of thought are useful to the extent they contribute in making the totality of the content of thinking "intelligible". These assumptions are unverifiable and unfalsifiable but they are not necessarily arbitrary. These themata in science must bear on logical possibilities - they must not be an empirical image of the world - in which case the "paradigm" becomes a metaphysical roadblock in the building of scientific hypotheses. The goal of these tacit presuppositions - as all the rest of the method - is to single out a logical order beyond - but governing - the phenomenal plane.

According to Planck, the problem of method could be summarized as follows:

- "There is a real outer world which exists independently of our act of knowing.
- The real outer world is not directly knowable."[23]

The first of these statements cannot be proved or disproved either by <u>a priori</u> arguments or by experiment; the stand of the solipsist is unassailable. For pragmatic reasons, however, the independent existence of an outer world must be granted. Planck's second canon therefore

[23]Max Planck, Where is science going? (N.Y., W.W. Norton & Co., 1932), p. 82.

implies that the real world which is the cause of our sensations, is not revealed to us by these sensations alone.

In our ordinary life our attention is absorbed by our sensations and perceptions, and the real impersonal world (the reality behind the appearances) is disregarded. But the physicist cannot restrict himself to such subjective statements as "snow is white" or "sugar is sweet"; he is compelled by the nature of his studies to peer beyond and explore the real world. Only thus can he discover the hidden relations that clarify the workings of phenomena. It is the disclosure of these relations that constitutes the aim of physical science. Since direct knowledge is insufficient to reveal the real world, the physicist proceeds in a roundabout way, by coordinating direct knowledge (e.g., the readings of his instruments), experiment, elementary inference, and rationalization. The picture he thus obtains represents the real world of physics.

The discovery of atmospheric pressure illustrates these points. The physicist has been led to believe that the atmosphere exerts a pressure of some 14 lbs. to the square inch. What evidence does he advance for this belief? He certainly does not claim that we are directly aware of this pressure on our bodies. Hence, should science be restricted to a cataloguing of immediate sense impressions, the very notion of atmospheric pressure would have no place in physics. The evidence in favour of atmospheric pressure is entirely indirect. Thus we note that a column of mercury stands at a certain height in a Torricelli tube. Or again, we exhaust the air between two hollow hemispheres and find that we are unable to tear them apart. In the second experiment direct knowledge comes into play through the effort we exert to separate the hemispheres, but only by argumentation and reasoning can we ascribe this effort to the existence of atmospheric pressure. Practically the whole of physical science is thus one mass of inference based ultimately, but not immediately, on direct knowledge.

D) The Basis of Modern Physics: Logical Relations

1. The Logic of Object

Contrary to empirical theories, the goal of science is not to describe the world but to find the dynamisms at work within it. Scientific thinking becomes an operational synthesis made up of logical elements. In this new approach the knowledge coming from normal perception plays a secondary role since the goal of a pure science is to shed any anthropomorphic phenomenalism. An advanced science replaces observation by logical transformation. It is not only a logical translation of what has been seen, it is more than that: it is a complete replacement of the sensate-based world by a logical-based world. Knowledge is no more descriptive but is a construct. Does this mean that objectivity disappears? No, it becomes a world of logical objects which means:

- the world is an abstract structure made up of interdependent relationships - nothing exists outside these relations;
- an "object" is an "inertial system", meaning that the sum total of the logical relations is integrated invariantly at some point of the structure;

Modern science has passed from a stage of describing the reality in terms of substance and properties to describing it in terms of abstract relations. Empirical objects have been superseded by "the mathematical formalism of modern physics which seeks to explain the world not in terms of substance, essence, properties and accidents, in others words, in terms of predicative judgments but in terms of functions and structures, that is, in terms of relational judgments".[24]

From this point of view, most of the current forms of knowledge appear as rudimentary "reisms" incapable of clearing away the relations and conditions on the basis of which "things" possess certain properties and not others. Modern science no longer postulates the existence of isolated objects defined by inherent qualities independent of their relations to other objects.

> "Even in simpler cases in which the object of science is readily perceived and appears as a solid and isolated substance, seemingly not having in itself and only in itself the origin of all its properties like Democritus atom, science points out the conditioned and relative character of these properties. The properties are not regarded as qualities which the object simply possesses directly and invariably but in relation to certain conditions on the basis of certain relationships.
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> When the contemporary chemist, for example, affirms, in describing sulphur, that it is a yellow solid body melting at 66°C and boiling at 145°C he does not define a substance and its properties in the classical traditional manner. On the contrary, the substance or matter called sulphur is defined by a number of relationships (laws) which express the conditions of its realization".[25]

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[24] L. Rougier, Traite de la connaissance (Paris, P.U.F., 1955), p. 100.

[25] H. Konezewksa, Le probleme de la substance (Paris, J. Vrin, 1937), p. 120.

Determining the object of investigation, the reality by means of certain relations is very important in the theories of contemporary physics. Modern physics, shows D. Broglie, tries to discover in the uninterrupted flow of phenomena, those elements easy to be detached from their context by a theoretical abstraction offering at the same time the possibility of being characterized by precise numerical values. These elements are the "observable, physical magnitudes" and the aim of physics is to establish the relations existing between the values of these magnitudes and their variation, then to interpret these relations and to show their meaning coordinating them inside the vast constructions of the human mind, i.e., theories.[26]

In modern science the properties of objects are not inherent qualities but the manifestation of a structural solidarity. An object - modernly defined - "is but the point of intersection of all its possible relations with the outside world".[27] Each thing is only the totality of its connections with all other things. In fact there is nothing really concrete or abstract but rather a fusion of the two - matter and abstract matter - we cannot say anymore than an object exists by itself - an object is only a function in a theory. An object is no more an isolated entity, but an element of a complex structure.[28]

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[26] L. De Broglie, <u>Physique et microphysique</u> (Paris, Albin Michel, 1947), p. 88.

[27] J. Ullmo, <u>op. cit.</u>, p. 633.

[28] A.W. Heisenberg, <u>Physique et Philosophie</u> (Paris, Edition Albin Michel, 1961), p. 47 and following.

2) The Logical Sub-Structure of Reality

The function of knowledge represented in the past by the idea of a substance continues to be present in modern science. It implies the idea of depth behind phenomenal appearances. But in this respect too, important changes have occurred affecting the idea of relation. The latter is associated to the object on both the abstract and empirical lines of knowledge. The notion of structure expresses exactly that situation.

A structure is in fact a mathematical pattern to which the scientific object is associated - by means of which that object is thought of. The introduction of the relationships WITHIN the objects was parallel with the passing from the empirical knowledge to a synthetic and operational one. Everything in the past that was attributed to substance is now attribute to structure. Modern science for example explains the properties of the atom through connections and interactions of certain entities of a purely functional nature - atoms are nothing outside that. In the substructuralist explanation of modern science, the components are significant only as members of relations (they are secondary functions of the relations). The individuality of these components and their role as individualities are strongly blurred.

Within this framework we can conceive the phenomenal appearances or structures (a complex unity of intertwined functional relations) emerging from an abstract sub-structure determining the parameters included in the structure.

The objects we see are no more components (even if they look like that) but they are a distribution in space or time of abstract properties. Unlike the notion of empirical substance which admits only the level of noticeable qualities of the phenomenal reality, the notion of structure admits a hierarchic organization of reality in which the complex unity of the object refers to an underlying process of a logical nature.

The world then becomes an organization of interacting structures and consequences of their interaction is provided by the functions they play in the sub-structure. What appears to be contingent interaction at the phenomenal level becomes determined <u>once we have discovered the abstract parameters involved in the situation</u>.

The reference system of modern science is not the elusive phenomenal observations but mathematical formalism. In empiricism, the inner content of an object is never determined - in axiomatic realism phenomenal reality becomes itself the particular case of an abstract reality that explains the behaviour and the composition of objects as interrelated functions. Intelligibility in axiomatic theorizing is enormously increased compared to the previous empirical one.[29]

This shows that contemporary science studies pure relations, that its content is reduced to a logico-mathematic formalism.

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[29] R. Rougier, <u>op. cit.</u>, p. 244.

3) The Field as a Formal Structure

"To the physicist" says Einstein, "the field as a reality standing by itself was inexistent; to him only the substances and their changes were real". He [the physicist] was trying hard to describe the action of two electric charges by means of notions directly related to the two charges. In the beginning the concept of field was only a way of viewing things. In the theory of the field, on the contrary, the major role is played by the field as such and not by charges. The idea of substance, that is, the electric charge, the corpusculum "matter", are secondary, the attention of the scientist being directed towards structure, that is, the system of relations (laws) that govern the transformations taking place inside the field and being expressed by means of a system of equations. "Emancipation of the notion of field from the assumed existence of a material support", says Einstein, "belongs with the most interesting events, from a psychologic standpoint of the physical thinking evolution".[30]

Concerning the objective reality of the "field", Einstein took a firm stand:

> "To the modern physicist, the electromagnetic field is something as real as the chair that he sits on".[31]

In abstract realism, the form is a relation. In fact the problem of the reality of the physical world has passed from the objective

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[30] A. Einstein, La Relativite (Paris, Payot, 1956), p. 167.

[31] A. Einstein, L'evolution des idees en physique (Paris, Payot, 1969), p. 119.

evidence of the senses to the logical evidence provided by a logical reference system.

Pondering over the emergence of the theory of relativity as a purely relationalist conceptual framework, Bachelard wrote:

> "Violating ways, perhaps even laws of thinking, scientists tried hard to grasp relation independent of the connecting terms, to postulate connections rather than objects, to give the members of the equation a significance only on the basis of that equation thus taking the objects as some strange functions of the function that brings them into relation. Everything for synthesis, everything by synthesis, that was the purpose and the method. The elements which sensation presented in a state of analysis that we could justly qualify in many respects as natural, were brought into relation and from then on they had a meaning only through that relation".[32]

In empirical research, the things are independent of the scientific laws while in contemporary science they are a by-product of the determinism revealed by the scientific law.

Finally, the dispute between empiricists and relationalists can be reduced to the dispute between those who favour knowledge through images, representations and intuitive models and the advocators of knowledge through abstract thinking, mathematical calculus, which in turn is reduced to the dispute between the adversaries and advocators of common-sense realism. If we take into account this dispute we may agree to Bachelard's assertion that nothing exists clearly except for relations.[33]

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[32] G. Bachelard, <u>La valeur de la relativite</u>, p. 88-89.

[33] G. Bachelard, <u>Le rationalisme applique</u> (Paris, P.U.F., 1962), p. 34.

. In the academic world these two knowledges are dissociated institutionally. The best example of this is the opposition found between engineering (which is an empirical knowledge) and theoretical physics (which is a formal-logical knowledge) - in the words of Michael Polanyi:

> "Engineering and physics are two different sciences. Engineering includes the operational principles of machines and some knowledge of physics bearing on those principles. Physics and chemistry, on the other hand, include no knowledge of the operational principles of machines. Hence a complete physical and chemical topography of an object would not tell us whether it is a machine, and if so, how it works, and for what purpose. --- But without physics, we can never account for the failure and ultimate breakdown of the machine and here physics and chemistry effectively come in."[34]

Only the physical-chemical structure of a machine can explain its failures. A machine is based on the "empirical" assumption that the laws embodied in the materials used for making the machine correspond to the principles of the machine - this is not so and the evolution of the machine will be a constant opposition between the machine and the physical laws.

The popular conception of science teaches that science is a collection of observable facts, which anybody can verify for himself. This is not true in the case of expert knowledge. Sense-reading is incommensurable to sense-giving. The empiricist is like a child reading a book of philosophy: he would not understand a thing by simply understanding the words - meaning always lies in an independent logical construct, never in the given facts. Knowing something scientifically is not equivalent to knowing something phenomenalistically - the first form

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[34] M. Polanyi, The tacit dimesion (N.Y., Garden City, Doubleday & Co., 1966), p. 39.

of knowledge deciphers an ultimate pattern behind the given data while the last form satisfies itself with a limited approach to reality and a marginal capacity to exercise control of it.

E) **The Basis of Modern Method: Axiomatics**

1) **Axiomatics**

If empirical science is nothing more than a description and classification of data with little or no generalizations being possible, the axiomatic science will be made exclusively of analogical models of the abstract sub-structure of reality. The method at this stage of science consists of the combination of imaginary operational concepts (axioms) with formal logic in the formulation of a hypothesis from which the deduced theorems must coincide with empirical measures of the relationships we try to explain.

From a chronological and logical point of view, this stage of science cannot appear before the empirical stage - it usually appears - almost strategically - when scientists realize that no further empirical research will ever establish an invariant scientific law. After a last reaction in favour of a return to the basic empirical method, the scientists finally adopted the axiomatic method as the only possible method of scientific theorizing.

The axiomatic postulates designate what is proposed to exist behind the phenomenal appearance. These axioms will - in a first attempt - be derived from a synthesis of available syndromes in the discipline.

The first axiomatic theory does not have to be empirically plausible, it must instead be logically plausible. In the first stage of science, formal logic had no role to play whatsoever but in this new stage it becomes a central feature of the method. The concepts themselves are logical constructs rather than empirical evaluations:

> "A concept by postulation is one the meaning of which in whole or part is designated by the postulates of some specific deductively formulated theory in which it occurs."[35]

All the modern theories (electromagnetism, quantum physics and relativity) are deductively formulated starting from an axiomatic conceptual scheme. These concepts are exclusively dependent upon the theory and have nothing to do with the previous historical and social determination of the empiricial concepts. The empirical concepts are relative to each culture, the axiomatic concepts are invariant across cultures.

2) The Emergence of Axiomatic Theorizing

The theory of abstract-deductive scientific theorizing appeared at the end of the 19th century as a result of the complex problems found in contemporary physics. Some scientists began to understand that theorizing was an activity that could not be reduced to empirical combination of observables. They began to make an effort to dissociate the theoretical and the observational language; this debate is still going on

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[35]F.S.C. Northrop, The logic of the sciences and the humanities (N.Y., McMillan & Co., 1947), p. 62.

today[36] but more and more scientists are rejecting empiricism as the unique way possible in science.[37]

The first element of this new conception appeared as a rejection of the empirical conception of science defended by Ernst Mach. For Mach, the world was simply a combination of elementary observable elements to which the observer had to adapt himself to their unending changing appearances. All theoretical constructs were there only to guide our perceptions of these facts. The goal of science was to represent the empirical reality in its complex combination of the basic elements.[38]

L. Boltzmann in 1897 was the first philosopher of science to reject the idea that modern science was the description of the empirical reality. He proposed instead, that science was based on analogical models.[39] For him, models do not express facts but logical properties. He believed that logic was analogous to the hidden mechanisms in the natural phenomena. In his mind, the construction of a model was more important than empirical investigation even if it was still necessary for verification of the postulates.

But it is the physicist H. Hertz that systematically described the process of axiomatic-model building in science. He developed his

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[36] W.R. Shea, "Beyond Logical Empiricism," Dialogue X (1971), p. 241.

[37] W.V. Quine, "Two Dogmas of Empiricism," The Philosophical Review (1951), p. 312.

[38] E. Mach, The Analysis of Sensations (N.Y., Dover Publc., 1959), p. 312.

[39] Dictionary of Scientific Biography: Boltzmann by S.G. Bush (N.Y., C. Scribners & Sons, 1970), p. 26.

method in the 1880s at Kiel University while studying the Maxwell theories. He soon realized that mathematical models were better guides to physical experiments than empirical evaluations, however objective they were. He came to consider that experiments that did not correspond to previously established hypotheses were meaningless. Hertz determined the existence of four continuous types of models able to explain a singular property: 1) empirical, 2) rational-empirical, 3) logical, 4) abstract which postulates that the observed reality is a particular case of the axiomatic reality. Hertz did not want to comment on the fact that modern science was turning reality upside-down so to speak: the epistemological foundation of reality being abstract he simply affirmed that these four models of theorizing could explain all the existing scientific theories in physics and more precisely the variances observed in their mathematical formulation.[40]

More recently, some philosophers of science have developed similar ideas about theorizing. Michael Polanyi[41] proposes that scientific reality is larger and more complex than the empirical appearances. He ascribes two poles to human knowledge: explicit and tacit. The first one is empirical, the second one is a synthesis of unobserved dynamisms explaining the variations in our observations. For Polanyi, we are indirectly aware of a complex reality that is larger than the observed phenomena. The two knowledges are complementary but if we

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[40]R. McCormmach, "Hertz" in Dictionary of Scientific Biography (N.Y., C. Scribners & Sons, 1970), p. 340-350.

[41]M. Polanyi, Personal Knowledge (London, Routledge & Kegan Paul, 1958).

concentrate on focal explicit knowledge, the synthesis of the whole reality becomes impossible. Our indirect perception of reality more fundamental than the empirical phenomena cannot be translated into explicit language, it is an intuition that guides the theoretical researcher towards an axiomatic conception of the fundamental reality he wants to explain.[42]

Therefore the theoretical mind is based on a gestaltist dynamism where elements are abstract coordinates of hypothetical relationships. The emerging pattern is a joint meaning of indirect clues pertaining to a hidden reality. This pattern is translated into a logical construct. Polanyi rejects empiricism as a superficial phenomenal flux that masks a more profound reality that can be conceived only by intuition and by logic.

Gaston Bachelard, a noted French philosopher of science has popularized the concept of rational empiricism as opposed to common-sense empiricism.[43] He proposes that empiricism is a distortion of the rational reality. For him, empirical knowledge opposes a tremendous resistance to scientific theorizing simply because it is based on the prejudices of common-sense conformism. Scientific discoveries are always discoveries of the exceptional - a discovery always destroys the certitudes of common sense and usually destroys also the conventional cultural viewpoint on a given problem. Science is a complete translation

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[42] M. Polanyi, <u>The Tacit Dimension</u> (Garden City, N.Y., Doubleday & Co., 1966), p. 40.

[43] G. Bachelard, <u>Le nouvel esprit scientifique</u> (Paris, P.U.F., 1934).

of empiricism into logical constructs capable of supporting deductive statements. Scientific empiricism is a rational reconstruction. The axiomatic method is thus an established fact in modern science and the implementation of this method in the construction of political science theory is simply a question of doing it.

3) Axiomatic Models

Empirical models are unverifiable according to Einstein because they are based on concepts that include too many possibilities simultaneously thus rendering the models meaningless. Any verification of an empirical model should lead to its refutation:

> "It is ... no useless game if we are practicing to analyze current notions and to point out on what conditions their justification and usefulness depends, how they have grown especially from the data of experience. In this way their exaggerated authority is broken. They are removed, if they cannot properly legitimate themselves; corrected, if their correspondence to the given things was too negligently established; replaced by others, if a new system can be developed that we prefer for good reasons."[44]

The verification of axiomatic models brings a new type of difficulty. The axiomatic model is in essence an analogy of a hidden dynamism, the consequences of which should correspond with observed empirical relations. Since we measure only the influences of these theories and never their postulates (which cannot be observed by

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[44]A. Schlipp, (Ed.), Einstein, Philosopher and Scientist (N.Y., The Library of Living Philosophers, Inc., Tudor Publications, 1949), p. 76.

definition), how are we going to be sure that our axiomatic construct does not coincide accidentally with the facts? The problem is magnified when more than one axiomatic model can fit the observed relations.

Heinrich Hertz found a solution to this problem while attempting to define an axiomatic model for Maxwell's theories.[45] Hertz was faced with a possibility of four different models for the same problem. Since further experimentation would never make any difference between the models, he came to the conclusion that the problem was a theoretical one, not an empirical one.

These basic axioms were irrefutable from a logical point of view - but their physical consequences could be interpeted differently. So Hertz made a first distinction: there are really two levels in the model: the level of the fundamental postulates - and the level of the deduced physical consequences. The model plays a role of intermediary between the postulates (axiomatic model) and the observed phenomena. It must unite the two very rigidly if the theory is to have some meaning. This rigidity will permit the correction of the basic axioms if the verification on the facts is negative - but to play this role, the theorems deduced from the axioms must themselves obey the three criteria according to Hertz.

First the model must be valid which means that the consequences must have been deduced logically and must not contradict the operational logic of any known axiomatic theory existing in relation to the observed problem.

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[45] L. Raphael, Wittgenstein et Hertz, Unpublished doctoral dissertation (Department of Philosophy, McGill University, 1977), p. 95-109.

Second, the theorems must be exact: the effects obtained by necessary logical deduction from the postulates must be simultaneously the symbolical representation of the same (and exact) effects in the observed phenomena. The deduction must coincide - almost absolutely - with a measured relation.

And, thirdly, the model must be appropriate. In Hertz's experiment, all the four possible models bearing on Maxwell's equations were Valid and Exact and a new evaluation of the model had to be brought in. Hertz discovered that the four models were different as to the number of relationships they were able to explain. In some models there were many empty relations and many good ones, in some others there were less empty relations and more meaningful ones. Hertz concluded that the correct theory was logically the one that coincided with the best model: the model that contains the least amount of empty relationships and the greatest number of exact relations was necessarily the correct one.

In her thesis, Leyla Raphael summarizes very well Hertz's conclusion:

> "Ainsi Hertz definit clairement les propriétés auxquelles on reconnaîtra un modele intelligible des choses du monde pour qu'il soit scientifique. Le modèle doit être logiquement valide et ne presenter aucune confusion ou obscurité des conceptions, autrement dit, il doit obéir aux lois de clarté et de cohérence de la pensée. La justesse de sa représentation doit en deuxième lieu être correctement vérifiée dans l'expérience, même s'il présente des éléments qui débordent le donne empirique, et en quoi il prend un caractere d'hypothèse. En troisième lieu enfin la représentation qu'il offre des choses du monde doit leur convenir de facon appropriée, comprenant toutes les relations qu'exhibe l'expérience, et limitant le plus possible les relations auxquelles rien ne correspond dans cette expérience."[46]

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[46] Ibid., p.119.

Conclusion

Axiomatic theorizing is at the origin of the modern scientific revolution. This epistemological breakthrough was due to the recognition that empirical causes are accidental by nature and that no necessary logic of the universe can emerge simply by the observation of the facts. Another troubling factor was the regular occurrence of empirical paradoxes in experiments - the non-additionality of the speed of light in the Michelson-Morley experiment being one of the most fundamental paradoxes supporting contemporary theoretical physics. These paradoxes being unexplainable (or more accurately said: being impossible) from an empirical point of view an intermediary stage of method (positivism phenomenalism) conceived the scientific theories as a trans-observational language, a sort of formal conceptual framework uniting disparate and even contradictory observations.

This definition of method could not, however, explain the growing gap between the theories and the observed data. The model of the world derived from the theoretical effort was increasingly in contradiction with the empirical view of this same world. Finally, the solution was provided by Albert Einstein and Max Planck: that the basis of reality was a network of abstract logical structures within which the empirical observable world was only a section and a particular case. Therefore the paradoxical events that were observed in experimental science could be explained as being the indicators of the existence of an abstract basic component of our material world. Einstein therefore - and other axiomatic philosophers after him - have turned reality updside-down: reality is not a self-evident huge fact that can be understood with ideas, matter itself is the particular case of a purely abstract reality. Human logic becomes the basis of the new scientific method that aims at building analogical models of the hidden reality and at verifying the value of these models by the identity of the logical consequences of the models with the measurable effects of the alleged concealed mechanism in empirical facts. The new science is not a copy of the empirical world, it is a mirror of the reality behind the facts - a reality that can be guessed only by the observation of empirical anomalies.

CHAPTER III

THE AXIOMATIC METHOD AS A DISTINCT SCIENTIFIC APPROACH: BASIC CONCEPTS

INTRODUCTION

By axiomatic we refer to that special form of deductive theorizing which dates from the last part of the last century. It is not enough to reckon with the concept that an axiomatic system is one composed of propositions deducible from a small number of initial propositions posited as axioms. There are several manners by which we can define axioms and the modern manner of defining it is the one that will be retained. However, this modern manner does not make sense unless we first briefly summarize the development of axiomatization in science.[1] During this evolution the functions of axiomatization became more and more complex ranging from early logic to theoretical epistemology of modern science and our aim is to determine what impact this conception can have on the reordering of scientific explanation, especially in Political Science.

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[1]Source: Robert Blanché: "Axiomatization" in Dictionary of the History of Ideas (New York, Charles Scribner's Sons, 1973), Vol. I, p. 162-172. Also his book L'axiomatique (Paris, P.U.F., 1955), p. 1-158.

A) Development of Axiomatic Method

1) Geometry

The earliest examples of axiomatics is the method with which Euclid expounded geometry 300 B.C. He rearranged the geometrics of his time according to logical rules. His system is made up of a combination of basic notions, postulates and definitions that suffice in demonstrating all the propositions of geometry. His invariable notions were in fact axioms. For example, his concept that "things equal to the same thing are equal to each other" is an axiom because: (a) it is a propositional function within a given system of logic and (b) it is a statement on an invariant necessary relation between things. With these new types of statements Euclid was able to transform geometry from an empirical to a theoretical science, from a knowledge based on observable factors to a knowledge based on a system of logic. The whole geometry was organized by him in a network in which all the propositions were linked to each other by logical relations, so that each proposition was made self-evident. Euclid's method was also applied by himself to his Optics. In a similar manner Archimedes demonstrated his propositions on equilibrium by starting with a few postulates from which theorems could be deduced.

Towards the end of Greek antiquity, mathematics, logic, and certain parts of physics had already entered in various degrees the realm of axiomatization. But the method was still at a beginning, it consisted of a logical exposition of scientific principles that did not add much to empirical observation. It would take almost 2000 years before the next stage of this method would appear.

2) Seventeenth-Century Physics

The emergence of modern science 300 years ago was accompanied by a new development in axiomatization. Galileo played a major role in this new approach. He was inspired by the method of Archimedes and tried to do for dynamics what Archimedes had done for statics. His conceptions were based on hypothetical principles from which thoerems corresponding with facts were deduced. His science was not based on direct observation. The fixity of the sun's position, for example, was not observed but postulated. With Galileo axiomatics ceased to be only a heuristic device to become a method for the discovery of non-directly observable properties of reality.

Before Galileo, axioms had always served as self-evident formal principles for the systematic presentation of science as a hierarchy of subordinated propositions. But starting with Galileo a new conception of axiomatics slowly emerged. It relied on a progressive dissociation of the two related components of the idea of axiom: self-evidence and primary proposition. In seventeenth-century physics the basic propositions were no longer regarded as principles of demonstration but as logical hypotheses that had to be proved by the empirical verification of their consequences. Hypothetical axiomatics consisted precisely in postulating the existence of a non-directly observable cause (or principle) from which the deduced theorems would correspond and explain empirical events. The new method consisted of a reversal of the hypothetico-deductive method: instead of extending from the premises to the consequences, the truth of the theory rebounded from the visible consequences to support the non-observable premises. Basic principles cannot be observed directly in this approach, their existence is inferred from the observation of effects that serve as symptoms of their concealed existence. Reality becomes larger than empirical reality and science ceases to be a description of observable phenomena to become a series of hypotheses bearing on the components of the non-directly observable reality.

An example of this new application of axiomatic can be found in Newton's theory of gravitation. The theory was based on an unobservable property (attraction at a distance) which was neither a self-evident principle nor a directly observable factor. The principle was considered as "proven" by the fact that its consequences corresponded with observation. The principle of the theory was made up of an undefined axiom and its consequences were empirical.

Thus classical science was slowly institutionalizing a separation between the abstract side of method which dealt increasingly with formal principles concealed among facts and the empirical side of method which dealt more and more with the verification of effects resulting from the abstract components of reality. The result was mechanics, an abstract-empirical science combining geometrical postulates and physical occurrences. Mechanical laws were rational statements confirmed by experiment. Axiomatics had thus passed from an early period where self-evident principles served to explain consequences to a period where a hypothetical deduction would prove a posteriori the truth of its hypothetical principle by the truth of its consequences.

The exact nature of axioms in modern theories has never been asserted. They represent abstract properties. These properties are neither purely formal nor purely material. A provisional explanation would have them represent complex associative properties of the universe that present the character of stable patterns. The exact nature of attraction or relativity or wave mechanics is still undefined but science postulates that those causes exist and explain a great amount of physical occurrences. Even if these causes cannot be seen directly, their existence is based on logical postulations that attend to observations. Axioms are not arbitrary fictions but hypotheses that refer to abstract properties. These hypotheses are believed to be true if there is an agreement between many of their consequences and observed data.

3) Modern Mathematics and Physics

Axiomatic theorizing reached a third stage in the second half of the nineteenth century where mathematical models came to represent the abstract underlying structure of reality. In field physics, quantum physics and relativity theory causes of events (represented by axiomatic principles) become purely mathematical in character. The mathematics involved in theory-building expressed more than links between facts, they served a hypothetical reference-system for the conceptualization of causes that had no immediate sensate meaning. This latest development was the result of transformations that had occurred both in mathematics and in physics.

The transformation of mathematics from a calculus type of knowledge to a hypothetico-deductive method started mainly with the emergence of non-Euclidean geometrics. Reflecting upon traditional geometry it became clear to some mathematicians (namely Bolyai, Lobatchevsky and Riemann) that more consistent geometrical systems could be reached by the negation of some postulates that made sense from an empirical point of view (the parallelism of two lines for example) but that failed to be adequately explained in axiomatic terms. The success of non-Euclidean geometrics therefore brought with it the idea that truth depended more on the formal consistency of the whole system than on the substantive meaning of its own axioms. Demonstration ceased to be a question of empirical evidence to become a question of formal logic. The new function of mathematics was to provide science with abstract postulates that would serve as premises of a deductive system.

This new approach widened the chasm between the abstract and the empirical side of reality. In modern mathematics (in non-Euclidean geometrics in particular) the new concepts did not correspond too well with a material picture of reality derived from perception. Therefore the new theories came to be supported by a logical apparatus that superseded by its logical coherence the empirical description of reality.

When theoretical physics met with facts of a new order at the end of the nineteenth century, facts that were not possible (such as the non-additionality of the velocity of light) or facts that had no empirical causes (such as the Brownian motion of pollen on a drop of liquid) the idea that those strange facts could be the consequences of the new formal picture of reality proposed by modern mathematics gradually appeared. Therefore, in modern physics the axiomatic method came to serve as an invariant reference system from which models of empirical occurrences were deduced. The axiomatic structure of an empirical system came to consist of properties cast in purely formal terms. This new approach could explain the existence of odd facts as a result of abstract properties of matter.

B) The Method as a Logical Tool

1) Definition

Therefore, theoretical developments in modern physics have left us with a new method: the axiomatic method is a process by which a discovery of scientific laws is obtained by deducing them from propositions admitted without demonstration. These propositions are of a special character. They are propositional functions making sense by their complementary interrelations in a logical closed pattern. The theory is a network of associative functions. Rules of deduction are established by convention and theorems are deduced. These theorems correspond to patterns existing in observed reality. The method refers to a hypothetical system of logical causes that are not directly observable but that mesh with observable events in their conclusions. The method postulates that specialized understanding cannot be reached until complex systems of logical relations are mastered by the scientist.(2) The method also postulates that complex patterns of relations cannot be disclosed by inductive analysis alone. The logical properties of reality are to be understood only by the building of models that include elements of formal logic.

2) Rationale

The axiomatic method seeks formal causes to observed effects. The rationale for doing so comes from a conception of the role of logic in knowledge. Briefly stated the problem is that there cannot be an infinite regression in causes: somehow a fixed point must be reached. This problem does not exist so much in inductive analysis where an

[2] A good physicist cannot do advanced research unless he is also a mathematician. Systematic procedures are also available in the social sciences such as path analysis, game theory, field theory, catastrophe theory and structural analysis.

arrangement of observable antecedent factors serves as an "explanans" to an observed occurrence, the "explanandum." Assuming that axiomatic method is a valid approach in science, its perspective can be described as follows:

> "To prove a theorem in a deductive system is to show that the theorem is a necessary logical consequence of some previously proved propositions; these, in turn, must themselves be proved; and so on. The process of mathematical proof would therefore be the impossible task of an infinite regression unless, in going back, one is permitted to stop at some point. Hence there must be a number of statements called postulates or axioms, which are accepted as true, and for which proof is not required. From these we may attempt to deduce all other theorems by purely logical argument. If the facts of a scientific field are brought into such a logical order that all can be shown to follow from a selected number of (preferably few, simple and plausible) statements, then the field is said to be presented in an axiomatic form."[3]

3) Axioms*

The choice of axioms is left to the researcher's imagination to a large extent but certain pragmatic rules have to be followed. The postulates must be simple, denoting only one concept at a time and few postulates should be combined together in any theoretical attempt.

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[3]Richard Courant and Hubert Robbins, What is mathematics,? (London, New York, Toronto, Oxford University Press, 1972), p. 214.

*Definition of axioms is standard knowledge. However, a complete exposé is available in Mario Bunge, "Philosophy of Physics" (Boston, Dordrecht-Holland, 1973), p. 145-155

Furthermore, these postulates must have a formal character, they must be invariant and independent from the meaning their concepts acquire when applied in a specific field of research. On the operational side of the theory, axioms must be non-contradictory and logically complementary (in geometry, concepts of point, line, plane and curves are complementary), they must also be independent, (no one being a consequence of the others). Finally, on the deductive aspect of the theory, axioms must be consistent in the sense that no two theorems deduced from them can be mutually contradictory and complete in the sense that every theorem of the system must be deducible from them.

Axioms make for the syntax of a formal language. They are the irreducible logical "words" that give meaning to an abstract sentence which is the theory. Like words, axioms provide for a meaning by their interrelations within a given statement. They are the proportional functions of a logical pattern. Their relation to empirical properties is necessary but secondary. Syntactic coherence is derived from logic prior to facts. The characteristics of this type of model are its internal strength, its degree of coherence and its capacity of penetrating reality. The axiomatic method leads to a coherence-type of theory rather than a correspondence-type of theory. Consequences of the theory are necessary rather than contingent.[4] An advanced theory is not a copy of reality but an operational construct made up of the hierarchical components of an abstract concept.[5]

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[4]R. BLanché, L'axiomatique (Paris, P.U.F., 1955), p. 22.

[5]J. Piaget, Psychologie et épistémologie, (Paris, Gauthier, 1970), p. 85.

According to Mario Bunge, most axiomatic theories are based on ordinary logic.[6] New theories such as quantum physics are based on classical mathematics - even if they are applied in a new manner. The problem of the logic to be used is purely a pragmatic question. When many logics are available, the most simple ones should be used. It is not the type of logic used that gives its force to the theory but the assumptions the logic helps to organize in a systematic form. The use of symbolic logic is usually not advocated except if a long formal polishing of the hypothetical structure is required.[7]

4) Formal Causes

The existence of formal causes bearing on empirical phenomena is postulated by the method. These causes are made up of synthetic relations between facts. They cannot be reached a priori; they must be reached by logical thinking. Principles attained with this method are invariant and consist of an unavoidable conclusion starting from observed effects. By hypothesis these causes represent unobservable complex patterns of interaction. They refer to operational principles at work within observed facts. These non-directly observable objects (or patterns) require for their designation concepts of a different type.

6M. Bunge, Philosophy of Physics (Boston, Dordrecht-Holland, 1973), p. 170.

7M. Bunge, ibid., p. 171.

They are concepts of postulation rather than concepts of apprehension. The meaning of the concept is linked to a theoretical scheme. It is a special application of the hypothetico-deductive method where the basic postulates designate what is proposed to exist.[8]

C) The Method as a Structural Conception of Reality*

1) Definition

The axiomatic method is also an empirical method. Somehow axioms and theorems still overlap with observable phenomena. The difference with mainstream empiricism however lies in its assumptions about the structure of reality. For empiricism, reality is more or less a homogeneous substance that can be pictured from different angles by inductive anaysis - science consisting (in straight line with the positivist conception) of a description of visible reality. Contrary to this

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[8]F.S.C. Northrop, The logic of the sciences and humanities (New York, MacMillan, 1947), p. 60.

*A conception of science as a knowledge of logical structures is proposed by J.L. Destouches, in La physique mathématique (Paris, P.U.F., 1969) and by Noel Mouloud in Les structures, la recherche et le savoir (Paris, Payot, 1968). Both authors argue that the concept of reality in an advanced science is made up of formal concepts referring to a systematic logic. Instead of statements about observable reality science consists of statements about formal models of that reality. The logical "structure" of reality is the new focus of science. Destouches insists more on the formal aspects of axiomatic schemes while Mouloud insists that the structural approach in science is a form of empiricism rendered more coherent by the addition of logical principles. Although proposing similar views on science, these authors differ as to the degree of abstraction that should serve as a standard for scientific theorizing.

camera-man type of knowledge, the axiomatic scientist could be considered as some sort of radiologist aiming at the logical skeleton embodied within the observed empirical system. Instead of X-Rays, he uses the axiomatic method. The concept of structure is central to the method because it determines its object of study.

At the end of the nineteenth century, the idea that emerged was that in the more advanced sciences, cause of events were sought in the inner structure of objects of study. Observed phenomena (facts) were reinterpreted as contradictory manifestations of a built-in network of formal relations. Empirical laws were just surface and local applications of more fundamental, more abstract and more determining causes. The abstract machinery of nature operating behind the scene and generating observable occurrences became an object of study in itself. However, since this intrinsic component of material reality was non-directly observable, it had to be inversely deduced (as hidden causes) from the outward expression of things (as effects). Effects had to lead to cause by a process of formal deduction from principles representing the hidden formal structure of reality. These principles were cast into axiomatic models serving as analogies of the postulated pattern. Operative relations included in the model stood as independent principle that subordinated observed facts to an underlying necessary process. The whole of reality became governed by inner rules of logic. This inner logic was the "structure," the logical skeleton of reality which was at the same time independent of and overlapping with observed reality.

The visible world became a projection of abstract principles - (the videogame of an axiomatic program to use a contemporary metaphor). Visible structures and occurrences became analytic operators and functions of this hypothetical definition of reality. Odd occurrences in particular, were held to be caused by the presence of a formal structure at work within the system of observable reality.

2) The Fusion Between Abstract Structure and Empirical System

The term "protophysics" was coined by Mario Bunge.[9] Protophysics means that systems are not only empirical. In fact patterns of relations as expressed in axiomatic theories have a dual nature, they are empirical and abstract at the same time. This leads to a new concept of system. It does not consist anymore of a cadre for contingent empirical interactions, it consists instead of a projection (into observed facts) of a logical structure. The system is a pragmatic consequence of a model of the structure. The system will be an empirical pattern displaying the abstract-structural properties proposed by the theory. For example the bending of light rays at the proximity of a planet testifies as to the existence of an intensified curvature of space at the proximity of a huge solid mass. The curvature of space however is an axiomatic concept - it is not something that can be perceived by human senses.

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[9] M. Bunge, Philosophy of Physics, p. 235.

Therefore, the focus of the method bears on analytic properties displayed by empirical systems. Any fact that cannot be interpreted as the logical consequence of an antecedent arrangements of observable factors becomes by hypothesis an indicator of the activity of an underlying principle. Such occurrences are rare, they can be discovered by accident but most of the time their existence can be found only within a complex conceptual and research apparatus such as the one provided for in modern physics. Odd facts cannot be observed every day and when they are, it takes a very sophisticated conceptual framework to link them to an underlying logical structure. In an advanced science, the observed reality embodies a model (the structure) the properties of which being displayed in certain symptomatic occurrences. Reality becomes half a model and half "reality" as may be illustrated by the following example which is a standard definition of matrix mechanisms:

> "A branch of mechanics that originated simultaneously with but independently of wave mechanics. It is equivalent to wave mechanics but in it the wave functions of wave mechanics (the mathematical function of a particle) are replaced by vectors in a suitable space (Hilbert space: a multidimensional space in which the proper functions of wave mechanics are translated into orthogonal unit vectors) and the observable things of the physical world, e.g., energy, momenta, coordinates, etc., are represented by matrices."[10]

In this example, the matrix and the system (in this occurrence, the atomic system) are fused together. Observations momentum and

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[10] N.H. Pitt, The Penguin Dictionary of Physics (New York, Penguin Books, 1975), p. 236.

observation of particles position are not fixed but change over time according to properties of the "model-empirical" relations: here momentum and position are not physical quantities but analytic operators. These operators form abstract-empirical matrices that obey a precise relationship ($pq - qp = {}^{i}k/2$). Matrices are structures that can predict various states of the system as well as different results resulting from successive observations of the system. Reality in axiomatic method is a fusion of relatively independent abstract and material properties - it is neither one nor the other, it is an interaction in a network of mutually exclusive but complementary relations.

3) The Three Layers of Abstraction

A fully axiomatized science should in principle contain three types of axiomatics. This leads to the concept of a science made up of multiple layers of scientific laws.[11] The first level of science consists of concepts abstracted from inductive analysis and simple theorems connecting them. According to Einstein however the totality of concepts and relations obtained in this manner are seriously lacking in logical unity. Therories are unrelated one to another and offer weak

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[11] Sources: Albert Einstein, Ideas and Opinions (New York, Dell Publ. 1964), p. 293-315 (Physics and Reality) and Gerald Holton, "What precisely is thinking? Einstein's answer" in A.P. French, Einstein, a Centenary Volume (Cambridge, Harvard University Press, 1979), p. 153-163.

coherence. After this stage of analysis comes a second system of ideas in which both empirical concepts and relations are logically derived. This secondary system pays for its higher logical unity by having as its own elementary concepts only those which are logically derived from the field of observation but which are no longer connected with complexes of sense experiment. Further striving for logical unity should bring the scientists to a tertiary system still poorer in concepts and relations but of a far greater rational coherence. At this level the theory deals with complex arragements of reality that cannot be observed but only postulated.

For Einstein those three layers were not necessarily fixed although certain authors proposed that they were.[12] For Einstein the empirical as well as intermediary layers were only temporary forms of science. Each of these layers contained contradictions that had eventually to give way to more unified theories. Einstein illustrated his point by commenting on the development of mechanics.[13] For him, classical mechanics was insufficient because laws of force could not be obtained by logical and formal considerations. For Einstein the constant reliance on a close correspondence between the theory and observed

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[12] J.L. Destouches, La physique mathématique (Paris, P.U.F., 1969), p. 20-21. The author proposes three fixed levels of scientific theorizing: empirical generalizations, abstract properties expressed by partial differential equations, abstract properties expressed by geodetic functions of space.

[13] A. Einstein, op. cit., p. 293-296.

reality constituted an unnecessary mode of justification. The relevance of the theory was not a problem. The problem was in the feeble articulation of logical properties of classical mechanics. Then a second layer of theorizing appeared in which mechanics as a system was determined by a principle: potential energy. However the concept was still too much dependent in its principle from empirical organization of reality. Then a new level in abstraction was reached when mechanics became characterized by the idea that density and speed of matter were dependent in a continuous manner upon specific coordinates over time. This hydrodynamic theory was of greater scope and of greater logic than those before.

For Einstein, therefore, there was no question about the importance of the role of ideas in science. For him research meant a meeting ground between background theories and observed data, it never consisted of a simple (even if systematic) recording of reality. For Einstein the inductive method was a method reserved only for the first layer of scientific investigation, beyond that stage there were other modes of thinking regrouped under the concept of axiomatic theorizing. Even Newton (says Einstein) was an axiomatic scientist: as an inventor of the kinetic theory of gasses and statistical mechanics, Newton was able to provide unifying axiomatic hypotheses that could provide for new types of connection between phenomena related to gasses (viscosity, diffusion, heat, conductivity, radiometric phenomena.) These developments led eventually to the formulation of thermodynamic theory. Therefore even Newton used the axiomatic method to improve on events properties that could not be derived by induction or by abstraction of observed phenomena. With Newton's theories science ceased to be descriptive and became based on principles.

4) **Inferred Knowledge: The Role of Observation in Axiomatic Theorizing**

Quantum theory has done more than any other recent development in knowledge to shake the solid observational foundations of science. A recent article summarized the problem in the following manner:

> "That is the commonsense view:
> - There is a real world, whose existence is independent of any observer and in which an observed phenomenon has a physical cause.
> - That being so, you can draw valid conclusions about cause and effect from consistent observations.
> - It is legitimate to regard well-separated objects and events as truly distinct. If you explode a shell, you can make independent observations on the properties and behaviour of each of the fragments that spin off. Once they have parted company, one fragment will not influence another. Nor will observations made on one fragment affect the outcome of observations made on another fragment. And, in principle, what is true of the fragments created by exploding a shell must also be true of the subatomic particles created by exploding an atom.
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> Until quantum theory came along, these 'realist' assumptions were taken for granted by all scientists. The assumptions seemed self-evident. Also, in the macro-world, they worked beautifully....
>
> In the Paris experiment, two subatomic particles were emitted by an atom and then flew apart (like the fragments of an exploding shell). In making their predictions of how the two particles would behave, the realist physicists had assumed that, once the two particles had moved apart, neither could influence the other.
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> It is not at all obvious how, in the Paris experiment, two subatomic particles could have influenced one another once they had moved apart. Yet the results of the experiment make sense only if one assumes either that the particles did influence each other (and, moreover, used a signal travelling faster than the speed of light) or that, in some sense, the particles never became truly distinct entities but remained integral parts of a greater whole.

In interpreting these results, physicists do not jettison all the assumptions of common sense. But they argue that one is faced with a choice of either rejecting causality or rejecting the traditional view of the independent existence of the world. Most continue to believe in cause and effect; they would find it very hard to understand nature without that concept. Most also continue to believe that such things as tables and chairs exist. But, they insist, when it comes to the subatomic level, to talk about a particular particle in a particular place with particular properties is meaningless -- until you actually observe it. And the way you choose to measure it will influence the outcome.

Of course, this opens Pandora's box. If subatomic objects 'exist' only when they are being observed -- if the object and the observer are not independent of one another -- what about the larger objects of everyday life, which themselves are made up of subatomic particles? Some scientists say you have to accept that the existence of these larger objects, too, is not independent of an observer. Others deny this and say the common-sense view of reality still holds when it comes to tables and chairs."[14]

One of the standard features of modern science as typified in this article is that direct sensate knowledge is of limited use in scientific experiments. The observed phenomena are in fact of an inferential nature which means that the object of study is not directly visible and that the observed characteristics cannot be understood outside an abstract theory. If, then, the concept of "direct observation" is retained, it is only a metaphor where the previously accepted meanings of the words are extended. For some other classes of observations, the metaphor will become even more exaggerated: the quantum theorists regard ultra-violet light as observable -- yet it is invisible.

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[14]"Physicists redefine reality," The Economist, 29 September 1981), p. 95.

The observable things in those experiments are occurrences attributed to the presence of a non-directly observable element. Therefore a large number of "observables" in modern physics are in reality non-directly observable (or non-observable) things and patterns revealed through inference. If the inference is so plausible and immediate as to be accepted without question, then the distinction between common sense observables and scientific observables may not be so striking as to necessitate a redefinition of science in analytic terms, but when inferences refer to very complex patterns that have no phenomenological meaning such as space-time continuum and wave mechanics it becomes completely confusing to maintain that science is dealing with visible occurrences as a form of final datum -- it would be more exact to say that science is dealing with the visible symptoms of hidden patterns. Reality therefore is as much in the hidden pattern (which constitutes the object of study of theoretical physics) as it is in the visible occurrences.

The inferred theory makes the observation of occurrences possible. In modern science it is the theory that determines what type of occurrences will be observed -- not induction. Without the inferred theory the occurrences will probably go unnoticed. Max Planck explained this situation in the following manner:

> "For the question whether a physical magnitude can in principle be observed, or whether a certain question has a meaning as applied to Physics, can never be answered a priori, but only from the standpoint of a given theory. The distinction between the different theories consists precisely in the fact that according to one theory a certain magnitude can in principle be observed, and a certain question have a meaning as applied to

Physics; while according to the other theory this is not the case. For example, according to the theories of Fresnel and Lorentz, with their assumption of a stationary ether, the absolute velocity of the earth can in principle be observed; but according to the theory of Relativity it cannot; again, the absolute acceleration of a body can be in principle observed according to Newtonian mechanics, but according to Relativity mechanics it cannot. Similarly the problem of the construction of a perpetuum mobile had a meaning before the principle of the conservation of energy was introduced, but ceased to have a meaning after its introduction. Hence it is not sufficient to describe the superiority of Quantum-mechanics as opposed to classical mechanics, by saying that it confines itself to quantities and magnitudes which can in principle be observed, for in its own way this is true also of classical mechanics. We must indicate the particular magnitudes or quantities which, according to Quantum-mechanics, are or are not in principle observed; after this has been done it remains to demonstrate that experience agrees with the assertion."[15]

In the absence of a theory, observed occurrences have no meaning by definition -- within the analytic definition of an observable as the symptom of an underlying pattern, as long as a model of the pattern is not provided for by a theory, the observable refers to an implicit code that remains to be deciphered. The problem with the commonplace concept of science is that the theory must be empirical which is an inappropriate conception: although some theories are empirical, some others are not and these latter are usually much more precise than the former. The purpose of a scientific theory is to establish causal relations between occurrences observed, so that from given occurrences, others may be predicted. But a causal connection between two observed occurrences, A and B, need not express a direct efficient (empirical and

[15] Max Planck, The Universe in the Light of Modern Physics (New York, W.W. Morton, 1931), p. 49.

visible) relation; more often than not the essential relation between two occurrences will involve connections made within a non-directly observable underlying pattern. And here a difference between empirical and analytic method may arise:

- The empirical theory of knowledge will stipulate that all the facts, occurrences and magnitudes in the causal chain must be observable, in this form of science explanation is restricted to measures of correlations between the observed variables (efficient causality only is sought).
- The axiomatic theory of knowledge will postulate the existence of intermediary magnitudes which are not directly observed as providing for an essential causal link between the facts. Theories of this type involve hidden occurrences the evidence of which is necessarily indirect and inferential.

5) The Two Methods in Science: Empirical and Axiomatic

Following the distinction between the empirical method and the axiomatic one there comes a point where the inferential knowledge is in contradiction with direct perception. The direct perception of water cannot give a clue as to its inner composition of two gases. The direct perception of time as unrelated to space is contrary to the inferential knowledge of relativity. The direct perception of matter is in direct contradiction with our inferential knowledge that it is a form of energy. Even some forms of inferential knowledge such as quantum theory have no directly perceived counterparts: wave functions, matrix elements, transition probabilities are elements of an abstract form of matter that cannot be really visualized even in imagination.

Therefore with the creation of modern phsyics a transition has occurred from the phenomenal knowledge of the directly observable to the inferential knowledge of a non-directly observable underlying reality. This underlying reality obeys laws that are not compatible with classical physics. Quantum mechanics for example does not arise out of a physical model but instead tries to reach the nature of reality through mathematics. It postulates (implicitly) that reality consists (almost) of a mathematical (rather than material) substance. The experiment here is mathematical rather than perceptual. The resulting model is almost meaningless in terms of human perceptual categories. In that sense the popular conception of the atom as a raspberry-shaped lump of nucleus surrounded by whirling coloured streamers is a misleading mechanical image that could at best fit a simple hydrogen atom but not the others. The world of inferential knowledge contradicts very systematically the preconceptions on nature held by the empirical conception of the world.

Direct evidence will show that a stone when released, falls to the ground -- inferential knowledge will show, however, that there is no direct relationship between the earth and the stone. In the general theory of relativity, the causal connection is indirect: the earth causes a warping of the four-dimensional space-time, and this warping, which is not observable, is then assumed to be the cause which directs the stone in its fall to earth. Modern science therefore is not the continuation of the classical empirical science of the visible world based on an inductive analysis; it is a new science where the internal pattern of reality becomes the object of study. This internal pattern cannot be understood outside hypothetical theories.[16]

Thus the distinction between the empirical and the axiomatic method brings us to the concept of the existence side-by-side of two distinct sciences: the first is based on direct evidence and the second on inferential knowledge. In empirical science, attention is limited to visible properties appearing at the level of sensate experiment and these properties are incorrectly viewed as identical to the properties of the inner structure of things. In axiomatic science, the fundamental properties of realit· ·onsist of hidden or unseen structures that differ markedly from their phenomenological (i.e., empirical) counterparts.

These two sciences operate on the basis of different epistemologies: materialist for the empirical science, essentially logical and mathematical for the axiomatic science; they also operate on the basis of different methods: inductive analysis for the former (from the concrete to the abstract) and hypothetico-deductive analysis for the latter (from the abstract theory to the concrete symptoms). These two sciences can explain the same phenomena in a different manner. For example, empirical evidence of electromagnetism will consist of conductors, charged bodies and electric currents; an empirical theory of electromagnetism involves systems of relations connecting these magnitudes directly. An axiomatic

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[16]Albert Einstein, L'évolution des idées en physique (Paris, Payot, 1960), p. 288.

theory of electromagnetism will include on the other hand concepts referring to the existence of an inner structure of electromagnetism: electrons, Protons and fields of electrons. Then equations will express the relations between electrons and fields. Then by submitting the microscopic magnitudes thus obtained to an averaging process the results will be identical to the empirical magnitudes established within the previous approach. The basic difference between the two sciences is that the approach used by the axiomatic method goes far deeper in interpreting reality than the common-sense realism of the other method.

The empirical theory of knowledge insists that theories which postulate hidden occurrences should be rejected in favour of direct evidence.[17] Hidden occurrences would be akin to metaphysical speculation -- but metaphysical concepts are arbitrary, they do not refer to any form of inferential knowledge like the concepts of theoretical physics. Empiricism is a popular conception of science that prevents its transition from a limited form of knowledge to a more advanced form.

Both sciences have advantages and disadvantages. Empirical science is rather high on concrete evidences but deals only with relatively simple situations; the method is very weak on theory and consists only of generalizations of phenomenal characteristics that dissolve to the extent that secondary factors are taken into consideration.

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[17]This rejection is implicit since empiricism does not make a difference except in the case of metaphysics.

The reliability of inductive generalizations is therfore more apparent than real. On the other hand, the axiomatic method is extremely complicated and demands incomparably more difficult intellection to be achieved properly -- also indirect evidence supporting the inferred type of knowledge is not easily observable and demands considerable technical means of investigation.

However, when empirical laws are compared to axiomatic laws,[18] their validity becomes very relative. For example, the empirical law of entropy in thermodynamics becomes only a statistical device when confronted with the kinetic theory of gases. Empirical laws by focussing on the phenomenal appearance of reality are seriously limited as an explanation of events. In fact they are superficial. The expressed relations are only those directly observed. Predictions made at that level are usually vague -- the existing unobserved occurrences that are not taken into consideration may make a terrible difference in the outcome. In fact the ignorance of underlying structures and dynamisms constitutes the upper limit of the empirical method -- when this limit is recognized the usefulness of the axiomatic method can be considered as a necessary alternative method of investigation.

Another limit of the empirical method is its relative incapacity of explaining unexpected or strange occurrences. In fact the

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[18] By convention an axiomatic law is a formula expressing an underlying structural link between two sets of occurrences -- as opposed to an empirical law that simply establishes a direct correlation between the two.

empirical worldview tends to mask these occurrences or when faced with them tends to ignore them. It took centuries to realize that the speed of falling objects was independent from their respective weights. Empirical theories are very easy to build but their capacity for explanation is much lower than the one offered by axiomatic theories.

From an historical perspective, empirical science appeared before axiomatic science. It was normal after all that visible relations between things were to be observed first. However, science could not stop at those relations. Some sort of common (or essential) cause for the existence of empirical properties had to be sought at some point in the development of science. In order to enter the realm of axiomatic theories, hypothetical assumptions about the internal constitution of matter had to be made. Although experts do not agree on which was the first axiomatic theory, it is common knowledge that we find theories of the corpuscular type developed in connection with optical phenomena in the eighteenth century. Also the kinetic theory of gases that also appeared in the eighteenth century can be considered as a gigantic leap into the uncharted areas of axiomatic theorizing. However, the axiomatic method will really become a standard feature of science only with the beginnings of modern theoretical physics in the second half of the nineteenth century. Then people like Maxwell, Boltzman and Hertz launched the method on a path that was to lead to the second scientific revolution proposed by Albert Einstein.

Conclusion

1) The Axiomatic Method is a Distinct Scientific Method

In this chapter, we have presented some of the features of an axiomatic science as distinct from an empirical science. Both approaches operate starting from different epistemologies, different methods and different conceptions of science. The cost of these differences lies in the fact that modern science makes a sharp distinction between an essential reality concealed among the facts and a phenomenal reality that is directly observable. The empirical researcher will end his quest after he has gathered all the visible data obtainable on a given problem, he will not look for hidden variables and underlying patterns, he will simply correlate the variables in an attempt to generalize a more or less stable relation between them. In the axiomatic method, the emphasis is placed on the discovery of implicit patterns concealed among facts. These patterns can be understood with the help of formalized models. The facts become secondary elements corroborating the abstract theory (rather than verifying it). Mario Bunge summarizes this new perspective in the following manner:

"Consequently it is false that, as the inductivists claim, any theory should in principle entail the very same data from which it was induced. Not only are scientific theories not concocted out of pure data, but by themselves they entail none. Therefore theories cannot have any empirical content. Only single hypotheses, such as Snell's law of refraction and Galilei's law of falling bodies, might be said to yield, by mere specification, any number of data -- provided at least one item of empirical information is adjoined to them and provided the deep difference between theoretical and empirical statements is overlooked. But the theories to which these two hypotheses belong (wave optics and classical gravitation theory) are not testable just by instantiation. In other words, the conditional "$h \& e_1 \Rightarrow e_2$", which makes some sense for low-level hypotheses, cannot be exported to the domain of theories. As to the conditional "$e \Rightarrow h$", it makes no sense for scientific hypotheses, much less for scientific theories, since no set of data implies a hypothesis -- if only because the latter may contain predicates that fail to occur in the former. Yet it is the declared aim of most systems of inductive logic to evaluate the degree of confirmation (or logical probability) of conditionals of this kind. Which explains why such theories are irrelevant to science...

Inductivism and refutationism are then inadequate, for both restrict themselves to single hypotheses, both neglect the theoretical model that must be adjoined to a general theory in order to deduce testable consequences, and both accept the tenets that (a) only empirical tests matter and (b) the outcome of such tests is always clear-cut.[19]

Being superficial, an empirical test means nothing outside descriptive statements. Modern science is not based upon phenomenal description and the failure of current philosophies of science to provide for a distinction between empirical and analytic knowledge makes a genuine understanding of the modern scientific method much more difficult. The empirical approach was good only for classical science.

[19] Mario Bunge, Philosophy of Physics, op. cit., p. 235-236.

The differences between the empirical conception of science and the axiomatic can be summarized in the following points:

1. Facts are not the basis of reality. In the classical view, facts were the ultimate manifestation of reality. In the analytic approach, facts are superficial phenomena only. The essential substance they are supposed to embody does not exist. A fact is an image.

2. Facts are not the ultimate cause of events. In reality facts are contingent to an underlying structure that is not directly observable. At best facts are the symptoms of the underlying structure and they offer indirect evidence of the presence of this concealed mechanism.

3. Facts do not interrelate or correlate directly. In fact the underlying structure of the world constitues a huge intervening variable. Hidden variables explain much of the occurrences.

4. Facts are not homogeneous throughout reality. Facts do embody an impressive network of secondary factors that defeat any attempt at universal inductive generalization.

5. Facts are not staged on a neutral world. The observable world is a distortion of reality due to the narrow limits of human perception that cannot see behind phenomena. The whole of reality embodies different layers of a more and more abstract nature obeying laws that cannot be truly understood within the narrow limits of empirical concepts. The underlying reality is not passive, on the contrary it presents a hectic character (especially in quantum physics).

6. Therefore the world has no real empirical meaning since empirical knowledge is almost limited to superficial sense impressions. The apparent rationality of empirical knowledge does not resist the comparison with the analytic approach. Empiricism is the science of the surface-layer of reality only, since it has no knowledge of what is going on under it, empiricism remains a decriptive knowledge more than a science. To the extent that human political, ideological, and scientific conceptionsare limited to the empirical side of knowledge, mankind will remain by hypothesis dependent on uncontrollable underlying forces that explain economic crises and wars (among other things).

7. The visible reality is only a section and a particular case of the underlying reality that cannot be observed directly. If the world has any meaning at all, it can only be discovered through an enlarged perception based on logical and mathematical models encompassing all the different layers of reality.

8. Therefore science should not remain limited to the discovery of stable relationships among visible facts, it must go deeper and discover the abstract underlying structure of the world. If classical science was limited to descriptive statements about the visible world, modern science seeks to establish the formula linking events together in the underlying structure.

9. By analogy, the social sciences should stop concentrating on the visible human occurrences and start seeking the underlying structure of social action. Since all facts are mere epiphenomena of a concealed infrastructure, there is no reason why human facts should be different: by hypothesis human behaviour is the symptom of the presence of a concealed social infrastructure that remains to be discovered.

The following table summarizes the differences between the two approaches:

TABLE I: DIFFERENCES BETWEEN EMPIRICISM AND SCIENCE

EMPIRICAL	AXIOMATIC
EPISTEMOLOGY	
1. Facts are the basis of reality.	1. Facts are superficial phenomena.
2. Facts are finite and self-supporting.	2. Facts are contingent to an inner abstract structure.
3. Facts are interrelated mechanically.	3. The relation between facts is the symptom of an inner dynamism.
4. Facts are homogeneous throughout the world.	4. Facts are relative to the contexts of observation.
METHOD	
1. The world is a material substance that can be described.	1. The visible world is only a section and a particular case of a purely formal world that can be mathematized.
2. The process of events is staged on a neutral world.	2. The observed events are by-products of the structure of the world.
3. Science is the cumulation of facts.	3. Science is a mathematical formalism.
4. The world has a meaning by which we can judge it (evolution).	4. The world embodies pure mathematical laws only.
KNOWLEDGE	
1. Empirical regularities are scientific laws.	1. Axioms expressing abstract dynamics are scientific laws.
2. Knowledge is an evaluation of the world.	2. Knolwedge is an evaluation of the abstract structure of the world.
3. Human behaviour is rational and relatively independent of the world.	3. Human behaviour is an exact function in an unseen structure.
4. Man's actions are the cause of politics.	4. The abstract political structure is the cause of man's ideas and behaviour.
5. Political Science is information on the conditions of political action.	5. Political Science is a pure and exact science of the structure of politics.

2) The Axiomatic Method Can Lead to a Theoretical Science of Politics

Axiomatic reality constitutes the complement of the empirical reality (it is a profound reality that obeys its own logic). Immediate knowledge is only an indicator of the real reality that is concealed among the facts. From a direct realism we must pass to an abstract realism. In the new version of reality, the subjective observer is replaced by a logical reference-system and the "facts" are translated into a purified abstract version.

The new method is not based on "facts" but on facts representing the effects of an unseen structure. If a correct law can be established that correctly expresses the dynamics of abstract sub-structure, then prediction of precise events becomes possible by the recurrence of the activity of the abstract principle. The real reality is made up of abstract relations, nothing else exists and the visible world is only a distorted image of the real reality.

Scientific causes are formal and their consequences are empirical AND NOT EMPIRICAL-EMPIRICAL. Scientific knowledge is vertical so to speak while empirical knowledge is horizontal.

Reality is the totality of the relations and not only the apparent ones. Scientific reality is an invariant structure located behind the changing visible phenomena. The goal of science is to unveil the operational logic of the abstract sub-structure behind the events - the visible characteristics of the phenomena have no decisive importance.

The operational dynamics of reality is the only object of axiomatic science - independently of the factual realization of the principles.

a) Theorizing

All the axiomatic laws must replace their empirical corresponding notions. Science is a body of propositions about hidden properties of the universe that are confirmed by visible effects. Causality is a purely technical determinism that is far clearer than the chaotic correlations of empiricism. Science therefore is a pure logic that is complement to empirical description. Axiomatic science stands somewhere between empiricism and logic, it is not empiricism, it is not metaphysics, it is a specific (and special) mental process. Axiomatic science is a post-empirical construction that is made of symbolic deductions.

Axiomatic worldviews are the complement of empirical worldviews: they are not descriptive, instead they form a pure set of functional inter-dependent propositions. The axiomatic worldview becomes a mathematical model of the abstract reality sooner or later.

b) A New Type of Science

Science is no more the product of the cumulation of evidences, it is an endless methodological speculation that combines logic and observable effects in order to evaluate the essential causes at work within events. Science is no more a "knowledge", it is pure intelligence that can be expressed in invariant equations. The logical combinations are endless and in a sense science never is achieved, it is an open-ended process.

The theories are - by definition - the particular cases of future synthetical theories. The theories in an axiomatic science are often obtained by the combination of previously antagonistic theories (one theory is always a very complicated function of the other theory: in Einstein's equations, mass is a very complicated function of speed). In an axiomatic science, the theories are ultimately all complementary referring to a same basic logic. Science is a logical rather than historical process. Science finally is eternally relative to the discovery of any unsuspected variation of any effect predicted by an axiomatic theory.

In conclusion, we can estimate that modern science is based on the postulate that inductive analysis must be completed by the pursuit of a purely rational form of realism. Common sense and empirical knowledge deal exclusively with contingent aspects of reality - they perceive the world as a collection of concrete facts reacting one to an other while the new truth is that all these phenomena are the visible outgrowths of abstract causes.

c) A New Type of Political Science

Therefore, if we want to trace a dividing line between empirical political science and a pure science of politics, we would say that a pure science of politics would analyse the essential logic at work among the political phenomena (events or structures) while empirical political science limits itself to <u>ad hoc</u> descriptions of contingent facts.

The individual fact and the abstract structure must be distinguished and recognized as the two interrelated aspects of reality. The fact is always contingent (it could or could not have been present) but the law bearing on it is a universal "necessity". Science is interested mainly in abstract necessity, the singular events are there only as momentary symptoms of this necessity - the abstract curvature of space around the sun would still exist even if there were no planets around it. Therefore singular events are not interesting by themselves, they are interesting only to the extent that they display the influence of a concealed abstract structure.

The same should be true in political science: behaviour is not only an exact vector of the cumulation of the situational factors, it is also the consequence of an abstract structure that renders the observed reaction necesary. It is not to deny the existence of a form of situational causality - it is rather to explain the inner necessity at work within this superficial cause.

What is lacking in Political Science is the understanding of the existence of an essential abstract sub-structure. The analytic nature of politics remains completely ignored. Political Science is nothing more than a description of contingent political facts upon which we speculate regarding their future developments. Never can we link these facts to an underlying logical necessity that would explain the outome by deduction. We simply have no idea of the existence of an abstract sub-structure of the political reality. Our goal should be the discovery of the essence of politics rather than the description of the configuration of factors in numerous case studies and comparative analyses. These studies do not give us a single clue as to the dynamics of politics, they are descriptions of situational factors that could or could not have been present. Even in the comparative analyses of similar cases we end up with completely divergent outcomes that are either arbitrary or amenable to an explanation by the existence of an intervening abstract causality. Present-day political scientists have not yet concluded on this dead-end development of comparative analysis.

CHAPTER IV

IMPLEMENTING THE AXIOMATIC METHOD IN POLITICAL SCIENCE: PRACTICAL, EPISTEMOLOGICAL AND PARADIGMATIC CONSIDERATIONS

A) Explaining and Theorizing: the Difference

1) Explaining

Explaining and theorizing are two separate functions in an axiomatic perspective. The two terms are no more equivalent as they used to be in the strict empirical conception of science. There is a practical as well as an epistemological difference. On the practical side both approaches focus on different aspects of observed facts, explanation concentrates on the terms of a relationship while theory concentrates on the logic of the relation itself. On the epistemological side an explanation is limited to specific concrete cases while theory disengages a logical pattern that may apply rationally to a whole class of possible cases. The choice between the two approaches as distinct modes of reasoning is possible only within an axiomatic theory of knowledge that makes a difference between fact as final datum (the empirical perspective) and facts as symptoms of an underlying logical structure (the phenomenalist perspective). In the empirical perspective facts are substantive and the logical aspect of reality is co-terminous with its apparent aspect. In the axiomatic perspective facts are dependent on an unseen pattern. They are formal signs of this pattern and the logic of reality becomes relatively independent from the apparent order of things.

In an axiomatic perspective therefore there are marked differences between the empirical theorist (whose function is to explain) and the pure theorist (whose function is to determine the rational properties involved in a given situation).

The inductive analyst is an explainer of facts.[1] He tries to find out which variables lead to a particular occurrence. Factors affecting a particular situation are described carefully and the relation between independent and dependent variables is reported verbally or with a model of the situation or by providing a breakdown of variables in statistical terms. The approach can analyze the relevance and the specific weight of each of the converging factors involved in a given occurrence. The approach is multi-causal in character. Although there can be a dominant factor at work, usually a case is reported as the result of a mosaic of surrounding factors contingent to a visible occurrence. In that sense empirical science is a true science because its statements are rendered valid by a direct correspondence with observed facts. The problem with this science does not lie in its capacity for explanation in

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[1]By convention it is assumed that the "Behavioral Credo" consists of a positivist conception of knowledge relying on inductive analysis of observable facts. Deduction consists here of a generalization of patterns discovered by inductive analysis.

concrete terms - it lies instead in its relevance as a method for theory-building. Theories obtained from inductive analysis suffer from two built-in limitations, the first, logical, the second epistemological. For both of these problems the axiomatic researcher will try to offer a solution by proposing the adoption of a complementary method of theorizing.

Contrary to the critiques of Behavioralism stemming from traditional political theory and Marxist political theory which conceive of the approach in negative terms, the axiomatic perspective is able to provide for a positive comment. An axiomatic perspective is a logical development of a positivist perspective. An axiomatic approach would confirm the existence of empirical patterns in politics by providing for them a character of invariance and of generality of deeper rationality and wider scope than those presently established. An axiomatic approach cannot agree with a political theorist of traditional orientation that there are no stable patterns in the area of the social sciences, these are by virtue of simple observation, the approach cannot agree either with the Marxist that there is only one underlying structure of politics - in fact there can be a great number of underlying structures, each one being responsible for a class of observable empirical patterns. The axiomatic theorist will simply propose that there is a rational explanation for observable patterns that can be obtained by making them dependent upon necessary invariant principles.

If there is a disagreement between the axiomatic theorist and the empirical theorist it is a logical rather than ideological one. Both agree on the necessity of empirical science but the axiomatic theorist will maintain that inductive analysis alone is not sufficient to make relevant theories. As Einstein said in his historical address to the Prussian Academy of Science in 1914: "As long as principles capable of ordering data are not discovered, there is no need for supplementary empirical research." Our hypothesis is therefore quite Einsteinian in intention: empirical political science has discovered a wealth of empirical patterns, what is needed now (for theory-building) is not that we accumulate more case studies and comparative analyses but that we discover principles capable of ordering the enormous data at our disposal. Now political science is ready to enter a paradigmatic stage by implementing a post-positivist approach to knowledege: the axiomatic method.

The axiomatic critique of empiricism consists of a phenomenalist conception of facts: facts are contingent for the axiomatic thinker, they are there not by God's will (at least conceived as a natural deteriminism) but they are there by accident which entails two serious limitations: first their convergence in a given situation is accidential and second this convergence cannot be its own law - in practical terms it means that nothing can guarantee us that an observed pattern of factors will ever repeat itself exactly as it was observed and second we have no guarantee either that a similar pattern will necessarily create an identical outcome. The problem is not at the level of observation, it is at the level of generalization. The axiomatic approach does not believe in the logical validity of deriving the universal from the particular because the specifics of a given concrete case may change at random and second, the invariant logic at work in the case has been masked by those specifics.

The problem is that the convergence of different variables as revealed by inductive analysis does not constitute a good strategy for deriving theory. Inductive analysis is concretist theorizing that reports concrete circumstances and makes specific case studies. However, the method cannot prove that the observed pattern will ever repeat itself (specifics are forever changing in reality) and also it cannot say why this pattern occurred in analytic terms. Therefore what is observed is a particular case in empirical terms and an accidental case in axiomatic terms. Inductive analysis reports a case which is an end-result, it does not say anything about the rational necessity that brought this end-result nor can it prove that the elements implied in the given situation have a universal character. An entirely different situation could have been observed. Therefore, generalization from induction is not an automatic procedure as expressed in the following statement:

"Most behavioural propositions are, of course, less purely universal. They tend to be generalizations within a national framework. Thus we have observations about American parties and British elections. Unlike the natural scientist who speaks of neutrons and positrons, not American neutrons and British positrons, the political behaviouralist, despite his claim to be a scientist, tends to offer mostly what Professor Beer has recently called 'relative explanations,' namely explanatory statements which are 'not universal in form but ... relative to a certain context or contexts.' The question which naturally arises then is whether such contextually limited generalizations can serve the purpose of explaining adequately what have been designated as unique events.

In other words, it seems reasonable to think that if some events may be still better handled by statements which are so limited as to make it pointless to call them generalizations at all. The fact is that practically unrepeatable combinations of rich and complex qualities, combinations which we have called unique, require so many contextual limitations of appropriate general statements that by the time one had collected a sufficient number of limited and universal generalizations for the purpose of explaining the particular event in question, the collected set of general statements would certainly contain many propositions which would be relevant for no more than one particular instance."[2]

Therefore, precision requires that we concentrate on the situational factors surrounding a particular political event - unfortunately the situational factors are not amenable to generalization statements. The more general the statement the more meaningless it will be regarding each particular political event.

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[2]K.W. Kim, "The Limits of Behavioural Explanation in Politics," The Canadian Journal of Economics and Political Science, Vol. XXXI, 1965, p. 321.

Another difficulty met by the inductive approach is its relative incapacity to make analytic concepts. Concepts apply everywhere and to everything without providing for a rule to differentiate between the cases: what is the similarity, for example, between a group of Solomon islanders and a group of students? In fact the concepts are empty and they mean nothing outside the embodiment of situational empirical factors. Empirical universals are pseudo-universals since the implied pattern never exceeds In capacity of explanation the ad hoc factors of a case study. The concepts are either too general or too descriptive to be considered as theoretical terms.

On the other hand, the concepts cannot be rendered more relevant by being refined along operational lines. It soon appears that the process of operationalization is largely an artifical one where the antecedents and the deduced consequences are tautologically related. An example of this is provided by Giovanni Sartori in the following manner:

> "I have thus selected for my first detailed discussion the categories of 'structure' and 'function,' and this precisely on account of their crucial role in establishing the structural-functional approach in the political science setting ...
>
> The major problem with 'structure' is, in fact, that political bodies and institutions largely bear, if not a functional denomination, a functional definition. Either under the sheer force of names - which is in itself a tremendous force - or for the sake of brevity, political structures are seldom adequately defined on their own terms - qua structures. That is to say, on the one hand, that we dispose of a functional (purposive) vocabulary, whereas we badly lack a structural (descriptive)

> vocabulary; and that, on the other hand, even when we deliberately ask 'what is,' we are invariably prompted to reply in terms of 'what for.' What is an election? A means (a structure) for electing office holders. What is a legislature? An arrangement for producing legislation. What is a government? A set-up for governing. The structure is almost invariably perceived and qualified by its salient function. This makes a great deal of sense in practical politics, but represents a serious handicap for the understanding of politics."[3]

In other words the operational definition cannot separate the two terms "structure" and "function" without referring to situational factors. These concepts are vague conceptual frameworks that adapt to the observed facts without imposing on them any significant causal relationship. In summing up, not only are the concepts currently used in Political Science stretched to cover a wide variety of similar phenomena but beyond that the concepts are not amenable to an operational definition that would serve as a theoretical prerequisite to explain an event or an institution. These concepts are vague heuristic devices.

Why is Political Science incapable of forming theoretical concepts is therefore a question of epistemology and not of method. There is no such thing as an empirical necessity - what is empirical is necessarily limited and therefore the sequences of causes and effects always refer to ad hoc situational causes that are peculiar to a given context and cannot be generalized. To obtain an operational concept one has the choice to adopt an axiomatic-deductive approach that will relate

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[3] G. Sartori, "Concept Misformation in Comparative Politics," The American Political Science Review, Vol. LXIV (December 1970), p. 1046-1048.

empirical categories by theoretical means. Instead of being a summary of ad hoc observations, the theory will aim at disengaging the logical skeleton implied in a concrete situation. Chances are that the theory thus obtained will be of greater scope.

> "Empirical evidence is basic to science, but it is meaningless in itself unless interpreted by particular notions about its attributes, its effects, etc. In fact a large part of the structure of scientific knowledge is composed of abstractions, not of empirical evidence - i.e., of ideas about phenomena and their interrelations (theories or laws). To say that science is empirical is really to say that the court of last resort (i.e., of establishing the reliability of any particular knowledge) is the empirical prediction. But to contend that science is only, or basically empirical is to invalidly limit its whole theoretical structure."[4]

Modern explanation is based on logical relations rather than on antecedent variables leading to an outcome. The emphasis is on a pattern of relations and facts are explained by their function in the pattern. The "explanans" is a principle and the "explanandum" or concrete case is a local illustration of the principle. Several concrete cases can be deduced from a unique principle. The context of analysis produces the values of parameters included in the theory. The explanation thus produced is the "why" rather than the "how" of an observed pattern of events. The explanation refers to a formal cause embodied in a concrete situation. It is an explanation by principle - "assuming there are many levels of explanation, the goal is to reach a final theory."[5]

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[4]Carlo L. Lastrucci, The Scientific Approach (Cambridge, Shenkman, 1963), p. 30.

[5]Abraham Kaplan, The Conduct of Inquiring (San Francisco, Chandler Publ. 1964), p. 354.

To obtain this new type of explanation, the theorist will develop models that include which abstractly-conceived aspect of concrete reality is at work. Above the described convergent variables, the model must propose that certain aspects of concrete reality alone make the units of the logical system. Only certain aspects of reality are relevant to a principle - they must be singled out, linked to a principle, cast into a model and then verified by predicting the occurrence of a specific event in a particular context.

2) Theorizing

Therefore, the practical difference with the theorists who concentrate upon visible variables, is that axiomatic theorists concentrate upon proposing and sharpening purely logical formulations of the case under study. The task of these theorists is to clarify analytically conceived sectors of knowledge. The principles thus established will explain systemic aspects of reality in a most satisfying manner. The systemic-logical (or structural) formulation will supply useful information for the inductive-oriented "explanatory" scientist. General theories will add elements of understanding in the analysis of particular situations. They will not replace the inductive analyst who has the responsibility of bringing together empirical variables and logical theories in the explanation of particular occurrences, but they will deliver him from the burden of having to propose general theories out of particular case studies. Thus a new layer of explanation would be added to the current Behavioral tradition in political science. For the moment the new approach is a logical possibility. Nobody knows if it could work but logically there are no reasons that prevent its application in political science. Here are a few reasons why an axiomatic approach should be considered favourably in the social sciences: first, "Behavioralism does not pre-suppose positivism from a methodological point of view."[6] Behavior, defined as relations between individuals does not have to be explained only by description of surrounding variables. A social scientist can discover logical principles that will provide for a deeper explanation than the one obtained by inductive analysis alone. Patterns of social and political phenomena do possess implicitly a rational character that should refer to formal principles. Oligarchies, groups, social prestige layers, belief systems, voting patterns may embody more in terms of integrative processes than an interaction between empirically contingent factors. Social structures, social interactions and social trends may be more than concrete patterns, they may also embody some inner operational principle that makes these structures operate relatively independently from the conscious wish of

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[6]Richard S. Rudner, "Comment: on evolving standard views in philsophy of science," American Political Science Review, 1972, Vol. 66, p. 827.

the participating individuals. And this leads us to a second argument that the decisive aspects of politics are abstract in character:

> "The obscurity of political things arises in the first instance from the fact that they cannot be observed directly by the senses. It is simply impossible to perceive the political in the immediate or direct way that we experience bodies and their sensible qualities, including our own bodies. Insofar as political things have an embodiment, that bodily aspect is perceptible, has the shapes and qualities that are given to the senses can always be accounted for as something in themselves, so that there is no necessity to see them as something else, something political. We like to speak of observing political behaviour, but all that we can actually perceive with the senses are motions of limbs, facial expressions, articulate sounds, and artifacts of one sort or another. Strictly speaking, therefore, political things are unobservable things. The sensible contributes to political knowledge only insofar as it takes us beyond itself in one way or another to the unobservable. Verificationism is caught in this dilemma: if it interprets strictly its principle that politics is an empirical process, available to physical operations, it can never reach the political at all, if it interprets the principle loosely to mean only that the political is somehow inferred from the sensible, it undermines its theory of meaning and its distinction between facts and values."[7]

Therefore we can hypothesize that empirical models do not mirror an objective reality but rather creates it by organizing meaningful perceptions imposed on a complex world. Since Political Reality is not something given to observation - the models will be successful in creating shared meanings and perceptions - but they will not be scientific devices - only arbitrary conventions about phenomenal attributes.

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[7] E.F. Miller, "Metaphor and Political Knowledge," American Political Science Review, Vol. 73 (1-2) (1979), p. 163.

Models will remain designative devices useful within a shared political culture but useless as far as scientific hypothesis-testing is concerned. The models will project an intellectual convention upon the facts but will not unveil the ultimate relationships between them. Therefore the task of an axiomatic political scientist will be to furnish operational principles for the abstractly conceived side of politics. Politics is a second-order reality as it has often been suggested it is the by-product of a complex social organization that possesses its own grammar, its own logic so to speak. To consider politics as a reality in itself is a conventional rather than a theoretical choice because scientific imperatives would require at some point that the political system be considered as the outome of a necessary structure. Politics cannot explain a class of objects by a same class of objects, at some point in science an object must be understood as the intersection of classes of logical and empirical properties. The abstract aspect of politics which is postulated here brings us to a third argument which consists of the possibility of discovering invariant patterns of relations as a basis for an axiomatic theory of politics:

> "A related misconception is the supposition that wide differences in the specific traits and regularities of behavior manifested in a class of systems exludes the possibility that there is a common pattern of relations underlying these differences,

and that the patently dissimilar characteristics of the various systems cannot therefore be understood in terms of a single theory about those systems. This supposition usually originates in a failure to distinguish between the question whether there is a structure of relations invariant in a class of systems and capable of being formulated as a comprehensive theory (even if in highly abstract terms), and the question whether the initial conditions appropriate for applying the theory to any one of the systems are uniformly the same in all the systems. The fact that social processes vary with their institutional settings, and that the specific uniformities found to hold in one culture are not pervasive in all societies, does not preclude the possibility that these specific uniformities are specializations of relational structures invariant in all cultures.

For the recognized differences in the ways different societies are organized and in the modes of behavior occurring in them may be the consequences, not of incommensurably dissimilar patterns of social relations in those societies, but simply of differences in the specific values of some set of variables that constitute the elementary components in a structure of connections common to all the societies. However, it is any man's guess whether a comprehensive social theory of this sort is destined to remain permanently as a logical but unrealized possibility. The present discussion, which is not intended to be an exercise in crystal gazing, seeks merely to note a misconception that arises when this possibility is overlooked."[8]

Axiomatic theorizing is therefore a logical possibility of doing science in Political Science. Before such a task is realized however, there is a need to assert the nature and the shape of the abstract structure of politics. For without an idea on this abstract pattern, progress will not happen.

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[8]Ernest Nagel, "The Structure of Science," in Problems in the logics of scientific explanation (London, Routledge & Kegan Paul, 1961), p. 462.

B) The Concept of Underlying Causality

Social scientists, being engaged in a discipline where established axioms, theories, and operational constructs are largely absent tend to concentrate on defining problems to be solved and upon developing classificatory schemata and producing largely descriptive case studies. They tend to attribute their failure at building coherent theories to the complexity of their phenomena. The fault would lie in the phenomenological character of the object of study rather than in the method. Blaming the phenomena, however, is not a correct diagnosis. The reason why political science employs the classical empirical method and modern physics does not "is not that the disciplines differ inherently, but, rather that physics is more advanced in its epistemology."[9] Physics chooses the analytic method of parameter estimation because its theoretical constructs have superseded those of classical science which limited explanation to measure.

Modern science method as exemplified in contemporary theoretical physics adds the following dimensions as necessary features of scientific explanation:

- Causal (rational) laws are privileged as an instrument to explain empirical laws and to distinguish between them which is the main causal agent in a situation where many empirical laws are involved simultaneously.

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[9] P.H. Melanson, Political Science and Political Knowledge (Washington, D.C., Public Affairs Press, 1975), p. 96.

- Hidden occurrences and non-occurrences are considered as important or even more important for explanation than visible occurrences.
- A clear distinction is made between the world as an empirical structure and the same world as an analytic structure. In the latter case, the empirical structure of the visible world is considered as a function of the underlying analytic reality. Events can thus be explained as the results of underground shifts rather than as the results of changes in the visible contexts.

1) The Necessity of Causal Laws According to John Stuart Mill

In his world renowned book, A System of Logic,[10] Mill devotes more than two hundred pages to arguments in support of the idea that empirical uniformities in social science do not constitute science since a supplementary causal explanation must be given for them. The empirical law (or stable relationship) must be "converted into a scientific theorem by deducing it *a priori* from theoretical principles. Mill calls this procedure the inverse deductive method of analysis. For Mill the essence of scientific theorizing lies in the ability to make a distinction between an empirical law and the causal law it embodies. According to Mill a non-occurrence may still be an occurrence since the causal law it embodies may command an event not to occur:

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[10] John Stuart Mill, A System of Logic (London, George Routledge and Sons, 1866).

> "It is obvious that we cannot expect to find the law of a tendency, by an induction from cases in which the tendency is counteracted. The laws of motion could never have been brought to light from the observation of bodies kept at rest by the equilibrium of opposing forces. Even where the tendency is not, in the ordinary sense of the word, counteracted, but only modified by having its effects compounded with the effects arising from some other tendency or tendencies, we are still in an unfavourable position for tracing, by means of such cases, the law of the tendency itself. It would have been difficult to discover the law that every body in motion tends to continue moving in a straight line, by an induction from instances in which the motion is deflected into a curve, by being compounded with the effect of an accelerating force. Notwithstanding the resources afforded in this description of cases by the Method of Concomitant Variations, the principles of a judicious experimentation prescribe that the law of each of the tendencies should be studied, if possible in cases in which that tendency operates alone, or in combination with no agencies but those of which the effect can, from previous knowledge, be calculated and allowed for. Accordingly, in the cases, unhappily very numerous and important, in which the causes do not suffer themselves to be separated and observed apart, there is much difficulty in laying down, with due certainty, the inductive foundation necessary to support the deductive method."[11]

Implicit in Mill's whole argument is the idea that empirical structures may be functionally equivalent or that the same structure may be functionally different over time or in a different context. The task then is not to assert these differences by contextual explanations but rather to substitute an analytic structure to the empirical structure as the invariant rational cause of a specific function: the empirical structure is only the occasion for the manifestation of a more profound rational cause. As long as this distinction is not made, empirical

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[11] Ibid., p. 519.

generalizations remain almost educated guesses since they are tying together on equal footing different sorts of variables the parameters of which remain unknown:

> "An Empirical Law (it will be remembered) is a uniformity, whether of succession or of coexistence, which holds true in all instances within our limits of observation, but is not of a nature to afford any assurance that it would hold beyond those limits; either because the consequent is not really the effect of the antecedent, but forms part along with it of a chain of effects, flowing from prior causes not yet ascertained; or because there is ground to believe that the sequence (though a case of causation) is resolvable into simpler sequences, and, depending therefore upon a concurrence of several natural agencies, is exposed to an unknown multitude of possibilities of counteraction. In other words, an empirical law is a generalization, of which, not content with finding it true, we are obliged to ask, why is it true? knowing that its truth is not absolute, but depends upon some more general conditions, and that it can only be relied on in so far as there is ground of assurance that those conditions are realized."[12]

The observation of a stable relationship does not give a reason why such a relationship should exist. It is implied therefore that an empirical law is not an ultimate law. The empirical law must be accounted for strictly by logical means. The relationship must embody a principle distinct from the variation of surrounding conditions (which are only the occasion for the manifestation of the principle). There must be an internal necessity to the relationship beyond the fact of its empirical occurrence. This principle is the ultimate cause and the ultimate why of an empirical law. The periodical return of planets, comets and eclipses in astronomy are explained by empirical laws which

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[12] Ibid., p. 519.

are themselves explained by the superior laws of astrophysics -- the latter science is similar to the former except for the fact that it embodies logical causal laws beyond the mere observation of stable cycles. By definition a directly visible pattern will always correspond to an underlying analytic structure made up of causal laws. By deduction from causal laws, the empirical laws can be predicted as necessary consequences. These predicted (or deduced) empirical laws become derivative laws, that is, a law obtained by the exact combination of causal laws and empirical laws: meteorology, for example, is a combination of exact physical laws with weather conditions. By adding causal laws to empirical conditions, prediction becomes possible by deduction (rather than as a result of inductive generalization).

In an empirical law, the different causal laws that may be at work remain hidden and unknown. Therefore in true logic the generalization of an empirical law does not say when and why the relationship will cease to hold. Since we do not know why the relationship exists we have no right to believe that the relationship will still exist in another time or place where similar conditions will exist. "Empirical laws, therefore, can only be held true within the limits of time and place in which they have been found true by observation."[13] Stable relationships therefore constitute scientific laws of a very weak kind since the essential reason for the existence of the relationship is not asserted.

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[13] Ibid., p. 301.

Any empirical law suffers exceedingly large exceptions that severely diminish its explanatory power: that progress leads to democracy and non-ideological politics is an empirical law that does not apply too well outside western developed countries -- like any other empirical law it is a superficial correlation that lacks a substantive cause. The law of political development is therefore not a real scientific law since it does not embody any inner necessary cause.

In fact particular forms of government and social arrangements are the results of countless causes and occurrences. To assume one class of influencing circumstances to be the paramount rulers of phenomena is somewhat to fall into the trap of reification where an end product is taken as the cause of the process. The empirical law is always the consequence of very complex causes and when these causes are not asserted, the cases where empirical law will apply remain limited. The real scientific truths, then, are not made up of empirical laws, but of the causal laws which explain them.

2) The Underlying Structure of Social Reality

The search for causal laws necessarily brings the researcher to the concept of hidden variables. Since the empirical relations that we see cannot be considered as ultimate causal agents, then the ultimate cause of political events is unseen and can be discovered only by indirect evidence from the conceptualization of visible facts as symptoms of the underlying strcuture. The underlying structure may have (by hypothesis) characteristics very different from those observed at the visible level of reality. The fact that many far-reaching political decisions do not appear on the political agenda is also a good scientific argument: actually political upper ēlites can be engaged in unseen battles involving the control of the underlying structure: classified data usually being unavailable to political science, some of the most important aspects of politics are simply missed.

Therefore the Behavioural postulate that "politics is what we see" constitutes a very vulnerable point for empirical political science.[14] The restriction of politics to visible institutions and behaviour is scientifically self-defeating -- the causal laws never lie in the superficial empirical layer of reality.

Therefore the argument is that scientifically, sociologically and politically a distinction must be established between the visible concrete structures which are increasingly irrelevant as a source of explanation and the analytic underlying structures which are increasingly important not only as a source for the existence of the visible upper-structure but also as a source for direct political decisions. The complexity of modern politics forces both the politician and the political scientist to seek solutions in the deep structure of events.

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[14] Lindbloom, Charles, E., "Another State of Mind," American Political Science Review, Vol. 76, (March 1982), p. 15.

Ironically enough Karl Marx was the first scholar to have ever made any such distinction. Compared to modern-day Marxists who are mere leftists having no valid scientific training, Marx displayed a surprising cleverness about the distinction to be made concerning the object of study of social science; he refused any science that would not make the distinction between the visible structure and the underlying structure of events. For Marx there were no raw facts. Facts always depended upon something more fundamental. In a letter to Kugelmann dated 11 July 1868, Marx said:

> "There it will be seen how the economist's way of looking at things arises, namely, because it is only the immediate phenomenal form of these relations that is reflected in their brains and not their inner connection. Incidentally, if the latter were the case, what need would there be of science?"[15]

In other words empiricists stick empistemologically to the empirical. For them, appearance constitutes "the facts." According to Marx, if we could perceive the intrinsic and essential connection between things, there would be no need for science. Empirical knowledge sticks to appearance as if it were the ulitmate there is to know. Marx, himself, therefore proposed that the object of social science should consist of the underlying socio-economic structure of reality as distinct from the directly visible structure (his theory, however, is one of many possible models of that infrastructure). In Value, Price and Profit (1865), Marx denied that empirical evidence gives us knowledge of reality as it is:

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[15] K. Marx and F. Engels, Selected Correspondence: 1844-1895. (3rd rev. ed., Moscow: Progress Publishers, 1975), p. 179.

"To explain, therefore, the general nature of profits, you must start from the theorem that, on an average, commodities are sold at their real values, and that profits are derived from selling them at their values, that is, in proportion to the quantity of labour realised in them. If you cannot explain profit upon this supposition, you cannot explain it at all. This seems paradox and contrary to everyday observation. It is also paradox that the earth moves round thesun, and that water consists of two highly inflammable gases. Scientific truth is always paradox, if judged by everyday experience, which catches only the delusive appearance of things."[16]

This choice is between an analytic concept of science on the one end (where events are epiphenomena of underlying deterministic structures) and the empiricist concept of science where facts interact mechanically. Marx believed that deep causal laws were to be preferred even if they contradicted experiment based on appearance. In Chapter II of Book I of Capital, Marx adds:

"Economy which, indeed, 'has really learnt nothing,' here as everywhere sticks to appearances in opposition to the law which regulates and explains them. In opposition to Spinoza, it believes that 'ignorance is a sufficient reason.'"[17]

In his CCPRE (1859) Marx still insists on the necessity to go beyond empiricism and into the deeper layers of reality:

"Although encompassed by this bourgeois horizon, Ricardo analyses bouregois economy, whose deeper layers differ essentially from its surface appearances, with such theoretical acumen that Lord Brougham could say of him: 'Mr. Ricardo seemed as if he had dropped from another planet.'"[18]

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[16]K. Marx, Wage-Labour and Capital and Value, Price and Profit. (New York: International Publishers, 1976), p. 36-37.

[17]K. Marx, Capital. A Critique of Political Economy. (New York: International Publishers, 1967), Vol. I, p. 307.

[18]K. Marx, A Contribution to the Critique of Political Economy. (New York: International Publishers, 1970), p. 60-61.

According to Marx, Empiricism is "thingism" -- it cannot make the distinction between mechanical interaction and essential analytic relationships. Einstein would have said the same thing about time and space which are separated on the surface but essentially linked in analytic terms.

Therefore the analytic structure of society should be the key to politics. By the term analytic structure is meant any set of theorizable concepts whose movements might plausibly be thought to determine the more or less anarchic contingencies of visible political events. Any event may be taken as exemplifying a principle and political events may be scientifically understood as reflecting a conflict of hidden principles whose structure is of a deep rational order. Political life becomes a distorted reflection of underlying tensions that should become the new object of study of an advanced science of politics. The analytic structure becomes the determinant of political processes. The analytic structure is the new key to political knowledge. The underlying structure is not necessarily the socio-economic structure, it is not simply something that stands there passively beneath the surface of society, it is a dynamic pattern from which both the socio-economic structure and the visible events are by-products. Marx was totally wrong to stop his research at the first underlying structure he met, he should have gone deeper and reached a completely axiomatic type of explanation behind what he perceived to be an irreductible class struggle. Marx committed the error of making his basic principle dependent upon empirical circumstances and therefore confused himself at a higher level, analytic and the empirical structures.*

Empiricism is therefore a branch of traditional rather than modern science. The very separateness of the facts exists only at the phenomenal level, not at the structural level which exists beneath the facts and determines them. Therefore the process of accumulating facts is a pointless activity in itself since the facts are technically symptoms of an unseen structure: they do not exist by themselves.

The illusion is to believe that facts exist by themselves and that mathematics are at best an heuristic instrument that will correlate the facts among themselves in probability statements. The search for scientific laws that will explain the facts as the cause of other facts in an infinite chain of regressive factors is an impossible task and the only way to do science beyond the fluid contingency of the facts is to adopt a new concept of reality, precisely the one developed in modern theoretical physics.

Science explains the occurrence of events by logical necessity while empiricism is forced to imagine unprovable attributes referring to an imaginary substance of the facts. Empiricism does not seek invariant principles correctly since it looks for them among contingent facts.

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*Formal symmetry of action is the explanation of conflict, there is no need to subordinate this property to phenomenal characteristics as final motives.

C) The Political System

1) Rational Causality is Distinct from Empirical Causality

When we reach the idea that present-day political science is implementing a method similar to nineteenth century physics, we can ask ourselves if the new paradigm created by theoretical physics could not also be applied in the domain of the social sciences. We do not think of borrowing the laws and mathematical techniques but more simply of borrowing the new concept of reality and hypothesis formulation developed so far in theoretical physics. The greatest insight of the present stage of the evolution of knowledge (since the 1880s) is that if data do not fit the accepted, everyday organization of reality, then it is necessary to reorder and reorganize the concept of reality from which the data came, so that they do fit it, do behave meaningfully within it. Facts that do not seem to correspond to common sense rationality, facts that are paradoxical from an empirical perspective (for example the non-additionality of the speed of light) or facts that cannot be explained by previous changes in the pre-conditions of an occurrence (or an experiment) lead to a situation where the theory corresponding to these facts transcend the format of conventional definition of reality. Most scientists would probably agree that the concept of reality must only be changed in the realm in which the data are not lawful (quantum and relativity theories), and kept in the realms in which they are lawful but Einstein offers another solution: that the reality perceived by human senses is only a particular case of a more general reality that cannot be perceived but that can be discovered analyticaly. Between the two realities therefore rules of correspondence are possible. Thus in Einstein's reality where the speed of light is a basic constant, the perceived reality is moving at low speed where it conforms to a mechanical type of rationality. According to Einstein, we cannot limit science to the visible reality since it is only a particular instance of a more fundamental type of rationality.

> "Since, however, sense perception only gives information of this external world or of "physical reality" indirectly, we can only grasp the latter by speculative means. It follows from this that our notions of physical reality can never be final. We must always be ready to change these notions - that is to say, the axiomatic sub-structure of physics - in order to do justice to perceived facts in the most logically perfect way. Actually a glance at the development of physics shows that it has undergone far-reaching changes in the course of time.
>
> The greatest change in the axiomatic sub-structure of physics - in other words, of our conception of the structure of reality - since Newton laid the foundation of theoretical physics was brought about by Faraday's and Clerk Maxwell's work on electromagnetic phenomena."[19]

The rationale for the introduction of the analytic method in science, therefore, is not as much made to compensate the limitations of the empirical method as it is to offer a larger picture of reality within which both the unexpected as well as the expected phenomena do make sense according to more fundamental laws than the empirical ones. In fact the laws can even explain empirical laws as a particular application of a larger principle. The advantage of this method is

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[19] Albert Einstein, Essays in Science (New York, Philosophical Library, 1934), p. 40.

immediately given: it gives a much enlarged picture of scientific rationality and considers both exceptional and normal occurrences on an equal footing as the outcome of the variation of the same parameters within a general theory.

In a sense the Einsteinian scientific revolution is similar to the Galilean revolution except that it deals with the concept of reality instead of the solar system. In both cases the reality perceived by human senses is considered to be incomplete and rationally unjustified. Even if earth had been the center of the universe, it would not have provided for a reason why it was there in the first place. Not only do our senses deceive us but the order they describe is rather short on rational justification for its own existence. It is not because we describe correctly a visible order that we give a rational justification for that order. The analytic method is trying to compensate both these shortcomings by providing a model of the world based on a rational logic that serves as a pre-requisite for the existence of the world we see and that serves at the same time as a corrector of our limited sense impressions.

Analytic science seeks to go beyond sense impression in order to give an image of the inner structure of things in logical terms. In that sense it constradicts the "hard evidence of facts" and substitutes in its place an abstract sub-structure. Let's take an example: a realistic model of a table would describe all its features correctly; it may be built of wood, have a certain shape, weight, colour, etc. etc., but this type of evidence would completely overlook the fact that this substance is also made of molecules, atoms, particles, systems of waves, that it corresponds to geometrical laws, etc. etc. - in other words our explanation of reality can take two entirely different directions - in the first case the table is considered as a final datum while in the second case it is considered as the embodiment of abstract laws that differ markedly from the appearance of a substance described empirically. The empirical order then is not a final order, it is more precisely the super-structure of an abstract infra-structure. There is no reason to believe that empirical order takes into account the abstract sub-structure of things since we are dealing here with two different realities and two different sets of explanations that can be derived from observation. Of course the empirical thinker will recognize the existence of atoms, abstract laws and hidden variables but he will not recognize them as being of a different order than the features he sees - in which case he is not taking full advantage of the epistemological distinctions introduced by theoretical physics. By overlooking the possibility of an abstract rationality controlling the world, he shuts himself from the possibility of finding a global model for this rationality. At best he will find only limited abstract laws.

2) Making a Distinction Between Apparent and Abstract Order of Politics

These considerations lead us to two problems, one methodological and the second (as far as the social sciences are concerned) conceptual. If we accept the possibility of a dual nature of rationality (abstract and empirical), then how are we going to distinguish between the two? The dual nature of reality introduced by theoretical physics leads us to a new concept of the reality we see. The reality we see is at the same time a symptom of the underlying abstract reality and a mask of this reality. It is a mix of empirical and abstract interactions and perhaps the concept of interface would be appropriate to describe the perceived reality. A sound, for example, has a certain tone, force and direction (the doppler effect for example) but it is also a system of waves. How are we going to distinguish between the empirical and analytic structures of things? Assuming that we are interested in doing so, the history of science gives us some indications. To cut short two things are necessary to make an analytic discovery. First, it takes an unsuspected occurrence that contradicts a principle established empirically and second, this surprising occurrence is explained as being the result of an unseen structure that can be isolated either by experimental procedures (for example Làvoisier destroyed the phlogiston theory between 1772 and 1777 by showing that combustion took something from air rather than adding something - phlogiston - to air) or by analytic procedures (Galileo, Einstein) in which the unseen structure (the solar system and the space-time continuum) is deduced in logical terms as rendering justice to certain odd occurrences on a result of an organization of space more complex than one could observe directly. In those cases the inner structure of the elements involved in the odd occurences serves as a logical explanation that supersedes a previously established empirical generalization.

Our second problem is conceptual. How are we going to define human behaviour in order to make it amenable to analytic theorizing? Our mental testing could involve three components. First, in an attempt to emulate Galileo, let us assume for a moment that our belief in the creation of a technical society is the equivalent of the earth as the center of universe theory. In this case as in the case of Galileo, the world is perceived by us more or less as ranging from a developed center (the democratic industrialized countries) to an underdeveloped periphery (the developing countries) moving slowly towards the center. This perspective (the modernization theory) describes correctly the apparent position of political systems on a scale of modern development but fails on two major counts: first, it does not explain rationally why the democratic industrial systems have organized the way they did in the first place (the concept of evolution is descriptive rather than structural-rational) and second, the theory does not explain some very odd occurrences along the road to modernization like fascism, revolutions, guerrillas and irrationality under all its forms. To say that these occurrences are deviant cases does not give a why for this deviance. So our hypothesis could be that the implicit belief in an empirical order held by political science is based more on the apparent evolution of the systems than on a profound evaluation of their inner dynamics. The repeated violence experimented all around the world should provide a clue as to the limits of the model - after all the modern tehnical society could be considered itself as a deviant case in terms of numbers: only

30% of human beings living in a modern environment. Even rapidly modernizing societies such as Iran have erupted into revolution - modernization may be more an apparent than a real path.

If our scepticism is correct, then we could expand the argument by saying that our very conceptions of society and man are also more apparent than real, democracy tells us little about the structural dynamics of society and even the concept of "man" tells us very little about the inner structure of that pillar - concept of social science. Our concepts are much more cultural norms than scientific elements. As in the case of the earth as center of the cosmos theory, are we not defending a certain value system at the expense of deep science? Are we not defending an apparent order at the expense of a true understanding of political dynamics that would place scientific explanation beyond good and evil? Are we not defending a social convention, a normative order as being a scientific order? Are we not defending an ideal type instead of making deep theorizing?

Our <u>second</u> element would be the finding of an unexpected occurrence. In fact there exist many political surprises around the globe that cannot be explained too easily from the standard modernizing perspective. Political irrationality is obviously a case in which we could sustain the hypothesis that the observed occurrences cannot be fully explained by the existence of empirical pre-conditions. Fascism for example is an highly unexpected occurrence - why did Hitler kill so many people when he did not need to do so? The concept that he was crazy is a too easy one: what does being crazy mean? Again a moral judgment replaces a rational-structural explanation. The recent revolution in Iran is also a strange occurrence, since the country was modernizing very fast - then how can we explain such a strange phenomenon as Islamic revolution? And finally how can we explain the successes of communism? For a deviant form of modernization, let us recognize that it is a surprisingly enduring one. We can therefore sustain the idea that the political evolution of the world is full of occurrences that cannot be explained by a change in the conditions of action - modern societies like the backward ones can also move along a path that has nothing to do with the modernization theory.

Our <u>third</u> element is that maybe we should explain the unsuspected political developments as the outcome of unrecognized properties of the political structure that have not much to do with modernization. We could in fact build a theory within which both the normal modern society and the irrational political movement would make sense as a result of a simple variation in the parameters of unrecognized properties of the system. Let us suppose for a moment that society is an abstract structure that can equally push in the direction of democracy or anything else.

Therefore analytic theorizing is not impossible in social science provided that we are ready for a moment to make a distinction between an apparent order of things and an underlying structure of a different nature that would serve as a kind of remote control for the events we see. The task of an analytic political science would be the unveiling of this abstract infrastructure rendered plausible by the existence of unexplainable occurrences. The danger here is to explain away the unsuspected occurrences as the result of one element in the context - this is a reductionist type of explanation that never solves the problem entirely. To explain Nazism for example as the result of the German culture is completely false. An inquiry into racism during the first half of this century would reveal that most developed countries had strong racist ideological features that were discarded after 1939. The explanation can be sought elsewhere.

To summarize our argument therefore, we believe that behaviouralism, by focusing attention on the apparent political order, is misconstructing the difficulty of explaining politics. The solution, as offered in more advanced sciences, may reside in the unveiling of an abstract sub-structure of the political reality.

3) The Difficulty of Accepting a New Type of Rationality

A narrow definition of reality may now be hampering the progress of social science and even science in general. The sources from which a field grew may remain within it as an undefined core of assumptions that may still define what is real and true. When new data contradict these beliefs, a basic conflict may develop. There is great difficulty in recognizing and organizing the new problems within a paradigm that believes that solutions will be found simply by doing a little bit more research. In fact the problem lay at the core of our conception of science as a simple description of a mechanical type of order. Such an order may just be a mere appearance and we are not going very far by analyzing it.

The basis of our science goes back some centuries when everybody believed in an ordered cosmos made by a rational God. The world was therefore rational and the task of science was to understand the rational structure of the universe. All things were made the same way and there was one rationality governing everything. All phenomena in the world could be understood in consistent terms and followed consistent laws accessible to observation. Everything from particles to planets and from human behavior to machines could be understood in its terms. Widening this simple understanding was the work of science. There was no room for exceptions from the laws of reality. This concept of one rationality was closely associated with the visible behaviour of things. Things could be counted, added or subtracted since the universe was made of a finite list of things. By quantifying data, a science proved to be a mature form of knowledge. Everything could be seen and touched - what could not did not exist. All things were interacting mechanically with events and causes being contingent the ones to the others. The state of the system at one moment led to the state of the system at the next moment - the present events being the causes of the next events. The whole of reality became predictable if we described the causes and the conditions of action accurately. Everything in the world could be explained along mechanical push-pull lines and the cosmos itself was a giant clockwork.

Understanding meant that every occurrence could be visualized or pictured by simple analogy. Inductive generalization was in fact a universal law since there was no difference in rationality from one occurrence to myriads of occurrences. The relativity of contexts of observation, the entropy of observed relationships caused by the addition of secondary factors over time were not considered important. Typology was not different from theory and the inner structure of things was identical with their apparent features.

It first became clear to scientists that the assumptions that all phenomena could be visualized and explained by mechanical models was finally questioned by the work of James Clerk Maxwell and the development of the concept of field in physics. From a universe made of material points, the physical reality came to be represented as continuous fields, not mechanically explainable. It has not been clearly understood that this change meant the full and complete collapse of the system of one rationality ruling the entire universe. This new understanding however has remained curiously localized in theoretical physics - in other scientific disciplines the belief in one rationality is still strong. Against this belief that everything that is, is real in the same sense and follows consistent laws, is pitted the knowledge that many data cannot be fitted into the same rational system that described so well what happened in the visible realm of experiment. In modern science the new data point to the existence of a larger reality that must be understood in a new manner. The pre-conditions of action ceased to be the only conditions of action and new elements were introduced. By analogy social behaviour cannot be limited to pre-conditions of action but displays also some features that can be attributed to the existence of a hidden sub-structure. This new infrastrutural rationality is however not easy to be observed in social science.

It is very difficult to accept the fact that there is more than one valid way in which the world works and that different degrees of abstraction are necessary to discover these ways. This shaping of reality by hidden variables is a process that may stand at considerable variance from our usual ways of defining reality and society. That there may be more than one "real" reality is a concept bordering on the impossible. Nevertheless, very often, if we scientifically follow the data and their implications, our older theories must be abandoned. A consistent pursuit of classical science forces a transformation in the very heart of that science when we meet new data and problems that do not correspond to our definition of a clockwork rationality. Science today, both in physics and in the social sciences, has brought us to such a turning point. Science becomes effectively anew when the search for "first causes" and "forces" supersedes a type of scientific research centered purely on the visible order of things. Each field of science should go through similar stages. Modern science is characterized by a rejection of common sense explanation and by the systematization of knowledge in geometrical forms. The great discovery of theoretical physics is that everything is linked and is therefore amenable to a global model. There exists a limited continuity between prescientific knowledge (apparent order of things) and science (deep order of things). The transition is made difficult by conceptual obstacles which must be overcome.

4) Disengaging the Two Intertwined Rationalities of Politics

An understanding may gradually develop among social scientists that the organization of reality we are using - that of Western "common sense" and 19th-century physics - is not the only one possible. As we begin to comprehend that theoretical physics is using several different organizations of reality to deal with different kinds of data, we may be tempted to use one of the constructions of reality devised by theoretical physics directly as a conceptual scheme. In German political science for example, the concept of a social field attempts directly a description of society with the aid of sociograms displaying certain relational properties. But in so doing, we still miss a major point: that the reality we are studying is an <u>interface</u> made of abstract and empirical reality simultaneously. There is no advantage of applying an abstract concept such as the <u>field</u> directly on empirical data - it will not lead us to a distinction between the abstract and the empirical component of political reality. Instead we must attempt a redefinition of political reality as being both the result of abstract and empirical forces in an attempt to distinguish the two analytically. The model proposed in such a case is the model of the visible reality considered as an interface between two different sets of laws - it is not a final theory, it is only a transition theory that would redefine reality in a manner where analytical laws could be abstracted from the model. We could find an equivalent of this transitory step in what could have been the conceptual scheme used by Einstein before he discovered relativity in 1905: a universe conceived as a tensor field into which things were inertial systems moving along lines provided by non-Euclidean geometry. Riemannian geometry was the model used by Einstein to combine the properties of the tensor field with visible data. In the absence of such a model, Einstein could not have been led to the discovery of relativity. In a similar fashion, it is impossible to attempt analytic theorizing in the social sciences without first attempting the definition of an interface model of the political system. The second part of this dissertation consists precisely of the search for such an interface model that should serve as a transition between the empirical order we describe presently and the analytical laws that should exist in the domain of political science.

Analytic explanation is based on logical relations rather than on initial conditions of action. The emphasis is on the structure, on a pattern and on facts as functions of that pattern rather than on facts considered as the basis of the rational order. The explanation is the result of a unified system. The system is a logical structure rather than a systemic typology. Assuming we are looking for a deep cause for events we observe, the model must be refined until an invariant law emerges. Causal relations must serve as a rule of logic between the axioms. Within that perspective the real goal of the political system may differ from the apparent goal which is to maintain itself. The substantive goal of the system may possibly lead equally to progress or catastrophe by the application of the same logic to different patterns of circumstances. In that sense there is no such thing as good or bad political system and probably no such thing as collective moral responsibility - both the political system and the behaviour of individuals would react to hidden causes that escape direct human awareness as well as their capacity to handle such situations. The real test of the political system is its relative capacity to handle an unseen structure that determines both the events we see and the political system itself. In other words human beings have very little influence on the evolution of the political system which obeys laws that are presently beyond reach.

Dealing with something abstract and hard to conceive, the axiomatic theory will acquire a special character since its basis will apparently be less clear than in an empirical theory.

> "Any scientific theory may be conceived of as consisting of an uninterpreted, deductively developed system and on an interpretation which confers empirical import upon the terms and sentences of the latter."[20]

However, something more must define the terms if they are undetermined - they will be defined by the logical validity of their assumptions.

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[20] Carl G. Hempel, Fundamentals of Concept Formation in Empirical Science (Chicago, University of Chicago Press, 1952), p. 34.

In the creation of our interface axiomatic conceptual scheme, certain concepts must be brought together in a manner forming a logical pattern from which deductions encompassing a great number of empirically observable occurrences are possible. The model is made of a combination of these assumptions. The question at this point is: where to we start? If there are no interface models in the social sciences, the job of creating one seems almost impossible. As we have said we are looking for the inner necessary logic of political occurrences and a possible starting point for our model could be provided by an enlargement of the assumptions of certain political theories. By expanding the concepts so that they seem to fit an inner necessity, we obtain a new picture of the political system that could possibly support analytic theorizing. Many assumptions proposed by already existing theories are surprisingly close to what we are looking for (a global logical model of all interactions in the political system) except that our own version of the theory will be based on a different set of postulates.

Conclusion

Axiomatic theories bring with them a new paradigm in the social sciences. By defining observable reality as the by-product of an underlying structure, a new conception of the political system, of method and of scientific knowledge becomes possible. The axiomatic method is more than an ordinary method that would reorder facts according to a model.

It is also a method capable of producing scientific revolutions. The major task of the axiomatic method being a redefinition of observed reality, the method has a paradigmatic function that has no counterpart in the empirical method. Kuhn gave an historical account of scientific revolutions by describing them as changes in analytic structures - however, he never explained the mechanism of these changes.

The conception of political occurrences as being derived from two dimensions of the political system - a rational and an empirical one - constitutes a scientific revolution. By postulating the existence of an underlying necessity amenable to representation in terms of invariant relations we should be able to predict occurrences by the interplay of this concealed mechanism with visible empirical factors as observed in the political system. The new rationale is that the visible system - being an end result rather than a causal system is there only as a carrier of visible variables that have a function within the hypothetical underlying structure. When the shape and the dynamics of this structure are discovered with the help of axiomatic method, prediction by necessary deduction will become possible.

CHAPTER V

PRE-AXIOMATIC CONCEPTUAL SCHEMES IN POLITICAL SCIENCE

Introduction

Conditions that have led to the emergence of axiomatic theorizing in modern physics do not exist to the same extent in political science. In physics the combination of new facts (among others the Brownian motion and the non-additionality of the speed of light) combined with the creation of non-Euclidean geometrics and the development of vector fields for the study of electro-magnetic phenomena led to the idea that the core of observable reality was made up of relational patterns that could be understood only in terms of formal logic. Modern physics, based as it is on Riemannian geodesics and quantic isotopic spins is in fact a physics of formal properties of speed and formal constituents of atoms. In this analytic physics empirical occurrences are mediating variables between abstract structures conceived as the ultimate logical cause of events. The new science is made up of models of reality that consider anthropomorphic and positivist knowledge as a local adaptation of a more abstract and more coherent form of knowledge.

In other words the axiomatic method deals with abstract organization of reality in terms specific to this organization.

By so doing the axiomatic theorist claims he can unveil the necessary causes of events in contrast with contingent (and therefore partly accidental) causality found in visible factors surrounding an occurrence. The axiomatic theorist claims that an empirical approach is incapable of establishing an infinite regression in the factors bearing on visible occurrences. Not only because he does not possess enough information, not only because the number of variables involved could become considerable but simply because of the constant interference of secondary factors that add for a measure of uncontrollable spuriousness in any attempt to reach essential causality by sheer empirical means.

In comparison with modern physics researchers, political scientists have not reached the same level of self-consciouness in their evaluation of the phenomenal character of visible factors. Despite the existence of certain political events almost unexplainable in empirical terms (by definition extreme violence may be termed as unnecessary in empirical terms) there has been a general disinterest in trying to explain these facts as the by-product of formal patterns of the political reality. Anthropomorphic explanations have been preferred. But these explanations have to be explained themselves, to explain odd political behaviour by irrationality does not explain irrationality and therefore the onus of the burden is shifted one step further. The relative absence of formal models that could be fitted with political occurrences excuses up to a certain extent the lack of effort shown by the social sciences in the direction of building essential formal theories.

Also the underdevelopment of structural analyses that would establish invariant relations between the different structures supporting politics (demographic, economic, technical, cultural and ecological) is also responsible for a lack of theory that would link empirical to formal properties of the political system. Therefore there has been no attempt to build a model or a theory of a pre-order of politics starting from a recognition of the logical limits of existing explanations in the field.

The idea of adopting such an approach in Political Science may come instead from a recognition that modern physics is using a new scientific method - the axiomatic method - that proposes general hypotheses on the structure of reality. If it could be understood that modern physics is adopting for itself a version of a general method,[1] therefore political scientists could be interested in knowing if an adaptation of this method to the study of politics is possible. At this point a review of some axiomatic pioneer work in the social sciences may help in defining the possibilities and the difficulties of such an approach. Before reviewing these conceptual schemes let us define here what could be the basic requirements of an axiomatic approach to politics.

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[1]The case can be put forward that "local" versions of axiomatics have been discovered in mathematics and in modern physics before any attempt at proposing the method as a general method of investigation could have been made.

The Focus: The Logical Structure Underlying Politics

As we have seen in previous chapters it is difficult to disengage a logical structure from surrounding empirical factors. It is made by postulating its existence rather than observing it. The hypothesis is that patterns of invariant relations exist at the base of each political system. Different combinations of these irreducible elements would explain the variations observed between different political systems and between classes of similar political occurrences. These patterns are difficult to discover since they manifest themselves only in their effects. Their presence may not be clearly manifest either since this type of causality can be mediated through different variables that may not have much in common at first glance - a same axiomatic cause can be responsible for multiple effects. The political system is to be conceived in "geological" terms: successive layers of causality are held to exist under the visible empirical layers. The axiomatic method should be able to uncover any of those layers depending on which level of abstraction is determined as strategically important for a theoretical explanation of a given outcome.

The Structure: A System of Essential Relations

By definition axiomatic structures are systems of formal relations. These systems carry their own sets of laws as systems independently of properties of empirical elements they tie together. Structures are systems of logic that interpret empirical factors as functions in the abstract structure. The "substance" of the theory becomes far less important than its logic. The theory defines the facts according to its own autonomous logic. Reality is conceived in analytic terms and theorizing becomes a research game between competing systems of logic that could fit behaviour of facts.

A Model of the Nature of Politics

Structures are also models. The relational elements contained in them are to be submitted to a rule of formal logic. In an axiomatic pattern (like geometry for example) each element is conceptually a complement to all others. These elements may remain undefined notions taken as postulates, what counts is the network of relations that can be built between them and from which meaningful consequences can be derived for the explanation of visible occurrences.

In other words the axiomatic political scientist would try to discover the elements and relations between elements of a dynamic system specific to political occurrences. Similar to the Galilean-Newtonian revolution that transformed astronomy into astrophysics, the axiomatic revolution in political science would make the discipline capable of structural explanation.

In the social sciences today some models may serve as a starting point for an axiomatic interpretation of politics. Few models are available among theories that profess an axiomatic intent and these models try to explain different aspects of politics. If the models were fully axiomatized they could possibly lead to the first axiomatic interpretation of politics. Each theory, however, explains the occurrences of political phenomena as the result of some sets of abstract factors linked by a necessary principle. In their capacity to formulate axiomatic hypotheses, the theories are of interest. But to the extent they have not been shaped in final axiomatic form nor tested properly, these theories remain hypothetical conceptual schemes. In this chapter we review four of these schemes.

G.L.S. Shackle's theory of choice aims at explaining sudden political changes as the result of an epistemological problem confronting men living in a modern society. Uncertainty is the root of status quo. According to Shackle men are confronted with two impossible choices: the finite list of choices proposed by the status quo cannot satisfy the infinite desires of men but these infinite desires being of an indefinite nature men are afraid to choose the unknown. The system will therefore alternate between periods of routine boredom and periods of catastrophes where the repressed but undefined desires will lead to uncontrollable developments. The rationale of the theory is that each time the visible system of material choices seems to be definitely blocked and does not allow for hope, the system will embark on a catastrophic course.

Shackle, however, does not specify further the inner dynamics of the catastrophic course nor does he offer practical examples of those changes that could have been taken for example from the peasants' revolution in nineteenth-century China or from the emergence of fascist movements that seem to fit what Shackle is trying to explain.

Pareto's theory deals with cyclical circulation of political elites. The principle at work is one of "psychic" correspondence (meaning a way of evaluating politics) between the population and the elite. This correspondence is not conceived in terms of value content but more in terms of presentation of these values. As progress occurs, there will be a latent dysfunction occurring between the way of thinking of the population and the way of thinking of the elite. This dysfunction will generate an alternative elite embodying the new pattern of cultural values. This elite will enter into conflict with the existing elite until it takes power. Like Shackle, however, Pareto does not establish a link between these patterns of thinking (defined as "residues") and changes in the configuration of evolving political cultures. If the theory was formalized we could obtain a mechanics of the evolution of political cultures.

The following theories do not deal with political culture but rather offer different interpretations of conflicting structural interests embodied in the political systems. The field-theory of politics is a theory of domination. The theory embodies postulates that are close to certain concepts of modern physics. The rationale of the theory is that decisive relations in a political system generate a pattern of tension that exerts some kind of abstract - physical force - thereby forcing men to comply and to adopt values against their best conscious interests. As a quasi-physical theory of conformism the theory suggests more or less explicitly that in each system patterns of relations are subordinated one to another in terms of power, of access to resources and in terms of capacity to impose values.

The Marxist theory has been retained in an attempt to explain politics as the result of a binding underlying pattern of relations among men. The theory has never been axiomatized but contains a scheme that could be amenable to axiomatic re-interpretation. The theory is an explanation of unequal access to collectively produced goods. The principle is that a phenomenal management of the system does not pay attention to structural constraints. Since phenomenal management is embodied in an incompetent elite and structural constraints bear only on a dependent group, both groups will conflict over the norms governing the system. As a logical scheme the theory makes sense: if the real structure of reality cannot be known by ordinary knowledge, then any political system based on that kind of knowledge is by definition incompetent with regard to the control of structural dynamics of politics. This severe theory could apply as well to modern communist regimes.

A) The Choice Network

1) Elements

Empirical social science overlooks a dimension of immense importance concealed within visible society: the social system is based in fact on thoughts actual or potential, and not things. Social values depend not only on judgments of the capacity of society (or politics) to satisfy immediate need - they rest on judgments of what other people's judgments will be.[2] Not only does an individual's thinking try to get hold of the entire web of material circumstances of the modern world that are so complex and appear as a skein of endless possibilities, but he also speculates as to his own place in the entire "judgment's network" of the world - what he is to others - including symbolic others - form the ultimate source of behaviour. This thinking process is somewhat hectic due to two basic problems of human epistemics: the first one being the ignorance of the evolution of others' choices and the second one being the binding nature of human choice. To choose is always to run the risk of embarking on a binding path leading to failure.

The human entity therefore has a "big problem," it is trapped in a double-bind process (so well described by the British anti-psychiatry school of thought) - there is no possibility of not choosing because not choosing is a choice and on the other hand there is no

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[2]This section is an interpetation of: G.L.S. Shackle, Epistemics and Economics: A Critique of Economic Doctrines (Cambridge University Press, 1972).

possibility of choice due to the "de facto" ignorance of what will be the others' choice in the forthcoming sequence of time. The human entity is therefore forced to participate but he never knows where he is. The basis of social choice is therefore epistemic and strategic at the same time.. In order to find his place in a network of human choices, the individual agrees to participate but in order not to be crushed in a binding choice that might be rejected by others, the individual needs to surround himself with a logical space of concealment and deception and personal power. Social values - the conventions about interactions in society - represent an equilibrium between the logical space of avoidance and the logical time of binding choices. But those values will mutate constantly according to the possibilities of the social context. Conventions then, are not "laws of nature" but a tenuous equilibrium between collective homeostatic systems of avoidance and commitment. Both systems rest on conjunctural possibilities and when one system ceases to be synchronized with the other one, there is an immense social surprise - most often a catastrophe.

The system of commitment constitutes the visible aspect of society, its outward aspect, and since all the institutions, the code of behaviour, the languages and the thinking processes are imposed by the visible aspect of society, the natural tendency is to believe that nothing else exists. The system of avoidance that is the other (and determining) aspect of society is invisible because it rests on the unsolvable problem of having to choose and not being able to choose.

This problem of the irrational origin of human choice is traditionally considered as a psychological or even theological problem. Philosophy, too, has a lot to say about that - but in an axiomatic social science we are not interested in the ontological aspect of this problem, only in its conjunctural aspect - for the problem of epistemic choice is a social function that obeys precise laws. Man is not only seeking bread and fun and prestige, he is also seeking a place in the imponderable network of others' choices - this network obeys conjunctural laws (by hypothesis). The visible society therefore has a double function: pragmatic and epistemic and the combination of these two functions explains the evolution-catastrophic sequence of human systems. Men cannot agree on a completely pragmatic program because such a common sense approach would leave the epistemic problem untouched. In the visible society the epistemic problem is voluntarily ignored, repressed and forgotten - by convention - but it is always there nevertheless.

All the non-human aspects of life in society refer to the existence of the epistemic problem. Choice is binding and therefore has a very poor if not negligible distributive value - love, for example, is not distributive, we cannot love many people - except metaphorically - hatred, however, is the expression of non-choice and has a very high distributional value, we can hate a lot of people and aggressive behaviour is paradoxically a great unifier: Bonaparte could never have mobilized half a million people to send them to love Russians in 1812 - but to shoot Russians, he could. Man has a need for a logical space of non-choice, this need is permanently menacing the existence of the visible society (which rests on choice by convention on interaction values) and this need has no "cure" - it is partly a logical property of space itself that imposes upon man.

Political science therefore must in fact study the two aspects of society: the visible structure of conventional commitment and the invisible structure of epistemic choice. The interaction of these two structures across time should bring us to a thorough understanding of social and political dynamics.

2) The Impact of Epistemic Choice on Society

In practice, the dilemma of choice for each man is lived throughout social issues and situations. The metaphysical dimension of human thinking is transposed in mundane terms and practical decisions of individuals and social institutions are shrouded in very remote but powerful considerations. The pattern that ensues is extremely difficult to identify at first glance but would be something approaching a "strategy of values." Every close observer of the political scene knows that certain values or principles would never be accepted at a certain time but would be eagerly accepted at another time. The same thing goes for wording certain issues - there are certain expressions that may be suicidal at certain times and innocuous at other times - for no apparent reason. The same thing goes for the use of political symbols: the deposed Shah of Iran was such a negative symbol that he was instrumental in bringing about the American hostage crisis of 1980 and possibly also the assassination of Anwar El Sadat in 1981. The structure of epistemic choice determines the modalities in the uses of power. Human beings cannot live in peace, cannot solve the problems of food shortage in the Third World and cannot abolish unemployment and political repression simply because the political institutions are in fact dependent on the structure of epistemic choice at any given point in time. From an empirical point of view the social problems are technical but from an axiomatic point of view they are in fact epistemic.

Politics is therefore a process of check and balance between visible interests of a practical nature and the invisible interests of epistemic choice that cannot be seen but that can be "felt." Human feelings are epistemic, not "psychological" - psychology is an awkward type of knowledge that reifies immediate observations into "natural laws" - feelings are pre-patterned, they do not exist only as reactions to external events, even if they appear to proceed like that.

To be free to take some course, rather than obey some necessity, is to be confronted with a number of rival available courses. But the same is true of other men also and the sequel to the course man takes will be shaped in part by the particular respective course that they take. To be free to choose means that the sequel of this choice cannot be known. For the choice is always made in a world of choice, and the freedom of men to choose destroys their power to know. The structure of choice must then be pre-reconciled which brings the existence of society but since the structure of choice is subject to a constant turmoil between the avoidance of binding choice and the necessity to choose which might impose on the sequel of today's choice, the social system builds in itself very considerable resistances that integrate the structure of resistance at the heart of the structure of action.

These resistances are then perceived as "power." Power is simultaneously a sub-system of decision-making as well as a sub-system of organized resistance. The concept of class-struggle which is central to the Marxist theory is an accurate description of the distribution of resistance in pre-modern societies - the bourgeois were, however, not exploiting the workers as a prime motive - they were resisting the problem of the structure of choice of their epoch. In modern society, the distribution of resistance will take other avenues - but it is always there. The focus of conflict between the structure of choice and the structure of commitment will vary across time and across political systems: the conflict can be economic, cultural, technical, demographic, etc., etc. Each time the structure of choice is menaced by a social function, it will put an immense pressure on this function which will then react by organizing a repressive apparatus. But repression - if it is dysfunctional from an organization point of view - is functional from another point of view since it focusses the energies of the epistemic turmoil on an easy target. The Communist would lose his "raison d'être" without the bourgeois - the enemy is always an epistemic enemy, never a strict material adversary. Men use social functions to vent their metaphysical fears - but again this is an invisible process - a deterministic pattern based on conjunctural variations that completely escape normal human awareness.

Even mass consumption depends on epistemic choices: people are not simply buying things, they buy cultural symbols to which social values are tied - the same applies to politics. In each human behaviour therefore, there is a patterned irrational behaviour determined by the structure of epistemic choice in a given setting.

From an analytical point of view, there are two possibilities: if the structure of choice and the structure of visible commitment are synchronized, people will choose their alternative paths of action out of a finite list imposed by society - people will not even think there can be anything else in life than to aspire to a middle-class standing in a suburb with all the rituals of a well-meaning and boring conformism. This type of behaviour can be understood very well with the use of statistics, and political decisions in such regimes are taken out of predictable averages. But if the two structures are not synchronized, the probability of choice becomes indefinable because choices will be made out of invisible considerations. These choices can lead to social surprises and even catastrophes. The only manner by which an indefinable possibility of choice can be treated is by axiomatic treatment. This treatment is well exposed by G.L.S. Shackle:

"Axiomatic treatment of probability as an indefinable

At the outset, then, we see two kinds of discussion which, in both purpose and procedure, virtually turn their backs on each other. One of these is a branch of pure logic or pure mathematics in which probability is an indefinable. This treatment is prepared, like a geometry or any system of pure reasoning, to define (freely or arbitrarily) relations amongst otherwise undefined elements, to invent propositions connecting the resulting constructs, and to call these invented propositions, axioms. From the set of axioms thus created, logical consequences are then deduced. The resulting structure is not in its own nature related to any observed or experienced aspect of anything outside the mind. It exists *in vacuo* in its own right of logic. When other treatments have provided suggestions as to realistic nature of a probability concept, one of these suggestions may be found perfectly conformable to the axioms of the pure system, thus serving to anchor that system to some real class of phenomena. The developed axiomatic system is then ready-made to exhibit a great array of detailed features which will apply to any subjectmatter to which a 'probability' of the suggested kind seems appropriate. The axiomatic treatment does not concern itself with the nature or basis of any concept of probability, but only with the elaboration of a structure of theorems about an undefined entity. Such theorems are to be the logical consequences of a set of axioms, that is to say, of a set of propositions exempted *ad hoc* from dispute, which can be freely invented subject only to their being consistent with each other. Something may of course be inferable from the character of the axioms themselves, about the nature of the entity which could serve as their basis. But the axiomatic treatment starts from the axioms, not from the study of human nature, the human predicament, or the observable structure of the cosmos. Logic is its only test."[3]

What Professor Shackle arrives at quite correctly is that the axiomatic model is obtained by inversely deducting a hidden logical principle determining the visible events. This process of inverse deduction must refer to an underlying property of the world. In our

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[3]G.L.S. Shackle, *op. cit.*, p. 321.

hypothesis the underlying principle determining society is the structure of choice or more precisely a deterministic pattern of avoidance of binding choices built in the fabric of each social system.

Professor Shackle goes on to state:

> "Only by the method of studying the abstract adjustments which the expectations and beliefs (of any degree of conflict and diversity amongst themselves) prevailing at some moment would lead to, given a breathing-space or moratorium to work out their logical inter-active consequences, and then of imagining, so far as possible, the cascade of real events which must flow from the inevitable upset of any such state of rest accidentally attained. It is such a method which I seek to designate by the term 'kaleidic economics.'"[4]

3) The Analysis of Essentially Unstable Systems

The unique is also the product of universal laws. The unique in society is a question of momentous choice. A choice of a policy that steers the course of events down a road from which there can be no return to any other roads which were hypothetically available before the choice was made.* The crucial choice may be a power-train leading to explosive consequences. The power of one person to influence millions of others, to set fire to their desires could not be possible without the existence of an epistemic dilemma at the roots of human thinking in society. The crucial choice simply sanctions the displacement of the choice structure.

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[4] Ibid., p. 435.

*By convention we will define as an explosive system any system whose power will expand violently as the result of a successful integration of highly incompatible social structures.

The analytic method which arises from this line of thought is different from both the achronic general systems analysis and the dia-chronic growth model of modernization theory. The method implicit in an axiomatic theory is to regard politics as subject to sudden landslides of readjustments to new ephemeral quasi-equilibrium, in which variables based on expectation, speculative hope and conjecture are delicately stacked in a card-house of momentary immobility, waiting for "the news" to upset everything again and start a new dis-equilibrium phase. Politics is a speculation that rests on conflict of expectations. Since Shackle has not operationalized his model however, the scheme remains at a pre-axiomatic stage.

B) The Irrationality Pattern

4) Pareto's Focus on Axiomatic Theorizing

Pareto (1848-1923), was firmly convinced of the abstract-deductive nature of science along the lines of the founders of modern physics. He therefore developed a set of rules for the use of deductive method in the social sciences. There were five major rules in his approach: a) the mutual dependence of any relationship, b) functional causality instead of empirical causality, c) the study of the constant elements of a social system, not the particular, d) a study of their variations in space and itme, e) the making of formulae referring to the extremely complex dynamics of social reality.[5]

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[5] P. Sorokin, <u>Contemporary Sociological Theories</u> (N.Y., Harper Torch Books, 1964), p. 45.

He believed that empirical social science was superficial and bound by descriptions, incidental factors and historical circumstances instead of paying attention to logical uniformities. Even if he committed the error of including definitional concepts in his model that render it impracticable, Pareto can be considered as having been ahead of his time in his understanding of how an advanced scientific method could be applied to the study of social and political problems.

Pareto's methodological proposals are almost identical with those upheld by noted methodologists of science. His concepts of rational causality and determinism are very modern and his concept of a social system opposing disruptive and integrative forces comes very close to form an axiomatic proposal. He finally paid more attention to the social contexts in which the observed events were occurring. Despite all these precautions, Pareto did not understand that an axiomatic model is an a priori logical construct that must get rid of descriptive concepts in order to form an ultimate equation between logical properties. Axiomatic understanding is not an explanation but rather an ultimate deduction. If the model includes terms that must be explained by reference to the facts, then the model cannot become a scientific theory because the very definition of the axioms would change with circumstances. An axiomatic model is a logical analogy that considers a particular observation to be a particular case or a secondary consequence of an abstract law. An axiomatic model is an ultimate model that includes all the conditions of variance in the observations as an essential deduction from the axiomatic law, not as a circumstantial adaptation of a more general proposition. Pareto made the structure of the political system depend upon the structure of elite attitudes;

the error here is that the concept "elite attitudes" is not axiomatic,* it can change with circumstances in an unpredictable manner, therefore the model does not offer a final equation of the political reality. To be correct, Pareto should have invented a meta-concept linking attitudes with social structures, a meta-concept, the variance of which would have been a general law of the political systems.

The problem of overcoming empirical concepts in order to attain the level of axiomatic theorizing demands that the model should be operationalized with logic before any reference is made to empirical facts. The model should be made only of inter-dependently defined concepts and the goal of the model should not be to describe the observed facts but to determine the hidden connection between the facts. The rational reality must be independent of any circumstances: the acceleration of a falling object is absolutely dependent on time independently of the inclination of the fall - for example, the speed of the fall will vary according with inclination but the speed in the occurrence constitutes only a secondary feature; the basic axiomatic equation is $S = t/t^1$.

Because he attempted the implementation of an axiomatic form of theorizing in the social sciences, Pareto's work is worth mentioning since it illustrates the types of problems one may encounter along this course of thinking.

When Pareto's system is analyzed in detail, it becomes quite clear that - though the structural patterning of social facts and social relationships formed a part of it - it was, very substantially, indeed

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*Since it can be itself explained by pre-conditions - an axiom should express an irreductible property.

essentially, an analysis of the equilibrium of social relationships in terms of basic, universal, enduring psychological forces. Far more than any of the other great "system-builders," Pareto's systematic analysis of society and social change was not only one of "collective socio-psychological conditions" (as Durkheim's could be said to be), but also rested upon the stipulation of basic psychological propensities of the human mind which underlay all the varieties of social and cultural organization in all societies. Pareto's chief contribution lay in providing, specifically and exactingly, a systematic account of the "psychological aspects of society."

Of course the very concept of "psychological force" is not really axiomatic since it cannot be expressed with a mathematical formula - however, his idea of a hidden principle at work within human events is certainly pre-axiomatic and capable of suggesting useful avenues in the building of a truly axiomatic theory of the political system. His focus was explicitly the discovery of a logical underlying pattern.

Though accepting central elements of the "evolutionary" perspective from earlier theories, Pareto's central preoccupation and emphasis was upon analyzing the equilibrium-disequilibrium adjustments of social systems in terms of certain cyclical fluctuations; so that it is fair to say that the overall weight of his theoretical approach was towards the provision of an apparatus of concepts for the accurate analysis of social systems, rather than a focus upon the understanding of the long-term pattern of social evolution for its own sake.

2) The Analysis of the Conditions of Social Equilibrium

a) The Model

Following from what we have said, Pareto's axiomatic aim was very plain, and can be taken as the starting-point - indeed, the basis - of his whole system. Though accepting the evolutionary perspective, and other important elements of the nineteenth century, his own preoccupation for the development of sociology was the analysis of the equilibrium conditions of social systems.

This equilibrium was achieved as a result of abstract qualities of the interactions in the system:

- The model is a variation of structural-functional analysis.
- The pattern of interaction of a multiplicity of components is the comanding variable.
- Social change is conceived in terms of a cycle of equilibrium-disequilibrium.
- The internal components of the system are more important than the empirical context.
- The model of interaction between the elements of the system is mechanical.
- The model is diacrhonic: equilibrium and disequilibrium are time-dependent variables.

Pareto's method was extremely modern - at least in intention - since it was of the relationalist type. His conception of the system as a network of purely logical relationships was no different from the conception of reality found in contemporary physics. In physics, Riemannian geometrics have replaced Euclidian geometrics: the world has become a world of relations - rather than a world of "things."

b) **The Epistemic Problem of the Social Man**

In our previous section, we discussed the importance of the epistemic dimension for the understanding of social behaviour: since men's choices are made in a world of choices that is never clear to anybody, we assumed that society was a permanent bridge between a structure of irrational uncertainty and pragmatic considerations. Characteristically enough, Pareto also conceived society's equilibrium as a result of a tension between what he called logical and non-logical actions.

Since his entire analysis of society and its equilibrium was based upon his persuasion about the universal persistence of certain distinctive qualities of the human mind, Pareto's first step was to make what he considered a distinction of the most fundamental importance. It was the distinction between "logical" and "non-logical" action, and it was important because each required a different kind of analysis and understanding and employed distinctive methods of theorizing, and also because one was far more preponderant in social action than the other.

"Logical Action," as Pareto defined it, was almost pure "rational action" (in the calculation of the means-end relationship) with the addition of the fact that it rested upon knowledge which was objectively true.

This type of action was mainly linked to the search of economic material gratification and the logico-experimental type of knowledge (statistics and averages) was more than enough to understand the evolution of this characteristic of human action. Non-logical actions were an entirely different matter according to Pareto and were much more important in determining the evolution of the social system.

"Non-Logical Action" consisted of all other kinds of human action which were rooted in attachment to sentiment or subjecive desire, sometimes wihtout a definite orientation to ends, sometimes oriented to ends which were vague, diffuse, unattainable, and impossible to estimate in terms of logic or experimental test, and which, in fact, failed to attain either the end, or the achievement (or continuity) of the "psychic state" which they sought.

Non-logical attachments of this kind were the very basis of the life of societies; they were the chief springs of aspiration and of conflict; and far and away the greater part of the entirety of action in society stemmed from them.

The theories which men held about non-logical action were supremely important for their utility, not their truth, and it was his growing consciousness of the significance of this point which was, in fact, the reason why Pareto insisted upon this distinction. He was very definite about this. Having considered certain "theories of society" - such as religious theories, or "Marxism" - Pareto wrote:

> "... we realized that from the logico-experimental viewpoint they were absolutely lacking in precision and devoid of any strict accord with the facts. On the other hand, we could not deny their great importance in history and in determining the social equilibrium. This realization gave strength to an idea which had already come to mind and which will acquire greater importance as our enquiry develops, namely that there is a

> clear distinction between the experimental 'truth' of certain theories and their social 'utility' - these being two things which are not only quite different from one another but may be, and often are, in direct contradiction. The separation of experimental 'truth' from social 'utility' is as important as the distinction between logical and non-logical behaviour."[6]

It is clear, in this statement, that Pareto thought of theories which supported "non-logical" action in society as being of great importance among the determinants of "social equilibrium" irrespective of their truth. They possessed power as ideologies. Even so, Pareto emphasized one other point. Whereas, in "logical actions," it was the "logico-experimental method" which tested and demonstrated their truth; in "non-logical" action, it was not the theory which was the ground for the actions, though this seemed to be so. Men held theories as to why they held such-and-such sentiments and performed such-and-such actions, but the explanation was not in the theories (as they thought) but in the irrational propensities masked by these rationalizations. Ideologies were always based on pseudo-logic.

c) The Social Structure

Pareto began his own "theory" of the social equilibrium by analyzing the "theories" which he found in society. Distinguishing between "logico-experimental" theories and those which underlay "non-logical" action, and maintaining a) that these latter were the predominating focusses of those powerful motivations which were active in

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[6] V. Pareto, The Treatise, Sociological Writings, Selected and introduced by S.E. Finer (N.Y., Pall Mall Press, 1966), p. 215-216.

social equilibirum, and b) that it was their use not their truth which mattered, Pareto then concentrated upon the analysis of these "nonlogical theories. An initial analysis, he argued, showed that such theories consisted of two components: 1) a "constant, instinctive, nonlogical element," and 2) a "deductive element, the purpose of which was to explain, justify and demonstrate the constant element." This provisional distinction, he claimed, had been arrived at inductively, but it provided the core-elements of a theory of the operation of "mind in society," which he then proceeded to develop.

In other words, Pareto was establshing a clear distinction between the purposeful social actions aiming at objectively calculable ends and the non-logical actions, based on instinct triggering a feeling in reaction to social circumstances which was then rationalized with mythical reasons couched in pseudo-rational terms. The contents of the rationalizations which form the social culture of each society have no meaning in themselves, what is important is the type of instinctual feeling they are trying to justify. According to Pareto, the instinct was not observable but was nevertheless forming the ultimate cause of men's actions in society. He considered the instincts (termed "residues") as basic constants in the manifestation of the human mind in society. They were basic social dipositions which were always found in societies - even though their theoretical and institutional dress (so to speak) was different. They were constant, universal and common features of men living in society:

"To clarify the terms we are using, it should be noted that, since sentiments are manifested by residues, it will often be the case that - for the sake of brevity - we shall refer simply to 'residues,' designating thereby also the sentiments they manifest. When we say that residues are among the elements which determine the social equilibrium, this statement must be translated and understood as meaning that 'the sentiments manifested by residues are among the elements which have a relationship of reciprocal determination with the social equilibrium.' Yet this statement also is elliptical and needs to be translated in its turn. We must beware of attributing an objective existence to residues or even to sentiments. What we observe in reality are human beings whose psychic state is revealed by what we call sentiments. Our proposition must therefore be translated in the following terms: 'The psychic states revealed by the sentiments expressed in residues are among the elements which have a relationship of reciprocal determination with the social equilibrium.' But even this is not enough if we want to express ourselves with the utmost precision. What are these 'psychic states'? They are abstractions. What underlies them? So we must say: 'The actions of human beings are among the elements which have a relationship of reciprocal determination with the social equilibrium.* Among such actions are certain manifestations which we term "residues" and which are closely correlated with other actions, so that if we know the residues, we may in certain circumstances know the actions. Hence we shall say that residues are among the elements which have a relationship of reciprocal determination with the social equilibrium.' Derivations also manifest sentiments. They directly express the sentiments corresponding to the residues from which they originate; indirectly they express sentiments through the residues which serve for purposes of derivation. But to speak of derivation in place of the residues they express, as is customary in ordinary language, could lead to serious errors; therefore we shall refrain from doing so in all cases where any doubt about the meaning of a statement is possible."[7]

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[7] V. Pareto, ibid., p. 218-219.

*The axiomatic theory would have been obtainted by combining the terms (residues) and the relations (mental-structural) under an algorithm. Not having done so, the theory remains unachieved.

Pareto was conceiving the action of instincts in reacting to society as a determining mechanism. According to him, social feelings could "boil" under pressure and eventually become "steam" at a certain degree of heat. However, he did not provide for a scale on which the observed changing sentiments would have indicated the building up of pressure. At a certain point, he thought that the psychological forces could erupt like a volcano on the social scene - but in the absence of a model of the volcano, the whole enterprise remains strictly pre-axiomatic. The fact is that Pareto never fully decided between the definition of psychological forces as social functions or as anthropological attributes.

Pareto then set out to describe six types of instincts, the combination of which could explain why certain types of elites were best suited to control certain political systems than others given the conditions for control involved in those systems at certain times. These categories are, however, still vague since they do not possess any built-in conceivable parameters that could permit us the possibility of conceptualizing that a new equilibrium has genuinely been attained between the "instincts" and the political conjuncture. These instincts are: (residues)

- The ability to see relations between things.
- Conservative attachment to one's own thinking scheme.
- The manifestation of sentiments by activity.
- The tendency to associate with others.

- The tendency to protect its individual integrity.
- Sexual appetite.

These instincts give birth to four types of social knowledge:

- The sheer assertion of sentiments as facts.
- The assertion of a fact imposed by an authoritative source.
- The assertion of a fact as enjoying wide popular support.
- The "proof" of a fact by pseudo-rational explanations.

The goal of society then is to manipulate the sentiments of people by offering them the type of argumentation adapted to a certain political situation.

d) Equilibrium Attained by Changing Elites

In order to analyze the conditions of equilibrium of a total society, Pareto therefore proposed a division of its entire population in this two-fold way. First: we should distinguish clearly - in all the activities of society - between the elite-groups and the larger nonelite. These could be regarded as the two significantly different "classes" in society. Then, secondly: we should make a distinction among the elites themselves - distinguishing between the governing (political) elite on the one hand, and all the other specific elites, who could be grouped together as the non-governing (non-political) elite on the other.

There were, then, two outstanding components in Pareto's system of sociological analysis: 1) his schematic analysis of "elites" and 2) his analysis of the psychological forces of society (instincts, sentiments, residues and derivations, taking the form of specific composite social facts). The link between the two was Pareto's persuasion (hypothesis) and that a) the specific structuring of the residues and derivations in the specific equilibrium (or disequilibrium!) of all the composite social phenomena at any time, depended crucially upon the nature and change of the elites, b) that the character and qualities of the elites was crucially a matter of distribution of a certain dominating pattern of residues and derivations among them, and c) that the changing equilibrium-disequilibrium condition of society was centrally a matter of a circulation among the elites coupled with a changing distribution of residues within and among them in accordance with changing situations. This conceptual apparatus thus permitted a systematic analysis of the equilibrium conditions of social systems in terms of those components which, according to the focus of his own hypothesis, Pareto considered to be the most important.

These Changing Elite Characteristics were Forming a Cycle

- The military society was based on elites having conservative instinctual tendencies imposing an extreme social conformism.

- After a war a new elite would appear possessing the instinct of combination and would enter into conflict with the military elite thus forming a phase of disequilibrium.

In other words, the characteristics of the elites were changing according to circumstances thus bringing a permanent tension between the established elite and the new elites formed by new circumstances.

3) A Comment on Pareto's Method

Pareto was completely conscious of the differences between the empirical method which concentrated on the visible structures of society only and a more scientific method that would try to reach the heart of social action as a problem separate from the visible structure. In that sense, he was trying very correctly to unveil the principles of a basic social dynamics that would explain change as a predictable cycle within the momentum of its own logic. His original aim, then, was clearly similar with the axiomatic perspective.

A second strong point in his approach was his conception of an epistemic problem at the root of social behaviour. He conceived this problem as the existence of pre-rational reactions to events that were justified by the elaboration of <u>ad hoc</u> rationalizations or more complex belief systems.

A third good point was his understanding that this structure made up of automatic irrational reactions was an essential feature in forming the equilibrium-disequilibrium cycle of society.

We believe, then, that Pareto offers useful avenues for the introduction of axiomatic theorizing in the social sciences. These avenues can be summed up as follows:

- There is an underlying dynamics to social change that cannot be reduced to empirical considerations about rational behaviour.

- The observation of non-logical behaviour is the best symptom of the existence of an underlying mechanism at work within the visible structure of society.

- All the interactions in society form a pattern that obeys rigid laws and within which the non-logical behaviour is the dominant component.

But having posed the problem correctly did not lead Pareto to an axiomatic theory due to the following errors in the implementation of the method:

- He did not express the non-logical behaviour in terms of a specific function within the network of social interaction but as a distinct element referring to an anthropological property: the instinct.

- By so doing he displaced the focus of theorizing from an axiomatic logic of the social network which would have explained the events by sheer logical necessity to a superficial typology of elites attitudes correlated with social change.

- The correlation of elites' attitudes with social changes is just a by-product of the mechanism he was trying to understand, not the mechanism itself.

Thus Pareto made an error similar to the one made by Durkheim in his analysis of suicide: instead of conceptualizing the irrational behaviour as the ultimate product of a necessary function in the logical network of social interactions, he contented himself to correlate the existence of non-logical attributes of behaviour with changing contexts. By so doing, he could no more explain social change as a necessary consequence of an implicit deterministic pattern that would explain society as the by-product of the logic of the associational network.

In other words, he escaped from axiomatic theorizing and reverted to conventional empirical analysis correlating visible attributes of society but not explaining change at the level of principles.

His original intention was to explain social change as being the by-product of non-logical actions and he ended up by correlating two phenomenal sets of attributes depending on a social change he did not explain. He simply confused the visible structure with the implied logical determinism of the associational network of society. Pareto does not give us a clue as to the logic of the interaction network which was supposed to be the determining element in the first place. He forgot that axiomatic theorizing consists of relational functions within a network and nothing else.

C) The Relational Structure Conceived as a Field

An alternative approach to axiomatic theorizing in the social sciences would consist of starting directly with a hypothetical model of the underlying abstract forces of society and politics. Such a model has been developed in psychology with the notion of "Gestalt." The model is still only a conceptual scheme but offers endless possibilities.

1) A Field-Theory of Politics

Field-theories appeared in the social sciences in 1965 at the inspiration of Kurt Lewin and can be conceived as the product of a modern discussion on scientific method in social sciences.[8] However, the field-theorists have remained at a speculative stage of inquiry partly because they did not study the axiomatic method of modern science in detail.

Field-theory as a conceptual framework is a combination of modern physics and Gestalt psychology. The main characteristics of the theory are the following:

1) The field is a totality of mutually interdependent factors.

2) The whole is different from the parts.

3) The model is a genotype - rather than a phenotype - of reality.

4) Space is an inherent function in the theory.

5) The field can be translated into differential equations.

6) The notions of energy and force designate changes in the field.

7) The nature of the energy of the field cannot be specified, only calculated.

The model will explain political structures and events as the by-product of tensions and poles of tensions in the social force-field. This expression will not be symbolical but based on an exact image of the structures and functions of this field and of its impact on society. The field represents a fundamental power-configuration that obeys strict laws. These laws express the contextual adaptations of the field, to

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[8] H. Mey, Field-Theory: A Study of Its Applications in the Social Sciences (London, Routledge, 1972).

paraphrase Einstein, the field would not be a geographical dynamism but rather a geodesic one.*

Therefore the model represents a method to conceptualize socio-political tensions and force relations. These force relationships should explain everything in society, including social ideas and variations of the political cultures. The concept of human causality is shunned as an ancillary phenomenalistic explanation, the concept of individuality is not retained for the same reasons. The social field is an holistic system of rigid interdependence, there is no freedom of movement at the level of rational causality. The model represents a total system of stress that eventually could be expressed by spatial models. In practice the field is the pressure pushing people to conform to a role or to surrender to a superior social force or propaganda. The individuals are micro-force-fields that react to the social macro force-field according to exact parameters, the reverse is true: a personal forcefield can influence the total field dramatically.

The concept of field is the closest to axiomatic theorizing ever attempted in the social sciences and a review of this effort cannot be dispensed with.

2) Assumptions of Field-Theories

An attempt at establishing field-theories in the studies of human and social problems was first developed in psychology within the

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*A space measured by functional vectors instead of traditional metric.

"Gestalt-theory" of behaviour. Then, it has been expanded to the so-called "social psychology" approach that gave birth to the well-known group dynamics approach of Bales, to the studies on prejudice by Allport and to the studies on social interactions by Homans and Goffman. The theory has been rejected out of sociology due to the success of the structural-functional theory and it has been left out of political science due to the early dominance of the Behavioural movement and by Easton's systems theory. Since the early fifties, the field-theory approach has simply vanished from the scene of social sciences in all countries except in Germany where the tradition has been maintained by a few scholars. Two of these scholars have published their views in Anglo-Saxon academic circles: Kurt Lewin in the early fifties and more recently Harold Mey of Konstanz University who published in 1972 a review of German social and political literature on the subject.[9] It appears that the rationale offered for the return of this type of theorizing in the social sciences partly parallels the discussion offered so far in this thesis.

First Point: Empirical Political Science Cannot Theorize

According to the "field theorists," the theories put forward by the Behavioural movement (systems theory, structural-functionalism, modernization and political development theories, socialization and political culture theories as well as group, elite and class theories)

[9] H. Mey, ibid.

are only classification schemes based on phenomenal ideal-types. The middle-range and narrow gauge theories are also classificatory devices - but based on case studies rather than ideal types these approaches neglect causal social determinism in favour of the purposiveness of human action. These approaches ignore the structural background of human action and stop their inquiry at some sort of "motive" for action. Such an approach does not permit the building of truly scientific models since the concept of causal determinism cannot be reconciled with the existence of voluntary arbitrariness. The Behaviouralists escape the problem by postulating implicitly the rationality of a human behaviour entirely focussed on the search of material interest. Political Science then is the ideal-type of a society based on conformism and classifies as "deviants" all other political systems that are not based on such norms. This type of approach does not explain but reifies a political system (which is after all only a convention) to the rank of a natural law. This internal descriptive function of Behaviouralism sacrifices genuine science for the presentation of a sort of casual knowledge.

Second Point: Empirical Political Science Cannot Explain Irrational Behaviour

According to field-theorists, many social sciences have encountered almost simultaneously the problem of irrational behaviour. In economy, the fluctuations of the market can go to extremes that are not explainable by rational empirical means. This recognition led economists to the assumption that the science of finance had a dual nature. The theory of fiscal efficiency, for example, is balanced by the investigation of psychological irrationalities in the behaviour of the taxpayer and in political power-conflicts which have an effect on financial policy. Irrational social forces have thus become a problem in evaluating the economic process.

In psychology and in theories of communication, certain patterns of speech which impose great powers of coercion on people have been found to be based implicitly on immensely complex patterns of reference that were well beyond normal awareness - as if the patterns of speech were obeying some principle of power relations transcending the individuals in a given context. Up until now these patterns cannot be explained, just observed.

In sociology, it is recognized that the emergence of irrational sub-cultures (like millenarian movements) or anti-cultures like Nazism cannot possibly be tackled with normal empirical objectivity. The existence of irrational behaviour has become a stumbling block that "normal" social sciences cannot understand.

Third Point: Empirical Political Science is Based on an Archaic Method

> "In the physics of the twentieth century there was a shift in scientific emphasis away from the classical mechanics which held sway during the nineteenth century. This led to a viewpoint which may be characterized as belonging to the field-theory. Together with the quantum physics of Planck and

> Heisenberg, which gave scope for the use of statistical laws in natural science, and Einstein's Theory of Relativity, field-physics constitutes the third pillar of the scientific view of the atomic age. This new development did not invalidate classical mechanics; but it did relegate it, as a special branch of physics of moderate importance, to a narrower sphere within the more comprehensive total picture given by the theories of field and relativity.
>
> Those tendencies in the social sciences which strive after scientific exactitude and do not simply utilize an approach based on history and the humanities still bear, even today, the unmistakable imprint of the nineteenth-century view of nature."[10]

These views led some researchers to the concept of field as a supplementary approach to the normal empirical approach. The concept of field means simply this: a totality of mutually coexisting facts obeying laws distinct from the facts involved. In other words, the facts of the world do not cumulate but obey new laws created by their very interdependence. The field implies the notion of tension between poles, a tension that would influence and even determine the observed movements of the facts. Up to the present day, the concept of field in the social sciences has served mainly in conceptualizing certain areas of tension between peoples and groups. It has become a conceptual scheme for social conflicts. However, the concept has not been axiomatized yet, at best it is a conceptual model still lacking the theorems that would link it with socially variable exact parameters in order to form a genuine theory. It is still an heuristic device only.

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[10] H. Mey, op. cit., p. 9.

Society as a whole can be viewed as a combination of different dynamic totalities, of divisions into segments and fields of tension and conflict. Presently, there is no field-theory dealing with society as a whole since the resources available for elaborating this were either inadequate or too complex. But a field-theory of the political system and of society is probably more possible today than ever before. Within this new point of view, the "normal" functioning of the political system is only possible if mutually contrary social forces are held in balance within definite zones. The visible political system and its later change are the result of differing constellations among similar social field-forces. The field-models of the political system should incorporate variables whose magnitudes reciprocally influence one another in multi co-variance patterns obeying a pre-established principle (or rather pre-discovered since the dynamics of the field cannot be postulated _a priori_ but established by a method of inverse axiomatic deduction).

From the enumeration of the various influences in the first section of this section, it must already be clear that in many cases field-theory can be thought of as a contrast to the structural or logical-rationalistic types of theory and to the extent that this type of theory suggests the existence of a principle distinct from the observable facts but dependent on the co-existence of these facts, we may very well have reached a concept that would permit us a transition from empirical to axiomatic theorizing.

3) A Definition of the Field The Field in Physics

The English scientists Faraday (as the pragmatic experimenter) and Maxwell (as his mathematical perfecter), can be taken as the founders of the physical-field theory, which describes the distribution of energy in empty space in the modern sense. Faraday discovered the lines of the magnetic field, the curved path of which, amongst other things, led him to conlcude that the medium between the starting- and finishing-points of force, the two poles, must iself have qualities which contradicted the assumption of a timeless and rectilinear communication of force at a distance, as was then advanced by physicists of the so-called "continental school."

The idea that space in between observable "solid" bodies might itself possess properties, was epoch-making. And it is amusing to note that the much-despised ether-theories of space, to which in fact even Faraday and Maxwell came very close, have turned out to be, in the form of modern field and quantum physics, not anything like so nonsensical as was at first believed.*

It is purely a matter of terminology what name one employs today to describe the energy distributed in space.

> "A field in mathematical physics is generally taken to be a region of space in which each point (with possibly isolated exceptions) is characterized by some quantity or quantities which are functions of the space co-ordinates and of time, the nature of quantities depending on the physical theory in which they occur. The properties of the field are described by

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*In modern physics the concept of material substance has been slowly replaced by that of a logical structure - empirical facts have also seen their status shrink from that of autonomous entities to mere symptoms of the logical structure.

> partial differential equations in which these co-ordinates are dependent variables, and the space and time co-ordinates are independent variables. In Euler's hands, hydrodynamics became a field theory, the field of motion of a fluid being characterized by the velocity of the fluid at each point, and the motion being described by partial differential equations involving the velocity components u, v, w, at the point [with the spatial co-ordinates] x, y, z and time t.[2]."[11]

The concept of field is better than mechanics since it means that energy can be communicated through variations in abstract space propert es. The question as to whether a field is a specific energy or an axiomatic formula is still open to debate. The field appears as an intervening variable between visible facts - this intervening variable can become the cause o ents in the factual world.

The Field in Politics

Before attempting to build a field-theory of politics, a definition of the field as a conceptual scheme is necessary. Here, I would like to discuss some general characteristics which presumably describe any field simply by virtue of of its being constituted as a field.

1) The field is not a static phenomenon but consists of patterned processes representing systems of organized energy which are in motion relative to one another.

2) In spite of the continual motion and change, the pattern of transactions among the various systems composing the field has a basic

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[11]H. Mey, op. cit., p. 3.

stability which can be discerned. If the pattern is observed along a spatial dimension, it appears as a structure. If it is observed along a temporal dimension, it appears as a function. In other words, the distinction between a structure in the field and a function in the field is not absolute but, rather, is relative to the position of the observer. The term pattern is inclusive of both structure and function.

3) The field is a four-dimensional continuum. Whether processes are pictured as patterned along a spatial dimension or along a temporal dimension depends on the position of the observer.

4) Since the field is a continuum of patterned, transactional processes, the structure-function of all the other parts of field, and, therefore, of the whole field, in other words, all parts of the field are in structure-function relation with each other. This total, diffuse dependence makes it theoretically impossible to isolate and observe transactions among adjacent parts of the field while ignoring the reverberating effect of changes taking place in more remote parts of the field as a result of the very processes being observed. In actual fact, however, such observations can be made on isolated parts of the field if it is stated that the reverberating effects limit the validity of the observation being made.

5) The structural-function interdependence of all parts of the field makes statements describing dominance or hierarchical relations of one part of the field over another essentially meaningless. For example, if biological, psychological, and cultural events are considered to be parts of the field, then such reductive statements as "psychological processes are derived from biological processes" or "personality is the

reflection in the individual of the prevailing cultural environment" become irrelevant.* Since they are all field phenomena, the particular form that each takes will depend upon the reciprocal relations among all three. One cannot be derived from another but must be considered as having spatial and temporal co-existence.

6) Although the field is a continuum so far as its dimensions are concerned it is not homogeneous. The energy systems of which it is composed are differentiated from each other as foci or modes of organization. The differentiation is discerned by the observer on the basis of criteria of integration and maintenance of a "steady state." The identity of the foci of organization is maintained by integrative processes which facilitate energy exchanges among the system foci at rates of exchange or equilibria which preserve the pattern or order within the system. Defence processes also occur and represent partial sacrifices of structure or function within the system foci designed to control energy exchanges resulting from strain, conflict, or incongruence which, if unchecked, would lead to disintegration or loss of order. Insofar as the system foci maintain their integration, they sustain boundaries which distinguish one from another, but the boundaries between the foci are ill-defined, incomplete and variable. The character of the boundary area depends upon the degree of order in the system resulting from transactions occurring at any particular time and place.

*Operational dominance however is allowed by the scheme - meaning that any observable factor can become the essential operator for a given class of outcomes under certain circumstances.

4) A New Focus: The Network of Relations

"Normal" relationships involving the routine performance of pre-established relationships are of no interest to the theory - these can be dealt with by empirical statistics and typologies.

Focussing on relationships means also the dismissal of individual purposeful action as a source of explanation for events. Individual behaviour is a false basis since it can be decomposed in many elements - more determining than human will.* Even so, social events vary in different persons and different situations that make them recognizable as subject to law. Social events do form in fact a field, that is a totality of co-existing facts possessing its own dynamics and imposing upon (and even across) individuals. Individuals are in fact reacting permanently to this unseen social force - much more than they are reacting to things. The laws of social fields would determine the interdependence of relatively autonomous holistic functions as the determining cause of all social events.

Society - or the political system - are networks of relations between different functions entering mutually interdependent performances in a relation of covariance defined by the entire field. Things, people, institutions, events become algebraic coordinates in an axiomatic system that can be expressed by spatial models. The difference, however, with a typological model expressing observable relations between different

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*In an axiomatic approach - all phenomena result from a pre-order that is not directly observable. Human will can be seen as a meta-control occurring at the end of the pre-order process - it can afffect the distribution function of the pre-order, nothing else. Like a chess player, it contols local moves of pawns while respecting the determinism of the game.

elements of the system is that the field is a totalistic system of stress determining the outcome of a relation by the amount of pressure it imposes on it.

Personal power does exist - not as a quality - but as the control of a field-function through which it can induce inner tension in other persons. Human relations of all types, legal, personal, institutional are in fact stress-systems in which field-functions are involved despite the fact that the participants are only "instinctively" aware of the tension. The tension determines their behaviour - but they will never understand that.

Inter-individual tension therefore is induced by the whole social field via individual characteristics. Any relationship is subjected to an invisible rule that will automatically (and almost instantaneously) establish a role-relation and a power-relation between two individuals (sometimes above their own preferences of the moment). Tension-relationships constitute the inner fabric of society and the real cause of social events. But as long as our social culture discourages the belief in the existence of any such power-relation network, we will go on conceptualizing what is really happening through a mist or moralizing deception. On the other hand, personal conflicts and inter-adjustment are so immensely numerous that in a sense they block our awareness of them. We wish so hard to get rid of these tensions that we are afraid to discover that it is a provable law. Tension, however, is probably the foundation of the social system, operating indpendently of it. Everyone is determined by the field - not absolutely - but relatively; the field does not prevent a person from taking a decision, but the impact of this decision on social events will be determined by the social field in a very rigorous manner. It is a relativistic determinsim by hypothesis.

5) Impact of the Field on Society

Most of the conceivable impact of the field on social behaviour is probably mediated through the social role. Not only is the social role the source of an empirical function in society that is amenable to empirical analysis but it is also the locus of power in society. A role creates tension in others and the higher the rank of the individual, the greater the tension he will generate in others. The axiomatic explanation of this tension is impossible at the moment since it rests apparently on a social convention about the importance of certain roles, but the problem could be more complex than that. For the moment, it is enough to understand that the social role and the social tension are closely related. The role generates tension empirically and the axiomatic reason should be couched in terms of the coordinates of the social role in the field structure of society. The basic axiom then would be that people generate force-fields that overlap within a bigger field - thus determining a behaviour. The field commands and controls the observable behaviour in a hypothetical precise pattern. The problem is, of course, to discover this pattern as well as the empirical parameters that would permit us to establish a causal determinism of events in society.

The equilibrium or disequilibrium of the system would no longer be the direct result of frustrated or fulfilled objective interests as it is with systems analysis but would depend entirely on the evolution of field dynamics within a given conjuncture. The whole theory rests on the theory that the field is not only a metaphor but on the contrary that it really exists.

If the field does really exist, therefore it can trigger the occurrence of events for no other reason than it is a function of life in society. Certain ideas, for example, can generate considerable impact for no apparent reason - rumours are also indicators of the presence of a social tension. These social tensions are not arbitrary or archaic according to the theory, they are rigidly determined. The influence of a group upon an individual, for example, is following a precise pattern well known in social psychology, but how are we going to explain this premise if we do not postulate the existence of a functional medium that will react to the existence of a group in such a manner as to get hold of the individuals who belong to that group? The structure of any group is also a rather conflictual affair following a precise pattern - all facts suggesting the presence of a dynamic field to which the members of the group react and adapt themselves.

The fact that the most ridiculous opinions of a group can become norms is a rather intriguing affair too.

In other words, the visible logic of a political system tells us little about its real occurrence or about the structure of political reality. The field as an underlying structure is a new manner of defining relations between political factors. It implies the existence of autonomous laws carrying their own weight on the relations between observables. But the terms of these relations and the combination of these terms with the relations have not been axiomatized yet.

D) A **Note** on **Marxism**

Instead of finding a measurable theorem connecting his two basic variables (economy and society) in an invariant factual interdependence, Marx chose another solution by substituting a worldview to what should have been a logical equation. Dialectical materialism and the historical opposition of the superstructure to the infrastructure is nonmeasurable. It is so immense an hypothesis that the whole world can be included in this philosophy without providing for a logical "Why" to anything that happens. It becomes a redundant ideal-type that defines everything and explains nothing.*

One of the reasons for this failure of Marxism to provide for an invariant equation is due in great part to an insufficient abstract deduction of the implicit logical properties of the social system. The concept of capital is by itself encyclopaedic rather than functional. And this is one of the greatest difficulties in axiomatic theorizing in the social sciences: the already known variables of the social system that could be amenable to logical relationships are at the same time very complex and vague. A very rigid preparatory process must be undertaken before we can attempt logical axiomatic theorizing.

Nevertheless, Marx (despite the political reality that today bears his name) should be recognized as the first man who really tried to

*In our perspective, Marxism is the correct description of the syndrome of the permanent opposition between the clusters of roles as it appeared at the beginning of the Industrial Revolution. However, Marx succeeded only in describing correctly a syndrome, he never succeeded in formulating an axiomatic theory starting from his observations - on the contrary he reified the syndrome to the rank of a natural law that could be generalized empirically. Marx remained a victim of 19th century inductive method, he did not understand that he was unveiling a syndrome pointing to the existence of an implicit abstract determinism - distinct from the syndrome. By confusing the syndrome with axiomatic causality he is the Kepler of social science - not its Galileo.

ask the right fundamental questions about the implicit dynamics of the social system and this was a stroke of genius: the dynamics of the social system is a logical infrastructure rather than the result of a set of random human reactions.

Marx was making a distinction between the infrastructure of society[12] and its superstructure. This distinction is really the piston of his theory. According to him the totality of relations surrounding the economy were obeying a dynamics that differed from the visible part of economy. If from the visible point of view economy was nothing else than exchange of goods and values according to accounting conventions, from a deeper perspective it was an unseen power structure that served as a basis for an oligarchy. According to him this oligarchical process was not understood by the social actors - neither by those who profited from it nor by those who did not profit from it. The dichotomy between the real functioning of the economy as an oligarchical structure and its visible counterpart which was apparently based on justice and free exchange could explain the functioning of all the visible institutions. The limited knowledge of visible institutions gave them false legitimacy since objective justice did not go deep enough to correct the infrastructural injustice concealed in the system. What Marx meant was that the real power relations in a society are invisible and therefore cannot be corrected by a "superstructural" administration incapable of deep analysis. For Marx the visible values of the system were bound to clash with the emergence of new values held by those who suffered from the system.

[12] Marta Hernecker, Les concepts élémentaires du matérialisme historique (Bruxelles, Contradictions, 1974), p. 79-85.

Conclusion

Theories reviewed in this chapter are not fully axiomatized. Their logic is not fully articulated and concepts are often close to ordinary concepts instead of being strictly propositional functions within the theory. Nevertheless, to the extent that these theories postulate a structural origin for certain political occurrences in a manner amenable to logical propositions they constitute pre-axiomatic conceptual schemes. In these schemes the origin of certain political occurrences is not visible, the reason why they occur and the degree to which they occur depend on shifts happening in an underlying structure. Those shifts are not accidental, they correspond to laws of these structures. Basically these theories try to explain three basic problems of the political system. These problems refer implicitly to the existence of some type of dynamism that escapes attention of political actors (leaders and citizens). The strategy of interaction between political actors corresponds to a pre-ordained strategy of the structures. Human behaviour becomes a mediating variable between structures interacting as autonomous systems.

Theories reviewed point to the existence of three structural problems of the political system.

Problem 1: Pattern of Opposition

Opposition in a political system does not occur at random. It forms a pattern. This pattern is in fact responsible for the maintenance of opposition in the system irrespective of the material gains involved. Visible political opposition is therefore the symptom of an underlying principle of opposition. In other words political opposition is structural in character, it cannot be reduced (except temporarily) by actors' cooperative behaviour. The logic of this opposition is explained by different principles. For G.L.S. Shackle the principle of opposition is chronic uncertainty. Opposition is latent. People are united by fear, they accept a minimal conventional normative system by fear of being alienated in the search for an undefinable gain. So opposition is within as well as between political actors - it is an opposition between two sets of equally undesirable alternatives: stagnation and chaos. Opposition has an intellectual origin, it comes from ignorance of what other people think and ignorance of the next phase of the sequence of interaction between individuals. Ignorance is then institutionalized in a status quo routine where cooperation and opposition between individuals will be reduced by normative rules of interaction between individuals. Opposition is therefore the pillar of the system and the "raison d'être" of the institutionalization process. Opposition will occur precisely over the institutionalization process to the extent that this process will be made against a group that symbolizes an unknown sequence of binding choices. Therefore political opposition has an epistemological root that cannot be reduced except by institutionalizing defence mechanisms.

Pareto explains opposition as the result of irreductible patterns of thinking that conflict with each other. These patterns (residues) emerge according to evolution of political junctures and conflict with each other as a result of a psychological determinism.

In the field-theory, opposition is conceived as poles in a tensor field. The "raison d'être" of opposition in structural terms is precisely the maintenance of the political field. Implicit in the theory is that opposition between groups and institutions in a society is intertwined with the existence of a political force-field from which groups can derive some form of energy. The distribution of opposition in a system would be a function of already existing distribution of energy.

For Marx, opposition occurs between an incompetent elite and a mass of dependent citizens affectred by problems of a junctural nature that do not find their way in the elite's Weltanschauung.

Example

The existence of a rationality of opposition is well illustrated by Michel Crozier in his book Le phénomêne bureaucratique.[13]

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[13]Michel Crozier, Le phénomêne bureaucratique (Paris, Albin Michel, 1966)

The author describes a process by which groups of workers will decrease their productivity and will combat any administrative measure intended to stop this trend. This resistance in the performance of an economic role is made for a reason that is not immediately apparent. In fact it appears that decreasing productivity occurs in areas where coalitions of workers have a monopoly over a precise function. This strategy aims at forcing correlated economic and management structures on the defensive by making their participation in the economic process dependent on a structure that institutionalizes obnoxiousness as a weapon. This process is only remotely connected with economic benefit - in fact substantive losses of gain may be involved in the process. The rationale for the behaviour would point to the existence of a power gain linked to opposition. This power gain corresponds to the degree it forces economic organization to comply. The reason for this behaviour would be in an unseen rationality of power.

If we combine what theories say on the origin of opposition we do not have a fully axiomatized theory but at least we may obtain classes of concepts from which further theories could be made. Opposition would originate in:

- social aggregates that are co-terminous in the result of their action but opposed in the process by which they get there;
- this opposition on the means would support mental schemes irreductible to one another;
- these mental schemes are shut one to another because they are based on different epistemologies;

- this double opposition - pragmatic and epistemological generates a tension in the political system that forces the whole system to subordinate itself to this tension.

What remains to be discovered is the exact configuration of this opposition mechanism and how variations of its elements could correspond to an axiomatic algorithm. Theorems and parameters of the theory could then be checked on several systems as displaying different variations of this basic mechanism.

Problem 2: Direction of Attitudes

Theories reviewed so far consider attitudes as patterns of evaluations embodying rationalities that are structural in origin. The problem of attitudes here differs from the contents of these attitudes. It links the character or the evaluation they propose to an underlying principle transforming the judgement into a political force. Attitudes are therefore rationalizations or pre-ordained judgements cast in the structures. Even subjective judgment is not free - it is determined by the role of the political actor and by his position in a power structure at any given point in time. Subjective thinking as a global procedure of rationalization masks the structural origin of opposition between individuals while mobilizing them on an opposition course largely for symbolic reasons. The serious character of political opposition does not lie in the reasons given for opposition but in the structural reasons why those reasons are uttered. Attitudes do form formal patterns, or micro-ideologies for each competing group in the system. These micro-ideologies are of interest only in their formal concept - that is to the extent they reveal the direction and intensity of their opposition in a network of competing groups. Attitudes are therefore nothing more than an opposition function.

Attitudes as symptoms of opposition are explained differently by the theories. For Shackle attitudes are determined by their place in the stochastic pattern - finite versus undefinable choice. Attitudes dealing with finite values seek to preserve the status quo (which classified leftist groups as conservatives by the fact they agree on the terms of the system - even if they don't agree on the distribution of the terms) while attitudes referring to values not offered by the system constitute the true menace of the system. For Pareto, political values are rationalizations of pre-existing (and irreductible) psychic states reacting to political junctures. In that sense attitudes are mere indicators of the presence of changing psychic structures of society. For field-theory, ideas are functions of a tensor-network - the energy they generate corresponds to their strategic position in an ad hoc power pattern. Ideas that work are in tune with the movements of the field in a given juncture while ideas that won't work have no meaning because they do not correspond to an underlying pattern. Ideas and values are therefore mere symptoms of an underlying pattern of stress that fluctuates with junctures. For Marx, ideas are either phenomenal rationalizations of structural problems or scientific theories.

Human beings are functional ignorants, the limits of their senses prevent them from understanding the limits of social organization and they justify problems in moral terms rather than understanding their structural origin.

Corroboration of the structural origin of political attitudes is provided for by sociology of knowledge and in particular by Karl Mannheim's thesis on origin of ideologies.[14] In his thesis the author recognizes that different meanings are attributed to similar descriptions of reality and politics depending on the structural background of those who express attitudes. The origin of the difference lies in the group of reference to which each individual belongs sociologically. Groups in competition will define reality according to their interests. This happens at two levels - an immediate level where interests are presented as facts and a universal level where interests are expressed by a major philosophical system. Since knowledge is dependent on a phenomenal method, it cannot be tested by a neutral method but is tested by the assumption of each group. Political opposition based on irreducible interest structures is therefore complemented by conflicting interpretations of reality based on convenient assumptions about knowledge. The superficial nature of this knowledge guarantees two things - that the structured cause of the conflict is ignored and that each of the opposing parties is convinced of its own rights. Ignorance is therefore a function of the underlying structure of politics.

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[14]Karl Mannheim, Ideology and Utopia (London, Routledge and Kegan Paul, 1954).

Problem 3: Inertia and Political Change

A third major problem addressed by the theories is the inertia of political structures or elites opposed to political and social change. This problem is usually interpreted by the traditional concept of objective interests that have to be preserved by archaic institutions at times of reform or revolution. This approach, however, may not explain everything since declining elites may cling to power despite untenable positions in terms of changing power configuration and untenable positions in terms of their capacity to sustain economic growth. The hypothesis therefore is that some kind of inertial structure is responsible for the inertia of declining elites. This structure by definition escapes awareness of the concerned elites even if they may be ready to recognize the difficulty of their situation in strict common sense terms. According to theories reviewed in this chapter therefore we may postulate that the mechanism of political change is structural in character and functions despite the relative capability of any one such elite to stay in power by conscious objective moves. G.L.S. Shackle's theory of uncertainty postulates (although implicitly) that political actors will limit their behaviour to a finite list of choices offered by the system for as long as this list has apparently not been exhausted. The fear of alternatives comes from the impossibility to control the sequence of choices required by mobilization around choices that are not defined by the system and that can lead by definition to any kind of outcome.

Therefore only those groups in society which have absolutely no hope of gain under a list of choices offered by the system will mobilize. According to Shackle this type of mobilization is most likely to lead to chaos as a transition phase towards a new system offering a new finite list of choices under which a new routine will emerge. This theory would therefore explain resistance to change as a consequence of an epistemological problem specific to life in society - old elites are not equipped intellectually to redefine a new social convention and will therefore drown with their dysfunctional assumptions about their changing political system. This characteristic can be verified in most revolutionary sequences where the "desertion of intellectuals"[15] is a function of this type of change.

Pareto explains political change in a similar manner. For him "residues" or psychic aggregations of values emerge as a result of structural changes. Residues are embodied In elites that depend on them. When residues are in accordance with a particular configuration of society, the elite will remain in power. When this configuration changes, a new elite embodying the new residues emerges and enters in conflict with the existing dominant elite. Eventually the new elite will replace the former one. Contrary to Shackle who sees change as resulting from a transition stage of chaos, Pareto conceives the new system as preordained in the residues resulting from structural change. Neither one

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[15] Crane Brinton, The Anatomy of Revolutions (New York, Vintage Books, 1965).

of these two theories offers an operationalization of change - they just provide conceptual frameworks within which elite inertia in face of change could be explained. Theories would have to be operationalized by comparing their schemes with actual examples in an attempt to formalize their concepts with more precision.

Field-theory offers a new perspective on inertia at times of change. The rationale of the theory as aleady expressed is that systems of relations between individuals and facts and ideas in society form invariant patterns of tension and energy depending on where the group is located in the system conceived as a tensor-field. If the number of decisive relations surrounding a group is high therefore it will control more energy than other groups and will bend the whole relational network of the system to its own advantage partly independently of the objective gain involved among competing groups. Dominance, control of ideas and behaviour and even occurrences depend therefore on quasi-physical properties of patterns of political relations. A fading elite would simply be one that does not control anymore a sufficient amount of decisive relations to maintain its energy. Implicit in the theory is the fact that power configuration lies in relations - the visible institutions operate successfully to the extent they correspond to clusters of decisive relations when they do not, they become empty shells and are eliminated. Despite the fact that the theory does not define clearly the political conditions of patterns of relations it is able to suggest a conception of political power that depends on a system of invariant relations.

Also of interest is the concept that the system is capable of imposing norms, ideas and rules by virtue of an abstract pattern of force surrounding the dominant pattern. This quasi-physical property of politics could explain why large quantities of people submit to numerically inferior elites - even before those elites can control military and police forces. The idea that the political system operates within a power-field generated by systems of relations is an interesting hypothesis.

Finally the Marxist theory explains global changes in the political system as a result of an adaptation of economic relations to new methods of production. Each time a dominant elite will define the rules of the system in a manner that will guarantee unequal access to collectively produced goods. Formal equality does not affect structural inequality which means that even equalitarian regimes are oligarchical in their functioning. The theory does not, however, address itself to a number of problems - if human knowledge is phenomenal in character and the structure of the system escapes immediate human awareness then it might be impossible to adjust the rules of society in accordance with extremely complex shifts of the underlying structure of society. This epistemological gap may be responsible for the existence of oligarchy in communist regimes. Marxism is a rudimentary axiomatic conceptual scheme. Although postulating correctly that the dynamics of any visible system does not lie in visible organization but in an underlying necessary pattern, this pattern is defined in terms of visible organization which blurs the necessary distinction that must be maintained in an axiomatic theory between analytic causality and empirical causality. The mechanistic character of the theory is no more apparent than in its explanation of political change. Here Marx is confusing the abstract necessary structure with the visible one.

Again circumstantial evidence of the structural nature of change is available here and there in political science literature. Barrington Moore's thesis on the origin of dictatorship and democracy[16] provides some examples that could be fitted with any one of the four theories reviewed here. The American Civil War would provide some evidence in favour of a Marxist interpretation of politics as based on different methods of production. The French Revolution of 1789 would provide for an illustration of the field-theory by a description of the impoverishment of the types of relations surrounding the French aristocracy. This elite became in fact a hollow shell. The peasant uprisings in nineteenth-century China would confirm Shackle's hypothesis that mobilization occurs (1) only when the finite list of choices proposed by a system offers absolutely no hope to a particular group of individuals (demographic presure rendering property of land unavailable for large quantities of peasants) and (2) results in chaos in the pursuit of undefined choices (peasant revolts were strictly anarchic in character) and finally changes in economic structure of England could be interpreted within the conceptual framework proposed by Pareto as a change of

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[16]Barrington Moorre, Jr., The social origins of dictatorship and democracy: Lord and Peasant in the making of the modern world (N.Y., Beacon Press, 1967).

residues embodied in a new elite as a result of new expectations offered by industrial-type organization of agriculture.

Therefore pre-axiomatic conceptual schemes are of interest because they postulate the existence of a logic of the political structures that differs from the visible organization of society and that explains certain features of the political system that cannot be explained as a result of the rational pursuit of objectives by political actors. The logic of this underlying structure would explain political opposition, the direction of political attitudes and inertia at times of political change by virtue of an underlying dynamics of the political system that cannot be observed directly. Theories reviewed here postulate that these structures are to be conceived as embodying a specific logic that cannot be derived from inductive analysis but instead has to be derived from properties of these structures conceived in axiomatic terms.

The abstract character of these structures is precisely what escapes the awareness of present-day political science. Too often those schemes are simply ignored or are conceived as co-terminous with their phenomenal counterparts. But in Shackle's and Pareto's works, it is not the content of political culture that is analyzed but its logic. In field-theory as in Marxism it is not the visible organization of society that is analyzed but hypothetical systems of invariant relations admittedly conceived to be concealed within the visible structure of the political system. Therefore these theories are axiomatic in intention by postulating the existence of autonomous formal patterns as the cause of political occurrences. The theories, however, retain a pre-axiomatic character due to three limitations: first, the concepts are insufficiently axiomatized, they retain too many analogies with their visible counterparts and they are not enough complementary components of a single logical concept; second, theorems are insufficiently deduced from the system of axioms, many of the consequences that can be deduced are only implicit in the theory; and third, the theories are insufficiently tested on reality.

Despite these shortcomings, this pioneer work in an axiomatic-structural interpretation of politics points the way to a new class of theories that would make political events explainable in terms of a logical pre-order. Theorems deduced from this pre-order could explain a wide range of phenomena by sheer logical necessity of this pre-order. In facts, this new approach is similar to the approach used in modern physics that makes physical occurrences explainable by their conformity to an underlying pattern of abstract relations. The difference between these political theories and modern physics theories stems from the fact that they are not as fully developed. With more axiomatization and more testing some of these theories could probably lead to acceptable axiomatic formulae in the not too distant future. Axiomatic theorizing depends on postulating the existence of purely formal properties of reality, in political science some theories have attempted to do so and from their limited experience it is possible to conclude that this approach to teorizing is affordable. What is needed now is better axiomatization in the formulation of hypothetical schemes.

CHAPTER VI

GAME THEORY AS AN AXIOMATIC THEORY OF POLITICS

Introduction

The growing complexity of politics demands a redefinition of causative relationships that entails more than usual descriptions of precise cases. The modern citizen is trapped in a jungle of norms, rules, conflicting loyalties and goals and is increasingly forced to adopt complex strategies that render his behaviour less and less predictable in empirical terms. The new solutions are bound to be more complex than past ones and a science based on the assumption that future occurrences will be simple repetitions of observed occurrences is possibly too optimistic. The rational model of behaviour currently in use in the discipline is too passive to account for the rules of permutation of complex choices. Game theory may prove to be an interesting alternative. It represents abstract symbolic maps of multidimensional phenomena which serve as a basic reference system. When relations between human beings and options become very complex, only a n-dimensional, abstract, symbolic mapping procedure can measure up to the task. Empirical procedure is more appropriate for unilinear simple relationships.

Game theory provides a powerful conceptual scheme for the analysis of behaviour as a function of complex logical choice structures.

Informally, a game may be conceived as a "context of strategic interaction" among a set of agents. Each has available alternative choices of action, the consequences of which are a joint function of the choices of all the agents. Unlike pre-axiomatic conceptual schemes the theory consists exclusively of propositional concepts of a logical nature thus permitting a description of behaviour in purely formal terms. The theory is axiomatic in the formal sense of the term. Starting from a number of pre-conditions defining the boundaries of contexts of strategic interaction (axioms) maximal decision criteria are deduced (theorems).

The importance of this approach for political science resides in the fact that choices are not only the result of rational options bearing on visible objects but rather constitute a system where outcomes are a function of strategic properties of that system. Viewed from this perspective the political system entails more than input and feedback, it is itself the institutionalization of abstract choice patterns.

A) THE AXIOMATICS OF GAME THEORY

1) The Formal Cadre

Game theory is an axiomatic theory. It is a branch of mathematics. As a method it is based on fundamental assertions linking certain terms and certain relations in an absolutely exact manner. These assertions are not obtained by infinite regress to assertions previously established - they are rather accepted without proof as basic axioms. Other assertions derived from these first ones are the theorems. The rationale of the theory is that human behaviour is subordinated to a logical structure of choice. Choice is no more reduced to (passive and natural) terms but becomes a pattern that is independent from the subject matter of action. The rationality of choice does not lie anymore in the utility of the object of choice but rather in the strategic value of the action of choosing itself. The approach can be described as an axiomatic theory of the logical structure of human strategy. As in physics where theorizing ranges from simple phenomenal occurrences to universal abstract laws, game theory is also a complex field of knowledge where a number of analytical levels are available.

The cadre of game theory is the mathematical theory of sets. The set is a collection of elements. Permutations of elements within sets combined with overlapping functions of sets form the distributive law of the theory. Assuming the correspondence between sets of ordinal and sets of cardinal elements, the theory will determine the range of utility or the range of gain available for pre-ordered sequences of moves (or choices). These values are best represented by vectors on an X-Y ordered plane. Comparisons between vectors resulting from different sequences will permit the discovery of the most strategic sequence. Correspondence between choices of moves and resulting values is quite complex due to the system of interdependence of the moves. Each move brings a transformation of the system that determines the value of following moves.

2) Elements

The new notions are derived from combinatorics proper to the subject matter and have little to do with any phenomenal description of the political system. Game theory unravels mathematical properties of human behaviour that can be stated axiomatically. The fundamental value of any game, (the minimax theorem of Von Neumann: $S = \max_{x} \min_{y} XAY = \min_{y} \max_{x} KAY$) leads to the discovery of abstract relationships in the unseen underlying social structure which without the aid of the theory would remain unknown.

Elements of games are universally known. What is less known however is that these elements can be modified so as to make different types of games. Nevertheless by convention any game must contain the following elements:

- The players: they can be individuals, groups, organizations for simple games and structures and even games for complex games.
- The strategies: they describe all possible courses of action for the players. These strategies depend on the evolution of a given game. In simple games the alternatives form a closed system (although a remarkably complex one on occasion) and in complex games they form an open system where surprises become possible.
- A choice of strategy: this is the formal goal of the game which means that given a network of computing moves a certain sequence of a series of choices will provide for a logical collapse into one single equivalent choice (the outcome) that may or may not coincide with players expectations.

These elements are then combined with the axiomatics of the cadre according to the following principles:

- Interdependence of choice: a strategic choice is a function of other players' choices. The interaction of choices produces a logical structure within which paths leading to sure outcomes are to be determined by the theory.
- Inverse relationship of outcome: in any game the strategy of any player effectively limits the strategy of other players to decreasing alternatives. Any move that does not assume this function is irrelevant to the theory.
- Maximization of strategy: by definition and as a corollary of the previous postulate each player seeks to maximize the efficiency of his strategic choices.

3) The Two Levels of Gaming

Once the format of gaming is accepted the question to be asked concerns the axiomatic principles to which different levels of gaming must correspond to account for observable moves. This last question leads to the formulation of axiomatic principles of political games. Viewed from this perspective game theory can be subdivided into two basic categories: functional games in which all the possible moves and payoffs are known in advance and structural games in which moves and payoffs change with the evolution of the game. Traditional game theory consists mostly of the analysis of functional games while a more modern version leads presently to the concept of structural games. Both approaches may be useful for the understanding of politics but structural games aim at a deeper level of analysis where general propositions on the functioning of the political system become possible. These different concepts of game lead to the analysis of successive layers of interaction in a manner germane to an axiomatic definition of reality. As an explanation of politics the game concept is probably able to provide for an accurate description of the inner dynamics of the political system as opposed to an explanation by the visible organization of the system which does not allow at the moment for valuable prediction of future outcomes.

Our hypothesis is that two successive layers of game can account for all possible political interactions. Each layer corresponds to axioms from which theorems can be deduced thus rendering the interactions necessary and therefore predictable. In other words human interactions are game functions, they are not arbitrary, they correspond to an abstract structural necessity. Game theory becomes a model describing the dynamics of politics. Such a model displays the parameters governing the dynamics of the political system. The effects of varying conditions of these parameters can be studied, and experimental results can thereby be expressed by invariant laws.

In our hypothesis, two types of games are postulated.

a) Functional Games

The game is the object of study of standard game theory. The players, the gains and the moves are simple, objectively defined and systematic. The choice of optional strategy is determined by the sequence of choices of pre-fixed positions. Within this format the outcome of action is determined by an equilibrium point of symmetric strategies.

Transposed as vectors on an X-Y ordered plan, these games are characterized by:

Symmetry:	players are equivalent.
Independence:	each player determines his preferred outcome.
Continuity:	similar games will include similar amount of conflict.
Boundedness:	the level of conflict is operational ranging by convention between 0 and 1.
Equivalent reductibility:	the new feasible outcomes will decrease the amount of conflict without affecting the <u>status quo</u> point.[1]

The axiomatization of the standard form of game theory consists of the postulation of combined conditions that determine sub-sets of maximal moves. Here the axiomatic enterprise bears on the characteristics of strategy as opposed to the axiomatics of the cadre which is simply the formalization of the context of strategy. Axioms for game-strategies are not always expressed in a specific manner. Sometimes they are taken for granted. For the purpose of our argument, however, we will render more explicit the axiomatic aspect of the theory.

[1]Robert Axelrod, "Conflict of Interest: An Axiomatic Approach," Journal of Conflict Resolutions, Vol. VI, No. 1, p. 88-91.

b) Structural Games

There has always been some kind of uneasiness about the implementation of game theory in political science. Although it was recognized that there was an analogy between games and politics, few political scientists had an idea on how this analogy could be articulated. In fact the type of games currently analyzed in game theory seem to apply only to very limited occurrences. As a model of politics the theory is in fact reduced to situations which display the following characteristics: 1) a finite material gain (or goal) that can be divided among players; 2) a unique form of tactical moves or choices); 3) a symmetry of players. Very few political occurrences corresponded to this type of game - only situations in which choices were highly institutionalized (small electorates, local market competition) were in fact amenable with some degree of validity to an analysis by games. As a theory of conflict or as a theory of coalition formation the theory had very little to say despite its prowess of delivering a full-scale theory of economics and society.[2]

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[2]A. Rapoport, N-Person Game Theory, Concepts and Applications, (Ann Arbor, The University of Michigan Press, 1970), p. 294.

Also the approach was based on a number of assumptions about game interactions that sounded a bit extreme in political terms - was it true that important problems could be reduced to a win/lose situation? - the theory had an unnerving tendency to go back regularly at the simpler "two-player zero-sum trap" for a reassertion of the minimax theorem which serves as some kind of pillar to the mathematical tractability of the resulting system. In other words the theory was accused of lack of relevance and reductionism. The concept of utility also applied somewhat oddly on big entities such as nations. The assumptions of the theory had to be adjusted if the whole approach was to be more than an artificial reconstruction of situations in which interactions were more complicated than those held by the theory.

Finally the more appropriate concept of metagame emerged[3] in the early '70s. In the new approach the gains, the players, the strategy itself depend on the situtation to be analyzed and are not arbitrarily pre-fixed. What does not change however is the logic of gaming which remains constant.

Over the past 10 years structural game theories have emerged in an attempt to avoid the pitfalls of the standard theory. At the moment

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[3]Nigel Howard, Paradoxes of Rationality: Theory of Games and Political Behaviour (M.I.T. Press, 1971).

several theories of this type are available but those presented by Nigel Howard will be retained here as a basis for our discussion.[4]

The basis of the new approach lies in an implicit postulate of complexity. The idea that a player always seeks to maximize his utility is considered as simplistic. Rationality implies much more than the choice of the alternatives that has the best consequences in terms of gain. This approach which is used most of the time in systems analysis and in economy for descriptive purposes is replaced by a new one in which utility is polyvalent. The problem is that any outcome is determined not by one or two political actors but by the interacting decisions of a good number of actors (persons, groups, institutions, organizations) with different objectives. If each of these actors is playing a different game then the political system becomes a complex network of interacting and overlapping games. In this context we cannot talk about gain as such for this notion has no meaning anymore, we talk about functional gain, that is a gain that confirms the strategic progress of the player (or the actor). Choices become second-order choices that have a functional consequence of fixing other players' choices to one's own advantage. This level of choice is the only one that can sustain successfully life in a complex system. Mere anthropological aspirations such as pressing for the maximization of objective interests may explain political behaviour,

[4]N. Howard, A Dynamic Theory of Games (Faculty of Management Sciences, Univerity of Ottawa, 1975), Working Paper 75-22.

at the level of the daily activities but as soon as the system becomes more complex, substantive goals are replaced by much more complex, subtle and decisive ones.

The second implicit postulate of the theory is that second-level choices are not necessarily conscious. Metagames are in fact immensely complicated processes that require the ability to solve at each instant complex systems of differential equations between a sea of competing choices. Human beings cannot solve these systems with conscious calculus even if their decisions are proven *a posteriori* to be the result of a fantastically complicated synthesis. Clearly human beings are solving the myriads of equations unconsciously. Therefore a theory that addresses itself to the task of deciphering this process cannot be a simple one:

> "In fact, explanations of interacting consciousness may be the hardest of all to follow, as they really involve becoming *self-conscious* to a depth not hitherto achieved in human *experience*. We are dealing, after all, with interactions between the most complex objects (human brains) known to us. Must we suppose that these interactions have to be terribly simple?"[5]

If metagame theory is taken as a political theory, it means that visible political occurrences, choices, developments, changes, surprises are the result of an abstract pre-order made up of functional relations between competing human choices.

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[5]N. Howard, *Prisoner's Dilemma: The "Solution" by General Metagames* (Ottawa University, Faculty of Management sciences, 1975), Working Paper No. 75-24, p. 14.

4) Game Theory as a Model

Game theory concerns the theory of mathematical modelling of opposition situations, that is, those situations in which relevant decisions are a function of partial decisions made by deciders pursuing conflicting goals. The theory is preferably to be used in situations where decisions are made under conditions of incomplete information about the situation.

The theory assumes that players are pursuing some sort of goals. The results of choices toward these goals are imputed a number characterizing the degree of realization of these goals. These choices are not simple however. Each choice proceeds from the presumption that there is a real law, as yet unknown to the decider (player), which leads other players to act in a manner least favourable to him. In such a pattern of interdependent antagonistic choices, decision criteria (usually theorems) are necessary for the selection of maximal strategies. These criteria are not intuitive, they are derived from axioms which in the case consist of necessary conditions to be repeated in an ordering of available acts (or strategies).

Usually the concept of a game is not the central concept of any axiomatic theory. There is still no unified mathematical theory of games. Instead there are a number of relatively connected models of conflictual situations classed more or less as game theories. At the moment separate axiomatics are built for different types of games. These axiomatics in practice are propositional functions which permit the deduction of optimality theorems in situations of ignorance and uncertainty. They permit a transformation of a conflictual situation from one in which no obvious solution is available to one in which choice becomes a decision between weighted risks.

At the moment game theory could be defined as an axiomatic problematics rather than an axiomatic theory of politics. Unlike other pre-axiomatic conceptual schemes, however, this approach can be developed indefinitely both at the level of formal scenarios and mathematical relationships and at the level of empirical testing. The theory also possesses the remarkable possibility of converting itself into a structural theory: in physics and in biology where the theory is used, there is no participation of a subject consciously making decisions.

In those fields the players are structures and the "decisions" consist of the selection of maximized functions. By comparison it could be interesting for political science to develop a game-theoretic version of structural-functional analysis where such functions as integration, adaptation, goal-attainment and pattern maintenance could be conceived as playing a game against their corresponding dysfunction within each subsystem of the political system. For the moment, however, game-theory is well developed for only one class of games: finite two-person zero-sum games. The rest of the field is presently occupied with the building of different types of games and logical and mathematical scenarios for solving these games. In the next section we will concentrate on one major problem as an example of how game theory can be useful in the breakdown of complex situations into their logical constituent parts.

B) CHOICE AS A FUNCTION OF UNKNOWN CHOICES: A GAME-THEORETIC TRANSLATION OF THE PROBLEM

1) The Problem

In Chapter 5, G.L.S. Shackle's choice problematics was summarized. It was suggested that choices made under uncertainty were crucial for the explanation of emerging destabilizing movements within previously stable political systems. It has also been proposed that no easy solution could be found for those situations that somewhat transcended the usual "common-sensical" conception of reason in which a solution is limited to a choice between several options known to the decider. When no clear options exist the "choice structure" of any political system may indeed become unmanageable. For such problems an interpretation of the case in terms of structural logic (axiomatic) may be more appropriate than an analysis conducted on a logical-positivist (inductive) basis. Game theory will therefore be applied in an attempt to examplify its merits as a research method applied to complex problems. It will be shown that game theory can provide -- first -- for an axiomatic conceptual scheme for the problem of choices made under uncertainty and -- second -- for game-theoretic genralizations about choices themselves.

2) R.D. Luce and H. Raiffa's Axiomatics

A conceptual scheme for the analysis of decision-making under uncertainty has beem developed by authors Luce and Raiffa.

In their approach axioms are utilized as necessary conditions that must be met by decision-criteria in the ordering of hypothetical choices made by a decider in a situation of very limited knowledge of the context of decision.

> "The approach used, which will be employed again in the next section, warrants a comment. We first commit ourselves to a class of axioms, thereby restricting the class of potential criteria. Second, we consider a simple class of d. p. u. u.'s for which we feel able to make subjective commitments as to the optimal sets. If our choice of axioms and special cases is clever, then by using the axioms we can logically extend the consistent decisions given for a simple class of d. p. u. u.'s to a precise formula which resolves all d. p. u. u.'s."[6]

The situation is represented by a decider (player 1) facing an adversary (context or player (player 2)) whose decisions are unknown to him. The method assumes that player 1 wants to order his acts on a continuum of possible consequences ranging from the best to the worst. To order his choices, player 1 needs a decision-criteria. Game theory will provide several decision criteria as theorems deduced from a convenient axiomatic scheme.

These theorems will be normative (providing for a solution to player 1) and descriptive (explaining the selection of a particular criterion as a property of choice in a closed system of possibilities).

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[6]Robert Duncan Luce and Howard Raiffa, Games and Decisions (Ch. 13: "Individual decision-making under uncertainty") (New York, John Wiley & Sons, 1966) p. 297. Here d. p. u. u. stands for "decision problem under uncertainty."

The format of the approach consists of an X-Y ordered plane forming a matrix. The points on the Y line represent the unknown choices (or situations) made by the adversary or nature (player 2). Points on the X line represent the possible courses of action open to player 1. To select the best option player 1 can make use of four decision criteria (maximin, minimax, Hurwicz' index and insufficient reason). These criteria evaluate the relative distribution of payoffs that player 1 ascribes to each consequence of each of his acts in the X-Y payoff matrix. The payoffs are all the (x, y) points in the matrix -- that are the resulting values of the intersections of a choice x made by player 1 with all the choices y made by player 2. When player 1 faces an adversary nature each point (x, y) will carry a single number representing the expected payoff of player 1; when nature is replaced by a conscious adversary, each point (x, y) will carry two numbers representing the respective payoffs of both players for each intersection of their choices as shown in the next figure.

	Y Choices →	PLAYER 2			
	X Choices ↓	Y^1	Y^2	Y^3	Y^n
	X^1	(x^1, y^1)	(x^1, y^2)	_ _ _ _	_ _ _ _
PLAYER 1	X^2	(x^2, y^1)	(x^2, y^2)	_ _ _ _	_ _ _ _
	X^3				
	X^n	(x^n, y^1)	_ _ _ _	_ _ _ _	(x^n, y^n)

FIGURE 1: THE PAY OFF MATRIX

Each decisison to be analyzed is represented by this matrix. Choices made by player 2 are hypotheses of all the possible situations or decisions nature or the adversary could put forward. Each one of these possible situations will intersect with the lines (rows) formed by player 1 choices and for each of these intersections (x, y) player 1 will determine a more or less positive outcome for the x and y or for the x only. Once these values are provided for the process of evaluating the situation begins according to an axiomatic rule.

3) Axioms for the Matrix

In the early fifties J.W. Milnor developed a series of axioms for the selection of decision criteria.[7] They could be applied to the payoff matrices utilized to analyse uncertainty problems. Authors R.D. Luce and H. Raiffa have developed and perfected them in chapter 13 of Games and Decisions.[8] They can be divided in three groups -- ordering of acts, domination and permutation:[9]

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[7]J.W. Milnor, Games Against Nature, Research Memorandum RM 679 (The Rand Corporation, Santa Monica, 1951).

[8]R.D. Luce and H. Raiffa, Op. cit. in 6, p. 275-326.

[9]Milnor's axioms are listed in R.D. Luce and H. Raiffa, Ibid., p. 297. They are reported in bold characters in the following three pages.

Ordering of Acts

Axiom 1 - Ordering: "All acts must be completely ordered"

This axiom means that the solution to the problem of a decision made under uncertainty is a sub-set of the set formed by all acts (Xs) as ranked on an optimality continuum. In other words there is a solution in nature that must be approached by ranking all the possible acts. If some possible options are omitted then the utility of the approach will be severely reduced leaving open the possibility of a surprise from player 2 or the possibility of missing an interesting act for player 1.

Axiom 2 - Symmetry: "The ordering is independent of labelling rows and columns"

The ordering of the acts must not be a function of their order in terms of description. The utility of an act must be independent from its empirical definition. The ordering is only a measure of a possible gain under risk. If a definition of an act influences its ordering then the consequences of this act are known. Such a knowledge transforms a situation of uncertainty into one where knowledge forms an intervening factor that defeats the approach.

Axion 3 - Linearity: "The ordering is not changed by linear utility transformation"

This axiom means that the utility scale which is adopted is simply a matter of convention. Whatever the scale, the relative values of the payoffs remain constant for each problem.

Domination

Axiom 4 - Strong domination: "Act A' is preferred to A" if A' strongly dominates A""

An act (X) is dominant if it is stronger or equal to acts found in a sub-set of optimal acts which are stronger than all other acts. This means that acts selected strictly along minimal lines are not necessarily stronger since they can be weaker in terms of payoffs. Depending on the case a clearly dominant act must have precedence over a weakly dominant one. The weakly dominant act can be retained over the strongly dominant if its capacity to minimize risk is decisive.

Axiom 5 - Convexity: "If A' and A" are indifferent in the ordering, then neither A' nor A" is preferred to (1/2 A', 1/2 A")"

If two acts are indifferent or optimal in an ordering, then a randomization of the two will also make a dominant act.

Permutation

Axiom 6 - Row adjunction: "The ordering between old rows is not changed by adding a new row"

This axiom means that an act cannot become optimal by adding new acts to the problem. If the new act is stronger than all others, the previously dominant one will become dominated. If it is weaker it will not displace the dominant one in favour of another.

Axiom 7 - Special row adjunction: "Adding a weakly dominated act does not change the ordering of old acts"

"This illustrates the important assumption implicit in axiom 6, namely, that adding new acts to a decision problem under uncertainty does not alter one's <u>a priori</u> information as to which is the true state of nature."[10]

Axiom 8 - Column linearity: "The ordering is not changed by adding a constant to a column"

This axiom means that the relative values of the payoffs among the columns must remain constant when they are randomized. This axiom places a very severe restriction on the admissibility of certain decision criteria because randomization can change the values of the best/worst payoffs (the maximin criterion) and the average value between the lowest and the highest value for a single act (the Hurwicz index). This axiom applies when a game is a function of a previous game.

Axiom 9 - Column duplication: "Adding an identical column does not change the ordering"

If all repetitious columns are collapsed into single ones then the ordering of acts does not change. This means that repetitious acts made by player 2 do no count.

When the axioms are combined in various proportions decision theorems can be deduced from them. In the literature four of these possible theorems are retained as having a significant value.

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[10] R.D. Luce and H. Raiffa, <u>op. cit</u>., p. 288.

4) Which Criterion Applies Best to Natural Uncertainty?

If the 9 axioms are taken as prerequisites, then certain decision criteria can follow. These criteria constitute the highest possible solution for a decision made under uncertainty:

> A criterion is well-defined if and only if it provides a precise algorithm which, for any d. p. u. u., unambiguously selects the act(s) which is (are) tautologically termed 'optimal according to the criterion.'"[11]

For decisons made under uncertainty, four criteria are proposed. Their purpose is to select the maximum payoff related to the minimum risk for each act on the X line. The different criteria suggest different types of risks.

The Maximin Criterion*

This criterion postualtes that security is inversely proportional to gain. Security will therefore be a function of minimal gain. To obtain a security index player 1 must select the minimum payoff in each row and then order the rows according to their lowest payoff. The row which obtains the highest of the lowest payoffs will be considered as corresponding to the act which can bring in the highest gain for the lowest risk. This criterion, however, cannot apply to all cases because it fails to meet the requirements of axioms 4 and 8. Axiom 4 (Strong domination) states that an act is dominant if it is equal to or stronger than other acts found in a sub-set of optimal acts.

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[11]R.D. Luce and H. Raiffa, quoted in 6, p. 278.

*Decision criteria are theorems.

In such a sub-set, however, player 1 may find some whose payoffs exceed the risk factor. If this is the case there might be more risks involved in avoiding a big gain than in insuring a sure low gain. To avoid such situations, axiom 4 recommends a principle of strong domination for the optimal act. Axiom 8 states that the relative values of the payoffs among columns must remain constant when they are randomized. In the cases where such a randomization changes the relative weights of the lowest payoffs, the criterion will not apply. This means that if the decision problem under uncertainty is a function of another situation in which payoffs are constant then the problem is not amenable to a solution obtained with the maximin criterion.

The Minimax Risk Criterion

This criterion is a variant of the maximin theorem. It is especially useful if one wants to avoid missing a potentially important gain registered for a particular act. Here the risk factor is defined as the amount that must be added to each act in order to equal the highest payoff for that act under each possible choice of player 2. The act which contains the lowest maximum risk is considered to be optional. Some authors suggest that this criterion is not totally valid since it partly fails to meet the requirement of axiom 6 which states that a dominated row (act) cannot become dominant by the addition of a new row. When controlled for each choice of player 2 a dominated row (A_2) can become dominant by the addition of a new row (A_3) as shown in the next matrix of maximum risks:

	S_1	S_2		
A^1	0	6	=	$6 < 8$
A^2	8	0		
+ A^3	5	9	=	$8 < 9$

<u>FIGURE 2</u>: INTERFERING ROW ADJUNCTION = $5 < 6$ in A^1

However if the rule of maximum risk for a row is maintained without any supplementary row being added the minimax theorem satisfies all other axioms.

The Hurwicz Index

This criterion is an attempt to avoid the problem of extreme pessimism in the selection of a dominant act X. The theorem recommends therefore a combination of best and worst payoffs for each act according to a constant inferior to 1. In each row the lowest payoff is multiplied by a constant C and then added to the product (1-C) multiplied by the highest payoff. When the C factor is < 0.5 we obtain an "optimism" index by placing greater emphasis on the highest payoff. For a C factor > 0.5 we have a "pessimism" index by giving a greater role to the lowest payoffs. Once the averages are calculated the row which has the highest outcome is selected as the dominant one. This approach does not satisfy all axioms however. By randomizing the values in each row this criterion cannot produce easily a strongly dominant option (axiom 4). It cannot distinguish either between two acts which are dominant <u>a priori</u> (axiom 5) and finally the randomization of columns (representing player 2's impact on player 1's expectations) may completely transform the averages -- (against the requirements of axiom 8).

The Theorem of "Insufficient reason"

Finally the decision of criteria based on the principle of "insufficient reason" is exposed in the following terms:

> "The criterion of insufficient reason asserts that, if one is 'completely ignorant' as to which state among s_1, s_2 ..., s_n obtains, then one should behave as if they are equally likely. Thus, one is to treat the problem as one of risk with the uniform a priori probability distribution over states, and to each act A_i assign its expected utility index,
>
> $$\frac{u_{i1} + u_{i2} + \dots + u_{in}}{n},$$
>
> and choose the act with the largest index."[12]

This theorem applies best in cases where uncertainty is absolute. When there is absolutely no means by which the adversary choices can be asserted then the only alternative is to add all expected payoffs registered under each act (of player 1 as influenced by each act of player 2) in order to make an average. This theorem satisfies all the axioms.

5) Commentary

The matrix axiomatics offered by Luce and Raiffa serves as a rule of relational logic for the selection of a binding algorithm in the solution of a decision made under uncertainty. The implicit assumption a theoretician can make is that in those situations the logic of the choice structure is binding for player 1. Interconnections between choices and the permutation of these interconnections refer to the existence of an underlying mathematical structure of human behaviour which is made more complex than observable behaviour and which entails a

[12] R.D. Luce and H. Raiffa, Ibid., p. 284.

problematics that differs in its principle from any solution that could have been proposed on an a priori level of inductive analysis. A contingent choice made at the level of empirical evidence is simply a limited case of the permutation of all possibilities as described by game-theory. Inductive observation tends to short-circuit the problem of permutation of possibilities. As in other cases in science the limits of inductive approach become more evident with certain problems. The problem of choice as a function of uncertain choices is therefore very useful by providing an opportunity to describe the complex structure of choice as a function of choice. In such a structure, choice becomes a function of axiomatic properties of the system and will itself display some game-theoretic properties as will be seen in the next section.

C) THE GAME-THEORETIC DERIVATION OF THE ROLE OF UNCERTAINTY IN POLITICS

What happens if we bring certain game concepts in line with axioms bearing on the role of uncertainty in politics? Here political uncertainty becomes the analytic operator of game theory considered as an axiomatic theory of interaction of choices in generalized form. The theory should permit us the deduction of theorems compatible with observable occurrences. Quite clearly these axioms do not pretend to exhaust the range of axiomatic formulations, other axioms could bear as well on the players, the moves, the gains, etc. By concentrating on one aspect of the players that is considered important by hypothesis, it is however possible to derive general principles.*

*The following four principles consist of generalizations of effects of decision criteria for different types of decisions made under uncertainty.

1) The Security Principle

Uncertainty in games is typical of players that interact for the first time and do not know anything about each other. In extreme cases the problem would be greatly increased if the players had very little means to communicate with each other coming from different socio-cultural backgrouds and even talking different languages. In terms of game theory, the role of uncertainty in an Interaction of players is shown as follows. First, we exhibit the classical "prisoners' dilemma,"

	COOPERATE	DEFECT
COOPERATE	3,3	1,4
DEFECT	4,1	2,2

FIGURE 3: TWO-PERSON PRISONERS' DILEMMA

"Each player (Row-chooser and Column-chooser) chooses one of the two generalized strategies 'Cooperate' or 'Defect'. These choices determine a cell, the first number in which represents Row's 'payoff', the second one, Column's 'payoff' - higher 'payoffs' being preferred. (Note that payoffs are ordinal. Thus the model is non-quantitative; any ordered symbols - e.g. 'a, b, c, d, d' - would do in place of the payoff numbers used.)"[13]

Here the consequences of choice depend on the choice made by the other player. In a normal game situation, the rational choice would depend on a more or less precise knowledge of the other's choice. The absence of any such knowledge in the prisoner's dilemma makes for a special case. Here the "defect" strategy is the most rational outcome for both players because it is the only choice that does not require a knowledge of the other's choice to guarantee a minimal gain.

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[13] N. Howard, The Game-Theoretic Breakdown of Rationality (University of Ottawa, Faculty of Management Sciences, 1976), Working Paper No. 76-6, p. 13.

By defecting each player has either an advantage (4,1) or at least equality (2=2) while cooperation entails a possible trap (1,4).

This situation also means that the principle of maximization of utility cannot serve as a basic principle of behaviour to the extent that utility is dependent on others' choices to be attained. The formal goal of controlling others' possible choices takes precedence over the substantive goal of reaching a gain. To be valid there should be as little clues as possible in the situation that would permit an indirect but valid assessment of the other players intentions. To the extent that indirect knowledge is possible the principle of "security" would not apply. But to the extent that the principle applies it can be formulated in the following manner.

The Security Principle

"This is the assertion that, with non-existing or insufficient information on the possibilities of a context or on other's intentions, actions tend toward the safest average of expected outcomes. If the adversary (player 2) is nature the theorem of insufficient reason will select the act that has the greatest average of outcomes since each possible situation determined by player 2 will be considered as having an identical risk value. If the adversary is a conscious player the maximin theorem will select the act of the best worst payoff. In a "prisoners' dilemma" juncture the best worst payoff will correspond to acts of defection."[14] The principle of security is a game-theoretic (as opposed

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[14] "The Nash solution serves as a justification for supposing that two rational decision makers converge to the equilibrium of a noncooperative game if, for example, this equilibrium is unique. The Prisoners' Dilemma is thus solvable in the Nash sense." William H. Riker and Peter C. Ordeshook, An introduction to positive political theory (Englewood Cliffs, N.J., Prentice Hall, 1973), p. 225.

to empirical) property of decisions made under uncertainty. It can serve as a principle justifying divisions and boundaries of all sorts. A human being from a given culture is at a logical disadvantage in assessing the intentions of a player from another culture. We can therefore propose he principle of security as a "choice-pattern" cause of human division as explained by game theory. A similar situation may occur in an already existing gaming area (a society in observable terms) when there is anomie. The breakdown of consensual definition of reality will equally bring a dissociation of the players resulting in social chaos. Knowledge is therefore an essential prerequisite for the integration of players understood in game theoretic terms. But knowledge cannot be added from the exterior of a game - like the rest it is a function of gaming. Since knowledge cannot result from a primal game that is never played it can only result from a metagame in which it will serve a function of sanction on players intentions.

2) The Domination Principle

A concept of hypergame has been developed by British professor Peter G. Bennett, along concepts of metagames developed by authors Nigel Howard and Steven J. Brams.[15] Bennett proposes a first metagame solution to the problem of uncertainty. In his definition of what he calls the "hypergame," uncertainty is the result of a player's perception and speculation on adversaries' choices as a result of the internal

[7]P.G. Bennett, "Hypergrames: Developing a Model of Conflict," Futures, Vol. 12, No. 6, December 1980, p. 489-508.

coherence of his own strategy. The assessment of other players intentions (in the absence of any communication from them) is rendered possible by the evaluation of their probable objective capacity to adjust to certain strategic moves the first player has the intention to initiate. This approach (which reduces knowledge to logistical components) effectively sanctions the non-cooperative intentions of other players by a realistic appreciation of the type of moves to which the other players are the least likely to resist - either because they would agree with it as meeting their own needs or because they would not be able to put up an appropriate defence.

If other players intend to reply, then their own assessment of the first player's intentions will be similar - his intentions will be "weighted" to his possible logistical reactions.[16]

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[16]Bennett describes the situation as follows on page 494 of "Hypergames" as quoted in 7:

Definition: a simple n-person hypergame is a system consisting of:

(i) A set N, of n elements;

(ii) For each p, q in N, a non-empty finite set S_{qp} (there are n^2 such sets in all);

(iii) For each p, q in N, an ordering relationship $>_{qp}$, defined over the product space $\Pi_q \; {}_N(S_{pp}) \in$ [ie ($S_{qp} \times S_{pp} \times S_{rp} \ldots$), denoted S_{Np})].

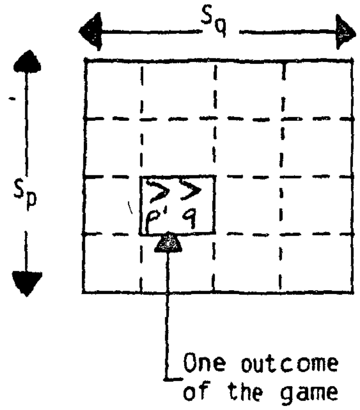
Interpetation: the elements of N are the players of the hypergame.

S_{qp} is the set of strategies for player q, as perceived by player p. $>_{qp}$ expresses qu's preference ordering, as perceived by p: this is defined for those outcomes that p sees - ie over his perceptual strategy space. (Thus $s >_{qp} t$ means 'p believes q prefers s to t'.)

The graphic representation of the theory includes:

FIGURE 4

a) The Basic Hypergame



p, q are the players

S_p represents p's strategy set

S_q represents q's strategy set

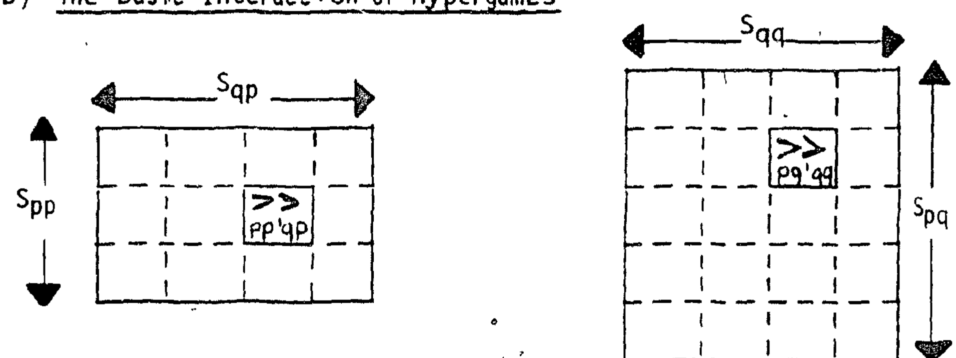
$>_p$ is p's preference for each outcome (one outcome 'cell' is shown)

$>_q$ similarly denotes q's preference

The structure of a two-player game (matrix representation)

FIGURE 5

b) The Basic Interaction of Hypergames



Player p's game:
S_{pp} (= S_p) is p's perception of his own strategy set
S_{qp} is p's perception of q's strategy set
Each outcome 'cell' contains an expression of p's preference for that outcome, $>_{pp}$ (= $_p$) and his perception of q's preference, $>_{qp}$

Player q's game:
S_{pq} is q's perception of p's strategy set
S_{qq} (= S_q) is q's perception of his own strategy set
Each outcome 'cell' contains an expression of q's perception of p's preference for that outcome $>_{pq}$, and his own preference $_{qq}$ (= $>_q$)*

*P.G. Bennet,, "Hypergames, p. 493-494.

Among possible developments, this approach can lead to the development of an "extra" strategy. This means that taking for granted that the opponent has a simple non-knowledge view of the situation, he will be taken advantage of by a player using a hypergame approach. Going back to the prisoner's dilemma problem, the situation would be the following:

	COOPERATE	DEFECT
COOPERATE	3,3	1,4
DEFECT	4,1	2,2
SURPRISE ATTACK	5,0	3,2

FIGURE 6: THE PRISONERS' DILEMMA HYPERGAME

Figures in cells represent ordinal preferences. Those of the first player (playing the hypergame) are shown first in each cell. Preferred outcomes are assigned higher number. Stable outcomes are circled. The first player assuming that the rational outcome of (2,2) is the one chosen by the opponent can expect a sure advantage (3,2) as a result of his unexpected move.[17]

If this game theoretic outcome of asymmetric knowledge is accepted then another principle of political behaviour again becomes possible.

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[17]Such a move in the context of a classical prisoners' dilemma opposing two suspects locked up in separate cells for a crime they are accused of jointly committing can take the form of a unilateral denunciation of his colleague by one prisoner as having committed the crime alone.

The Domination Principle

"This is the assertion that, in contexts where players' conceptions of a game become subordinated to a single player's superior strategic approach, the solution selected by the dominated player under uncertainty will lead him into a trap. The force of the hypergame solution consists of having the other player taken at fault in his conception of the game. By not having listed all the moves, the dominated player does not respect the first axiom for decisions taken under uncertainty."

These propositions may be verified against any open conflict that can be found. What is more interesting however, is the resulting creation of an oligarchical Process as a result of cumulation of hypergame conflicts. The process thus depicted could account for the creation of power blocks within as well as in between political systems. A variant of the theory could be that given strategic and tactical advantage a system may change from metagame to hypergame thereby artificially defining its intended prey as opponents. This process would explain why peace cannot be considered as a basic postulate of political dynamics for the simple reason that it offers no sure compensation to players who have a strategic advantage. The persistence of antagonist ideologies may be explained as the result of the same process: they are rationalizations of hypergames. And finally this hypergame dynamics may explain why politics has a "horror of the void" - those who have an advantage have no reason to refrain from using it (except ethical ones) and will naturally infiltrate other players' games along lines of least resistance.

As an historical determinism the hypergame may also explain the conflicts opposing social structures (social classes, ethnic conflicts, etc.) as a result of the same logic. The hypergame presents the immense advantage of guaranteeing sure outcomes by sanctioning opponents preferred alternatives. Therefore a great number of political interactions can be accounted for that way.

3) The Cooperation Principle

Finally, the problem of political interaction can be solved by the strategic interdependence of would-be-players. This process is to be understood in game-theoretic terms that will lead to the creation of a metagame that corresponds to existing normative systems as game sanctions of non-cooperative behaviour. In order to establish an operational strategic interdependence between players, the problem can be constructed in the following manner: assuming an original prisoner's dilemma case where defect (D,D) was the rational outcome (the unique point at which each player was optimizing against the other's choice) what would be the required level of gaming that would guarantee cooperation (CC) as the most rational outcome? According to Howard this will occur only at a second level metagame - the first metagame consisting of a bargaining on intentions and the second one of commitments on these intentions.

Here is how Howard determines a metagame of the prisoners' dilemma:

Player 2's commitments

Player 1's commitments		C	D	C	D
	C	3,3	1,4	3,3	1,4
	D	4,1	2,2	3,3	1,4
	C	3,3	1,4	3,3	1,4
	D	4,1	2,2	4,1	2,2

FIGURE 7: FULL METAGAME OF PRISONERS' DILEMMA IN PARTITION FORM

Each player first chooses a commitment. This determines a subgame, which is then played. A metastrategy for player 1 is a choice of one cell in each column such that: (a) all cells chosen belong to a single 1-commitment; (b) all cells chosen that belong to a single 2-commitment belong to a single 1-strategy (row). Circled cells show a metastrategy of player 1 that makes (3,3) rational (optimizing) for 2. Diamonded cells show a 2-metastrategy that makes (3,3) - in a different place - rational (optimizing) for 1. Yet (3,3) is nowhere an equilibrium![18]

In order to make CC a metaequilibrium of the metagame at (3,3), the players must reach a level of a full metagame of the full metagame which represents a higher level of perfect communication. There the

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[18] N. Howard, Prisoner's Dilemma: The "Solution" by General Metagames. Quoted in 5, p. 8.

players will make metacommitments on their basic commitments as well as on how they will choose to respond to others' choice of a basic commitment. Such a game is further removed from the game reported above. In such a meta game cooperation becomes possible on any one of the expressed commitments as a result of (3,3) being the metaequilibrium of the system. In practical terms this means that minimal consensus required for entering an interaction in which cooperation is the natural outcome cannot be reached until a very complex machinery capable of asserting the players' commitments has been set up. In the metagame of the metagame in which this equilibrium is reached CC is a symmetric equilibrium against all other possibilities sanctioned by the players' threat to play D. "An equilibrium is a point from which no player can move, while the other's strategies are fixed to a preferred outcome."[19]

Then from these game theoretic considerations we can derive a cooperation principle.

The Cooperation Principle

"This is the assertion that, in cases where information on others' choices is a function of a symmetric and interdependent strategic conceptions of the game, cooperative behaviour corresponds to maximum payoffs for minimized risks."

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[19] Ibid., p. 16.

4) The Principle of Conditional Cooperation

As an alternative to Nigel Howard's metagame cooperation scenario, Steven Brams proposes a more pragmatic approach to decision-making under uncertainty for two opposing players in the process of evaluating a potential cooperative equilibrium point between their opposing strategies.[20] The choice rule of conditional cooperation assumes that a second-level metagame is unnecessary when there is a first-level (or "leader") metagame which gives the follower a motive to cooperate against the leader's tit-for-tat[21] conditional strategy.

In this type of game one of the two players (assuming a prisoners' dilemma case) has proposed a conditional cooperation to the other if they would ever get caught (or to be more general if a situation arose in which commitments would have to be reached separately under the menace of circumstances). The game becomes one where cooperation depends on the knowledge each player has of the other player's capacity to predict his own strategy choice:

> "Then, however the players become aware of each other's powers of prediction, prediction probabilities that satisfy the previous inequalities are sufficient to protect the players against either's reneging on an agreement that is reached.

[20] Steven J. Brams, Paradoxes in Politics: An Introduction to the Nonobvious in Political Science, Ch. 8 "A Paradox of Prediction" (New York, The Free Press, 1976), p. 193-213.

[21] Tit-for-Tat: the leader plays C when the follower plays C and D when he plays D.

For given that each player knows that the other player's probability of predicting his own strategy choice is sufficiently high, he knows that he probably cannot 'get away with' a sudden switch in his strategy choice in the play of the game, because this move will already have been anticipated with a high probability in the preplay phase."[22]

If in a pre-play phase of the game, players become convinced that their later choices are predictable to a sufficiently high degree, they will select a cooperation course as the more advantageous. Here probabilities of correct prediction serve as parameters for the metagame solution of the prisoners' dilemma. The "choice rule" is a conditional strategy within a metagame. It proposes a game-theoretic formulation of trust in human transactions. Returning to player 1 in the prisoners' dilemma, his dominant strategy which was to choose defection as a sure minimax outcome will be replaced by a maximal utility strategy of cooperation to the extent he will consider player 2's capacity of predicting his own cooperative behaviour as sufficiently high.

In matrix form the case is the following:

		PLAYER 2	
		Predicts C	Predicts D
PLAYER 1	C	X_2	X_4
	D	X_1	X_3

FIGURE 8: Player 1 ordinal preferences in a non-cooperative game subjected to sanction by correct predictions by player 2.

[22]Steven J. Brams, Ibid., p. 209.

According to Brams: "if p. is the subjective probability that player 1 believes player 2's prediction about his strategy choice will be correct, then the expected - utility principle would prescribe that player 1 should choose strategy C if

$$X_2p + X_4 (1-p) > X_1 (1-p) + X_3p."[23]$$

Here the dilemma for player 1 is that although he would prefer strategy D and outcome X_1, the fact that he knows that this strategy would be sanctioned by prediction of player 2 (leading to X_3) makes him stick to strategy C as being both the one leading to the best outcome and the one which is the most predicted by player 2.

If this scheme is accepted as representative of underlying choice permutations existing in this particular case of decision-making under uncertainty, we therefore can propose the existence of a fourth principle as being an abstract intervening factor in human affairs.

The Conditional Cooperation Principle

"This is the assertion that, in systems of decision-making under uncertainty opposing conscious players, if cooperative behaviour is a function of the capacity of other players to predict such a behaviour, the outcome will correspond to the equilibirum point of each player's maximin."

This principle may serve as a justification of the institutionalizing process occurring in society and in political systems.

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[23]Steven J. Brams, Ibid., p. 203, Brams' terminology has been slightly changed here to correspond to that used in the previous examples.

Norms, values and beliefs systems can be seen as the outward expression (as well as the symbolic expression) of a process of meta-commitment consisting of the accumulation of millions of decisions in a given territory within a given time-span. Government itself can be seen as the ultimate embodiment of a process of cooperative meta-commitments. The capacity of a government to predict a certain type of cooperative behaviour entrenching that behaviour as the conventional norm of society.

CONCLUSION

From a review of the possibilities offered by game theory it is possible to conclude as to the axiomatic character of this approach. In the words of a founder of the theory:

> "The appearance of novel and complicated notions is due to a mathematical analysis that is germane to the subject matter and has nothing to do with any ideological or other conception of society. The mathematical analysis unravels implications of some generally accepted facts and observations, axiomatically stated, and then leads via the fundamental minimax theorem to the discovery of relationships in the empirically given social world which without the aid of the new theory have either escaped notice altogether or were at best only vaguely and qualitatively described."[24]

Game theory corresponds to the spirit of a science based on structural logic rather than on empirical generalizations of series of facts obtained by inductive analysis. Causality in this approach is not contingent, but structural (abstract-structural) -- consisting of a

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[24] Oskar Morgenstern, "Game Theory." Dictionary of the History of Ideas (New York, Charles Scribner's Sons, 1973), Vol. II, p. 271.

necessary iteration pattern that can be abstracted from matrices of choice intersections. This iteration takes the form of an algorithm amenable to algebraic representation. When translated in empirical terms it corresponds to principles governing reality.[25] This manner of explaining reality through the properties of its underlying logical skeleton is entirely new and identical to the structural-axiomatic approach used in modern theoretical physics. From axioms theorems are derived that lead to testable principles (or consequences) in observable reality. Game theory points to the existence of abstract events underlying the visible socio-political reality. These events (essentially permutations of choices) cannot be understood in empricial terms -- or at least not as well as with an approach made of mathematical combinatorics. The complexity of the structure is simply too great to be amenable to description by usual means. From an interpretation of underlying factors of the political system, a researcher can explain standards of behaviour as consequences of strategic algorithms rather than as results of contingent factors involved in the surrounding situation.

Game theory offers a more advanced type of theory and its problematics is more in tune with the complex political situation that has resulted from the modernization process. Instead of postulating a principle of indefinite (and possibly infinite) process of development

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[25] Principles similar to those described in this chapter can be found in chapter 10 of: William H. Riker, The Theory of Political Coalitions (New Haven, Yale University Press, 1962), p. 211-243.

and technologization. Game theory postulates at a somewhat deeper level that reality is in a perpetual state of quasi-disequilibrium.

Resembling quantum theory in its problematics game theory views reality through a set of new concepts which open new fields of investigations. The breakdown of reality into its game theoretic components examplifies a nature which is infinitely more complex and permutable than one could have imagined. Any human decision -- when observed from the side of its logical components -- is much more complex than the subject himself would have thought -- each choice being the end result of mathematical relations between all possible choices in each case. This complexity is at the same time a factor of instability. At the moment the theory is able to discern that social organizations may have no stable sets -- a fully symmetric arrangement (like democracy itself) is conducive to asymmetric developments through a coalition-formation process and social and political institutions being unable to integrate all factors in a manner satisfying a game-theoretic control algorithm. This last problem having been mostly developed by Milnor (for decision-making under uncertainty) and by Arrow (for electorally representative system). Reality in the perspective of game theory is therefore in a perpetual state of relative flux starting from a group of invariant relations. Like quantum theory once again game theory postulates the existence of an indeterminism the parameters of which are invariant.

One of the difficulties of game theory, however, is that the new concepts, language and problematics which are proposed are still considered more as heuristic devices (or techniques) than as elements for a more modern model of the political system. Despite the much superior formalism of the approach there is some hesitancy in using it for a re-interpretation of the structural-functional approach for example. If behaviour is a function of an iteration process in a reality conceived as a network of intersecting and interlocking choices then normally the major processes of the system (adaptation, integration, pattern--maintenance and goal-attainment) could be conceived as clusters of iteration patterns. If a correlation could be made between each of these functions and each of the basic choice-games described in this chapter (game, meta-game, hypergame and conditional cooperation) then we should reach a better understanding of the inner dynamics of the political system and possibly a core of logically invariant relationships serving as a necessary pre-order of the political life. Visible occurrences and developments could then be interpreted as necessary consequences of a binding inner logic of the system. It is our conclusion therefore that the superior logic of game theory, its more advanced problematics and its potential as a model of the political system are compatible with the implementation of the structural axiomatic method in political science.

CONCLUSION: A JUSTIFICATION OF AXIOMATIC METHOD

Problematics

Physics has traditionally been a source for the understanding of scientfic method. From classical physics scientists of many disciplines including the social sciences have gathered a sound understanding of the inductive-empirical method and have applied it with a reasonable amount of success. Unfortunately the axiomatic method as developed in modern physics and as exposed by Albert Einstein has not received any amount of particular interest in the scientific community. In fact few scientists outside the field of theoretical physics seem to be aware that the theories of modern physics result from the application of a new method. The consequence of this neglect is an incomplete understanding of the process of theory-building. The axiomatic method is more than a technique for data gathering, it is a logical strategy set up for the purpose of scientific theorizing. The idea behind it is that theory cannot result from the simple addition of facts or from an explanation linking facts together - theory implies more than that.

As an approach to theory-building the axiomatic method proposes a program that differs in many aspects from the actual approach. This program can be summarized in the following points:

- Generalizations of observed patterns of facts are very difficult to prove. In nature, the exact repetition of a conjunction of factors happens very rarely. The reason is that the number of conjunctions that can result from the permutation of factors involved in a single conjunction is very high. An observed occurrence is only a particular arrangement among a great number that could have occurred. To generalize this particular arrangement in a universal pattern is consequently unjustified.

- Factual behaviour is the result of a logical pre-order. Modern physics postulates the existence of logical pre-conditions of action in nature. Observed occurrences simply correspond to a pre-established pattern.

- Observed factors are structurally interrelated at an underlying level. Unseen connections between observable variables are decisive and form a tightly-knit structure.

In the axiomatic approach facts serve as symptoms of patterns of underlying relations and the axiomatic method serves as some sort of logical radar that seems to position these patterns by having them correspond to a necessary pre-order of the observable patterns. The assumption is that the real cause of events is somewhat below the surface in an arrangement of things corresponding to a necessary logic.

These arguments are new. They do not correspond exactly to current assumptions. They are somewhat more difficult to accept for social scientists due to the implicit determinism they propose. The question therefore is why should social sciences' facts behave like facts in modern physics? After all they are "human facts" which means they are relatively independent from deterministic schemes. In a sense the objection is understandable by current standards but is inconceivable by axiomatic standards. The axiomatic method maintains that facts cannot control the structure of events. They are controlled by it and if human liberty exists it is simply as the symptom of a complex structure - it is not decisive by itself, it is simply another way of carrying logical necessity.

What is important to understand is that in structural terms human liberty complies with a tightly-knit pattern of conditions of action that cannot be changed by the individual player. Each human being is subordinated consciously and unconsciously to far-reaching normative systems that tell him who he is an what he is allowed to do and even to think. This range of action is further restricted by conjunctions of surrounding factors (ecological, demographic, economic, technical, social and political) that are understandable in structural terms. The interaction of these patterns accounts surely for observed behaviour and the subjective impression of free choice. As a science of the pre-order of reality or the pre-conditions of action acting as autonomous sytems the axiomatic method in the social sciences can understand human behaviour (can also justify it) by an adaptation of the individual player to the strategy of the system in which he is - if he does not conform to this strategy, his action will fail for the strategy accounts for the necessary logic operating within a given human system.

We can assume therefore that given a margin of trial and error the conscious individual player will orient his individual behaviour on a course pre-determined by structural conditions of action if he wants results. Patterns formed by his own behaviour become symptoms of this underlying logic and permit for an axiomatic mode of thinking to take place. An analogy with chess may be helpful here: rules governing the pawn are simply a cadre within which strategies will take place - in facts the visible rules do not matter very much, what matters is the mathematical structure of the permutation of pawns that explains moves as necessary. In a similar manner the visible rules governing human action do not matter very much, they simply form a cadre within which action corresponds to a strategy of the system that transcends singular choices. Historical events and political events are better understood if we postulate that political sytems play a game of their own that transcends the singular choices of individuals. It is not only a question of statistical aggregation of individual choices it is also the hypothesis that collective patterns of human actions correspond to a necessary logic.

Once this perspective is understood the remaining task is to disover the structure of underlying necessity at work in human systems. Postulates that held for a science of behaviour limited to an analysis of the contingent conditions of action do not apply anymore. The problem facing the theorist at that point is an ominous one - he has to postulate the existence of an unseen pattern and his method for describing it consists of a puzzle of this pattern in which the pieces will fall together as corresponding to the simplest laws linking these pieces together in order to form a necessary pre-order of the observed patterns. From a science of observation method becomes a science of imagination of abstract patterns conceived as a pre-order of reality. Science becomes a bit of a logical game. The scientist can build up as many algorithms as he wants, those that will be retained are those which will best correspond to the observed patterns (conceived as consequences of the necessary logic proposed in the model).

If this program is accepted as another way of looking at things then modern physics becomes important because it describes precisely how this method was applied. It serves as a chart of what to do and what can be expected. Again the fact that this method is based on formal logic as an analytic epistemology must not be forgotten. The rules of high level theorizing are not based on substantive reality as in inductive modes of analysis but on a reality reinterpreted as a system of logic in which facts are simply reference points. As a system of logic it is a general method for the interpretation of facts. Obviously the models created for political analysis will not be those created for the analysis of particles behaviour but will have in common with models of theoretical physics the fact that they are set up by means of axiomatic logic. In the pages that follow we will review the axiomatic program in physics and conclude as to the possibilities political science may have to borrow from it.

A) Factual Logic

1) Conjunctions and Sequences of Facts

The strategy of axiomatic method rests on a new understanding of factual aspects of reality. This new concept has led to the rejection of inductive-based generalizations as a method for theory-building. Briefly stated the principle is the following: "factual sequences are purely accidental."[1] In other words no necessary connections can be derived from contingent interaction of facts. Contingent interaction as a given state of affairs can be reported as such and this type of case-by-case analysis is the one that is traditionally performed in political science. But from these interactions we cannot conclude as to their universality. If in a given conjunction of facts we find that 7 factors bear on a given occurrence, the chances that this same pattern occurs again exactly as it was observed are 1 in 5040 possibilities. This means that a permutation of 7 factors can create 5040 different conjunctions. It also means that visible reality is not representative of all the cases that can be obtained by all the possible arrangemets of factors involved. This accidental character of events means that generalization from a particular situation, or in other words an assessment as to its

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[1] W.F. Bynum, Dictionary of the history of science (Princeton University Press, New Jersey, 1981), "Laws," p. 230.

universality runs strictly against the odds. A second consequence of this paradox is that regression of factors bearing on a single occurrence will further decrease the capacity for generalization - at factor 10 the number of possible arrangements is above the two million mark. In experimental physics the control of accidental factors is obtained by the use of high-level technology. If a scientist simply assumes that the sequence of facts is identical to the conjunction of these facts then he is reifying the observed reality (which is a singular case in logical terms) into a natural law that leads to contradictions with future observations.

The necessity to distinguish which element in an accidental sequence forms a necessary cause led to the idea that some forms of unseen connections could exist between factors. The new approach postulates the existence of an ontological distinction between scientific laws and patterns of events. It makes for a transcendental realist system where laws are tendencies of abstract mechanisms which are exercised without necessarily being manifest in particular outcomes. Conjunctions of factors become mere symptoms of underlying control systems. The apparent order of the visible reality (despite the chronic accidentality of facts) is attributed to the presence of relational control patterns.

Since we cannot directly observe these control mechanisms, their functioning has to be expressed in terms of a control algorithm. It is an axiomatic procedure representing functional relationships in the controlling variables which can be linked to the stability of a given outcome. The algorithmic constant becomes the necessary cause of the outcome. The algorithm is the imaginary reference input of a conjunction of factors analytically conceived as forming a control system. The value of this input determines the outcome.

The axiomatic approach therefore proposes a new solution to the problem of unpredictability of facts. Since an exact analysis of their interaction will never reveal anything more than contingent causality, the only solution left is to locate necessary causality in formal patterns, as pre-condition for observed occurrences.

The traditional empirical position is that repeated conjunctions of events replace the necessary causality that could be attained if necessary connections in nature were knowable. In fact the axiomatic theorist is bringing a new method that gives access to necessary connections and renders the explanation by repeated conjunction of facts, an artificial way of building general theory. Necessary connections are no longer in visible events but in mechanisms generating them.

2) The Search for the Axiomatic Structure

Axiomatic science proposes a more interesting approach than trying to predict from an uncertain basis. What is proposed is a deep understanding of reality that makes observable events the consequence of a necessary abstract structure.

In axiomatic operationalism, the material facts are not the fundamental objects of scientific research. Instead the approach concentrates on hypothetical abstract events, on interaction of unseen properties that are reflected in the visible occurrences. Even if visible facts retain their character of being the terms of the relations, the new relations imply a deeper interdependence of the facts than the one revealed by contingent interaction. The relations as defined by axiomatics embody rational principles. Relations form a relatively independent system that guide the facts. The theory becomes a rationalistic interpretation of reality:

> "Although it is true that it is the goal of science to discover rules which permit the association and foretelling of facts, this is not its only aim. It also seeks to reduce the connections discovered to the smallest possible number of mutually independent conceptual elements. It is in this striving after the rational unification of the manifold that it encounters its greatest successes, even though it is precisely this attempt which causes it to run the greatest risk of falling prey to illusions. But who- ever has undergone the intense experience of successful advances made in this domain, is moved by profound reverence for the rationality made manifest in existence."[2]

For Einstein, no inductive method can lead to the fundamental concepts of physics. "Logical thinking is necessarily deductive; it is based upon hypothetical concepts and axioms.[3] The formal-logical content is a concrete consequence of axiomatic principles.

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[2]A. Einstein, Ideas and Opinions (N.Y., Dell Publ. 1954), p. 49.

[3]A. Einstein, Out of my later years (N.Y., Wisdom Library, 1950), p. 76-77.

Einstein repeated on many occasions that the axiomatic basis of theoretical physics had to be freely invented. This freedom was controlled a posteriori by comparing the consequences of the theory with actual occurrences. For Einstein axiomatic theorizing was somehow the equivalent of a crossword puzzle. Any concept could be proposed as a solution but there was only one that could fit the puzzle in all arts. The "puzzle" consists of abstract properties that satisfy the logical requisites of a pre-order. In Einsteinian physics these properties form a four-dimensional continuum.

> "If we postulate a Riemannian metric and try to find the simplest laws such a scheme can satisfy we arrive at a relativistic theory of gravitation - if in this continuum we assume an anti-symmetrical tensor field and ask again the simplest laws which such a field can satisfy we arrive at Maxwell's equations for empty space."[4]

In computer terms the axiomatic model is a "language" within which the axiomatic principles form different possible programs.

In the science of Albert Einstein the hypothetical structure of space-time is his scientific object of knowledge. It is the physical relatedness behind the physical object of knowledge. This structure remains invariant for all physical objects which are chosen as reference points for the empirical measurement of the experimental physicist. In fact the world we see becomes a function within the theory:

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[4]F.S.C. Northrop, "Einstein's conception of knowledge," in F.A. Schilpp, ed., Albert Einstein Philosopher and Scientist, op. cit., p. 135.

"The idea of invariance is the nucleus of the theory of relativity. To the layman, and sometimes to the philosopher, this theory represents quite the contrary, a set of laws which allow for variability from one observer to another. This one-sided conception is linguistically implied by the word relativity which does not characterize the theory as centrally as it should. The true state of affairs can be seen when attention is directed to the aforementioned postulate of objectivity which required that the basic laws (the differential equations of highest order used in description of reality) shall be invariant with respect to certain transformations. From this the variability, or relativity, of detailed observations may be shown to follow as a logical consequence. To give a simple example: the basic laws of electro-dynamics involve the speed of light, C. If these laws are to be invariant, C must be constant. But the constancy of C in different inertial systems requires that moving objects contract, that moving clocks be retarded, that there be no universal simultaneity, and so forth. To achieve objectivity of basic description, the theory must confer relativity upon the domain of immediate observations. In philosophic discussions too much emphasis has been placed upon the incidental consequence, doubtless because the spectacular tests of the theory involve this consequence."[5]

Therefore axiomatic causal laws consist of the laws to which the axiomatic conceptual scheme as a control mechanism must corresp ond in order to explain observed empirical consequences. Therefore there are several steps involved in the creation of an axiomatic theory.

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[5] Henry Margenau, "Einstein's Conception of Reality," in P.A. Schilpp, Albert Einstein Philosopher and Scientist, op. cit. p. 254.

The axiomatic method then proposes a new problem for science. It rejects cumulation of the facts of experience in an attempt to predict further occurrences as the unique possible accomplishment for science. It proposes instead the discovery of a single system of principles from which all visible occurrences could be explained by transformation of the original proposition. This theoretically designated conceptual system is not an abstraction from purely empirical, positivistic immediacy nor can it be logically deduced from it either. The understanding of empirical reality must come from within as the result of a built-in body of autonomous axioms. The axiomatic program in science amounts to the following elements:

"1) The reality which is the ultimate end of science is a simplest possible system of thought which can unify the observed facts.

2) This conceptual apparatus grasps reality independently of being observed. It has a 'being' as does the 'reality' which it grasps.

3) This conceptual system is at the same time a model of reality which represents things as they are in themselves.

5) This conceptual system does not stop at mere knowledge of ensembles of things but grasps things themselves.

6) It is reasonable to think that this reality can be grasped in all its depths."[6]

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[6] J.F. Kiley, Einstein and Aquinas: a rapprochment (The Hague, M. Mithoff, 1969), p. 55-56.

B) Consequences for the Future of Method in Political Science

The major consequence of axiomatic method for political science consists of the introduction of a new problematics. Instead of generalizing conjunctions of facts described by inductive analysis the axiomatic method proposes that we explain visible behaviour by the existence of hypothetical formal patterns underlying the visible political system. The reasons for doing so are - first that the postulate of generalization of inductive observations is over-optimistic and - second that an explanation by a formal sub-structure illuminates the area of political knowledge in greater depths and is capable of offering prediction in quasi-deterministic terms as a consequence of a self-evident system of logic.

The implementation of such an approach in political science requires two successive steps, the first one being a reconceptualization of method and the second being an attempt to create a conceptual cadre for future political axiomatic theorizing.

1) Reconceptualization of the Scientific Method

Starting from the previous discussion, the difficulty of Political Science is immediately given: we cannot derive a scientific logic from the superficial and contingent character of the facts.

By choosing the world instead of the abstract reality existing among the facts as the focus of analysis, political science proves that it is based on an insufficient method.

> "I would be the last to dispute the central importance of laws in sociological explanation, and the last to deny that these laws must be both derived theoretically and grounded empirically. On the other hand, in dealing with a field like social change, I have discovered a real scarcity of laws and a deficit of theoretically derived propositions, to say nothing of firmly established empirical regularities. The discrepancy between knowing what should be done and possessing the resources to do it was considerable.[7]

The empirical reality is irrational. Common sense knowledge is full of contradictions that are always attributed to the infinite variety of the facts involved in any context. The visible reality is a cinematics (a succession of images) to which we attribute an arbitrary meaning by cultural convention. This apparent reality cannot be the source of scientific knowledge due to its extreme fluency. The flow of events will change with the contexts of observation thus even rendering hazardous an empirical classification of the phenomena.[8]

The major consequence of the Einsteinian epistemology then is that common sense is an illusion:

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[7]Neil J. Smelser, "Some replies and some reflections," Sociological Inquiry, No. 39 (1969), p. 217.

[8]Gaston Bachelard, Le rationalisme appliqué, (Paris, Presses Universitaires de France, 1972), p. 122.

> "As with astronomy the difficulty of recognizing the motion of the earth lay in abandoning the immediate sensation of the earth's fixity and of the motion of the planets, so in history the difficulty of recognizing the subjection of personality to the laws of space, time and cause lies in renouncing the direct feeling of the independence of one's own personality. But as in astronomy the new view said: 'It is true that we do not feel the movement of the earth, but by admitting its immobility we arrive at absurdity while by admitting its motion (which we do not feel), we arrive at laws,' so also in history the new view says: 'it is true that we are not conscious of our dependence, but by admitting our free will we arrive at absurdity, while by admitting our dependence on the external world, on time, and on cause, we arrive at laws.'
>
> In the first case it was necessary to renounce the consciousness of an unreal immobility in space and to recognize a motion we did not feel; in the present case it is similarly necessary to renounce a freedom that does not exist, and to recognize a dependence of which we are not conscious."[9]

Empiricism has been eradicated from certain fields of science (astronomy was superseded by astrophysics, biology by biochemistry, etc.) and it can also be replaced in political science by a fundamental science of society. As G. Novack puts it:

> "In these fields of science the superficial phenomenal nature of facts was recognized and they were set aside as misleading. In the new method, the facts are reinterpreted as contradictory manifestations of a hidden network of causal relations which produced them. The machinery of nature operated behind the scenes to generate the effects we observe, just as clockwork moves the hands on the face of the clock. The task of science was to probe through the outward expressions which first impressed themselves upon our senses to the more remote and hidden materially active causes in the background."[10]

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[9] Leo Tolstoy, War and Peace, (London, Encyclopaedia Britannica, 1952), Second Appendix, p. 700.

[10] G. Novack, Empiricism and its evolution, (New York, Merit Publishers, 1968), p. 37.

In summary the problem of political science has been to limit the scope of scientific activity to a single method - the inductive empirical. This singular conception has overlooked the fact that there was another view of how science worked - axiomatic-deductive mode of reasoning. This point of view stresses that an inductive method is not only too optimistic in its conception of theory-building, but is also limiting and restrictive in its application and results:

> "Empirical research susceptible to statistical tests of validity and reliability is regarded as the only legitimate source of knowledge, while problems not susceptible to such methods are excluded from the domain of investigation ...
>
> The net aggregative effect of these tendencies is a strong predisposition to concentrate on micro-issues. Macro issues of social structure and dynamics - including most problems of high policy significance - are often regarded as subjects 'at present' not susceptible to 'scientific' examination, and therefore not to be dealt with by contemporary social sciences."[11]

Political Science has limited itself to the study of given conjunctions of factors which were relatively stable. The tendency to consider this normalcy on a standard for comparison may have prevented up to a certain extent the apparition of imaginative hypotheses. Too much emphasis may have been placed on conditions of maintenance of political equilibrium.

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[11] Y. Dror, "The barriers facing Policy Science," <u>American Behavioral Scientist</u>, 1965, p. 4.

"The conclusions, too, show the marks of the method. For if one is unwilling to grant the possible existence of a non-empirically verifiable structure, the range of available conclusions is sharply delimited. The methodology has, in effect, ruled out an entire genre of phenomena."[12]

According to Werner Heisenberg[13] it is scientific tradition that shapes the problematics of science. It gives consistency to the development of knowledge but at the same time prevents the emergence of new modes of thinking. The maintenance of the inductive-empirical concept testifies as to the great difficulty of changing our approach in this domain. Several reasons can be proposed for the neglect in which axiomatic method is held today.

Human Motives

As a conception of reality the axiomatic method does not correspond easily with sensate experience. Nobody has ever seen an antisymmetric tensor field or an isotopic spin. The new method talks about models of reality, reference systems, inertial systems. The conceptual structure is at odds with current experiences made by millions of individuals. The tendency is therefore to discard it as an unnecessary complication. This tendency is reinforced by what could be called the ideology of common sense. In our culture there is a positive prejudice

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[12] Bernard Susser, "The Behavioural Ideology: A Review and a Retrospect," Political Studies, 1974, 22, p. 276.

[13] W. Heisenberg, "The New Tradition in Science," CBC radio program, Toronto, October 1976.

in favour of down-to-earth pragmatic modes of reasoning. Collective error is seen as an impossibility since the rationality of common sense makes knowledge the equivalent of observational certainty. It does not occur easily to anybody; billions of human beings were wrong in assuming that time and space were separate elements nor did it occur to anybody that the whole of humanity was wrong at the time of Galileo concerning earth's fixity. Another aspect of this belief is anthropomorphism. In our culture - especially since Renaissance - man is seen as a yardstick by which we must judge society and politics. The problem is that man is also the dependent variable of a great number of structural factors ranging from brain chemistry to economic structure. By placing a severe restriction on non-anthropomorphic evaluation of politics science remains limited by moral assumptions.

Philosophical Tradition

Philosophy of science is still largely positivistic in character. Its interpretation of science as a collection of statements about observable reality maintains the idea that science is predominantly an inductive-empirical mode of thinking. This school of thought has not paid any real attention to the assumptions of modern axiomatic method. Like Ernst Mach most positivists assimilate the axiomatic method to a heuristic device derived from mathematics. They assimilate theoretical physics to mathematical physics and they do not realize the existence of axiomatic structures as genuine structures of reality.

Scientific Culture

Science in the modern context is assimilated to technology. The tremendous success of applied sciences has pushed back the theoretical side of science. The emphasis placed on solving problems associated with machines and computers has imposed the notion that rationality was limited to concrete things. Gathering data and explaining problems by visible variables has become a standard convention. By comparison high-level theorizing is considered as being reserved for the genius or for people interested in wasting their time on metaphysical speculation.

Politics As a Human Affair

The Behavioural revolution in the social sciences has not challenged the concept that decisive aspects of politics could lie only on conscious choices made by individuals. This conception supports implicitly the idea that Political Science is not amenable to pure scientific theory. However, human postulates are not incompatible with a pure science of politics. In fact many human problems should be better understood with an axiomatic approach. The problems of uniqueness of historical occurrences which seems to be a stumbling block for a theory of politics based on generalization would not bother the axiomatic approach which precisely postulates that repetition of precise conjunctions of factors is atypical. The postulates of subjective thinking and human liberty are not valid arguments against a pure science either since subjective thinking and human action form sequences of facts that can obey a logic of a higher order than the one implied in each conscious choice. Subjective thinking does not command political junctures - it is rather a dependent variable. The notion that politics constitutes a second order reality contrary to physics which deals with pure concreteness is totally refuted by modern axiomatic physics which postulate that the visible world of objects is also a by-product of an abstract substructure. Finally the idea that certain political events are pure surprises resulting from an unseen combination of events would not deter an axiomatic approach to politics which precisely postulates that sequences of facts are open to permanent permutations. In summary it is possible to maintain that an axiomatic science of politics would be in a better position to deal with the unpredictable aspect of human problems than the inductive-empirical method is. The fact that the axiomatic method is not an issue in the methodological debate in the discipline is unfortunate. During the past 20 years the concept of paradigm has become very popular despite the fact that it does not propose the means by which scientific revolutions could occur. The axiomatic method is a strategy that can support revolutionary theories in many areas of knowledge by providing a logical support for audacious and far-reaching hypotheses. The inclusion of the method as a tool for scientific revolutions would provide for a development of the methodological debate in the discipline.

2) The Possibility of Implementing the Method in Political Science

Possibilities for developing axiomatic theories of politics already exist in the discipline. As has been said a pre-requisite for the implementation of the method is a willingness to conceive political occurrences as resulting from formal patterns. In Chapters V we have reviewed some conceptual schemes that are pre-axiomatic in character. Our hypothesis is that these schemes provide for basic cadres defining which types of relations are to form the analytic context of the axiomatic theory. These cadres as we have seen are linked to certain structural occurrences of politics such as opposition, direction of attitudes and basis of power. For the moment these cadres are more or less provisory - in order to build an axiomatic theory a next step has to be taken: it consists of the postulation of a principle of internal dynamics that would satisfy a pre-order of logical conditions causing the occurrences.

This necessary causality could provide for a first axiomatic theory of the political system - therefore our conclusion is a provisory one: as a conceptual scheme the axiomatic method is certainly possible in Political Science. Since the method postulates itself the analytic structure that will become its object of study nothing can prevent it from defining an abstract structure of functional relations of politics but as long as principles governing these hypothetical structures are not proposed or tested the possibility of making scientific axiomatic theories of politics will remain a hypothesis.

In Chapter VI we have described how game theory could be used as a framework for the implementation of the new method. The theory provides for terms and relations that are easily amenable to axiomatic propositions. The resulting theorems seem to correspond to a majority of political occurrences and the mathematics involved in the theory should permit us to reach invariant equations.

In any case the new method provides for a better understanding of the nature of scientific theorizing. It is a precious aid in answering the question of how we know what we know. It provides for a greater basis in the range of theoretical speculation from which it may be possible to introduce reliable scientific knowledge to political science. We have always looked at physics for the methodology of science. It is important to understand that modern physics is now offering a different approach than it had in the past. This new approach is cast in the form of speculation and theorizing about complicated aspects of reality. The physical sciences provide a new direction to the social sciences. The new paradigm proposed by Einstein is capable of replacing the traditional Newtonian paradigms with fresher, more analytic and more coherent ideas. It is essential that we recognize the extraordinary possibilities offered by the new approach in its capacity to redefine at a higher level the problematics of scientific knowledge in general and of political science in particular. If as we have seen in previous chapters the method could already provide for new types of conceptual schemes for the study of politics there are logically no reasons why those schemes could not be fully axiomatized. The weight of circumstantial evidence in logical and conceptual terms is sufficient to make us conclude that the implementation of the new method in political science is a possibility.

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