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THE RULES OF THE GAME

Interdisciplinarity, Transdisciplinarity and Analytical Models in Scholarly Thought

EDITED BY TEODOR SHANIN

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We have endeavoured . . . to observe a kind of perspective, that one part may cast light upon another.

Francis Bacon

In so far as one can speak about scientific image of nature, one has to treat it not so much as an image of nature but rather as the image of our relation with nature.

Werner Heisenberg

When the understanding of scientific models and archetypes comes to be regarded as a reputable part of scientific culture, the gap between the sciences and the humanities will have been partly filled. For exercise of the imagination, with all its promises and its dangers, provides a common ground.

Max Black

The 1972 Foreword (amended)

This volume concerns itself with some major conceptual troublespots of contemporary scholarship. It's particular focus is that of disciplinarity and interdisciplinarity in scholarly thought, but it opens out to range over the whole field of knowledge-about-knowledge and it's crucial subject-object relations axis. It is not the work of professional philosophers of science, but reflections of scholars of various disciplines about the more general aspects of their trade. While it is written to stand scrutiny by the scholarly community, it keeps to language comprehensible to well-educated laymen, for each of us is a layman in fields other than his own. To explain why and how such a publication took shape we shall begin with an intellectual experiment by a group of researchers and present the way of reasoning and self-questioning, which brought this group into being.

Why do people pursue knowledge? Material needs and the quest for power to control fellow beings, which knowledge can serve, form basic determinants that are easy to detect. However, these are not sufficient to account for all the persistence of human search. They interrelate with more general and subtle needs and tendencies of human mind: the need to orient oneself in an infinitely complex reality, the tendency to order the endless particularity of human experience and to look for some essences behind the facts, the wish to attach meaning to being-in-the-world and also sheer intellectual curiosity -

the thirst for knowledge for it's own sake. The entrenched, if ambiguous, division between applied knowledge, embodied in technology, and the realm of "pure theory", provides both an indication of and the primary distinction between the different types of knowledge and different aims of it pursued.

An ideal of the "Renaissance man" expressed the happy symbiosis of specific technological skills with the abstract knowledge to which the artistic expressions and creative ability were often added as a matter of course. In our times we seem to be moving away from such an ideal towards division and specialization of knowledge with it's marvelous scientific achievements, but also with some unease at knowing more and more about less and less. One should not dismiss just as an utopian dreams the lingering wish of many scholars to search for more general knowledge transcending pragmatic needs, the tendency to cross-cut through accepted disciplinary boundaries and to look for deeper essence beyond appearances and common sense. The development of contemporary scholarship has been particularly fruitful at the interdisciplinary boundaries, while abstract theorizing have repeatedly turned out to be of more practical value than the technicians of science could have ever dreamt of. Moreover, practical considerations apart, the very fact of persistent existence of such tendencies raises doubts about any attempt to disregard them. To be sure, one can live an effective scholarly existence without ever reaching into those depths. It has been said, the "every person is either Platonist or an Aristotelian". The scholars' camp must have both, and more, while to those bitten by the bug of theoretical concerns, the contemporary feeling of decomposition of the rapidly growing field of scholarship has been particularly disturbing.

Half a century ago, five people met at the campus of Sheffield University: Shulamit Ramon, Michael Barratt-Brown, Paul Clark, Mark Pargeter and Teodor Shanin. Both their similarities

and differences between them were significant: they belonged to three different universities and represented four distinct disciplines: psychology, physics, economics and sociology, yet, in spite of the differences of disciplinary languages, aims and prejudices, a common denominator clearly emerged in (1) the feeling of corresponding conceptual confusion in a number of disciplines (2) the consequent wish to explore cross-disciplinary problems and characteristics of scholarly analysis and (3) the belief that a better understanding of subject-object relations in inquiry is necessary for the future advancement of knowledge. None of those present felt himself/herself competent to consider such issues single-handed. Could an interdisciplinary team take on the role of a collective "Renaissance man" at the contemporary levels of complexity? In a good academic fashion, the five decided on an experiment. Invitations to meet and talk it over were sent out to an additional dozens of scholars in a variety of disciplines. A decision was taken that, if at least ten come, an attempt would be made to establish a regular interdisciplinary seminar. More than double of that number turned up.

The character of the seminar those created was very much the result of spontaneous development. The founding members were propelled into position of an informal managing committee with the initiator Teodor Shanin chairing and Mark Pargeter taking on the burdens of the seminar's secretary. We agreed to call ourselves the "Subject-Object Relations Group". A wide variety of disciplines and fields of study were by now represented: physics, biology, mathematics, psychology, sociology, economics, philosophy, theology, statistics, creative arts, linguistics, mass communication. Meetings multiplied, with some of the group members travelling hundreds of miles to make it. Each meeting consisted of an opening paper by one of the participants and several more hours for a round-the-table discussion by scholars from different disciplines. The only limitation accepted was metaphorically to speak in a way

which could be followed by a well-educated laymen, for each of us has been a laymen in some of the fields far from our own. The discussion increasingly moved towards consideration of analytical models in diverse disciplines, their possible links and issues of knowledge about knowledge. The debate was always lively and instructive, at times "hot", at some moments sparkling. A wish eventually was voiced to try to present all that to the broader audiences - a de-facto argument for increasing inter-disciplinary contacts.

The 2018 Foreword
Looking Back at Interdisciplinarity

At the beginnings of 1970's the term "interdisciplinarity" and its' semantic "kinsmen", such as transdisciplinarity, cross-disciplinarity etc.., burst into European scholarly debate. It challenged the well-solidified vision of academic scholarship as a system of autonomous disciplines matched by university departments of the day. Each of these disciplines/departments undertook the study of an aspect of reality, the exclusivity of which was assumed. Each of them carried a basic definition, some fundamental texts and a set of prescribed methods of inquiry and verification. Each embraced teams of professional and technical personnel, audiences of students and some supporting budgetary arrangements.

This general image of academic scholarship was challenged at an international and interdisciplinary seminar, which met in 1970 in Nice under the auspices of the Organization of Economic co-Operation and Development (OECD). The counter-arguments came there from the eminent Swiss psychologist Jean Piaget, the Austrian-American astrophysicist Erich Jansch and the French mathematician Andre Lichnerowich. In their view the links ("bridges") rather than the divisions between academic disciplines were of major significance for the future of academic research. Different terminologies were used but the term "interdisciplinarity" was seemingly the most generic in describing that issue.

The critical approach to disciplinarity at the Nice seminar was not solitary. The topic of interdisciplinarity was clearly "in the air". A PhD thesis submitted in that period at the International University in San Diego has made separately some of the points considered by Erich Jansch. Broader in scope was the 1970-71 years-long seminar by Subject-Object Relation Group in Sheffield, UK, which was concerned with many of the issues raised in Nice. By 1972 two books in parallel followed the seminars in Nice and in Sheffield: Interdisciplinarity: Problems of Teaching and Research in Universities (OECD Publications, Paris, 1972) and The Rules of The Game (Tavistock press, London, 1972). Yet, the seminars of Nice and of Sheffield were clearly oblivious of each other: a manifest case of serendipity.

Looking at it from the distance of half-a-century, those were harbingers of a new turn in the way the very structure of academia was being approached. Following the Nice seminar, one can trace a rapidly growing wave, concerning interdisciplinarity, expressed in numerous publications, conferences and the setting up of new research institutions. The character and the path of the Sheffield seminar differed.

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The Subject-Object Relation Group's seminar in Sheffield of early 1970's was already mentioned in the initial foreword to the book. This seminar focused on considering similarities, differences and links between the academic disciplines. Its' participants were mostly members of the academic staff of the university of Sheffield but a number of them came over to each session from other universities. It was set up and developed with no grants and no employed staff – a fully "voluntaristic" setting. This informality went side-by-side with high levels of participation and lively debate in which even the controversial issues were fully explored while disagreements were ever taken in good spir-

it. The seminar was planned to take place about once a month, but it's meetings did become actually more frequent, following the wishes of its' members. The seminars' sessions usually begun by presenting paper of analytical model concerning one of the academic disciplines and proceeded for about three hours.

The discussion of analytical models of academic disciplines resulted in the growing significance given to the debate concerning interdisciplinarity and its' different forms. Also it often "overspilled" into considering more general issues of academic scholarship and the general problematic of knowledge about knowledge.

The end of the seminar of Subject-Object Relation Group came as the result of both its' informality and the patterns of mobility within the British universities of the day, linked to patterns of academic promotions. For many the move to a different university, or even to a different country, was usual and "good for advancement". The abler and the better known a scholar, the higher was the possibility of his\her disappearance at the end of the academic session. The end of Subject-Object Relation Group came not through its' decay, the seminar kept well the interest of its' members, but as the result of "promotional" disappearance of the hard core of its' members. Those left behind tried to keep the seminar going but failed.

It has been initially assumed that the seminar will last for 3 years. When it became clear that many of its' members plan to leave Sheffield at the end of that academic session, it was agreed to try to publish some of the contributions to it. It was also decided to add to the text a Part II devoted to works, which influenced our debate or else were specifically ordered to express a view presented by a member of the seminar. A contract was signed with the Tavistock Publishers. We selected the books' title which amused us. Looking back, it did not make sufficiently clear the book's content, which contributed to its' reaching a fairly narrow academic circle.

Models and Thought

TEODOR SHANIN

. . . the lens of mankind through
which men see, the medium by which
they interpret and report what they see.

C. Wright Mills

I. THE CREDIBILITY GAP IN SCHOLARSHIP – AN ASPECT OF THE SCIENTIFIC REVOLUTION

The major axis of cultural history seems to lie in the mutual causation of constant new experience and, just as constant, an attempt to generalize and formalize whatever passes for knowledge in society. Scholarly disciplines embody the formalization aspect. The very word 'discipline' conveys the images of order, control, and rigid training. It reflects, on the one hand, the need of the human mind for rationalizing and for orientation in an immensely complex reality, to be achieved by building up systematic and coherent general images and symbolic schemes.[1] It represents, on the other hand, a closed, self-supporting, and to a great extent self-validating group of specialists who reproduce themselves by initiating into their circle those youngsters who respond well to training. Qualities, of mind and of social organization, find expression in the stability of the paradigms of science, i.e. the 'universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners'.[2] More than that, such paradigms delineate the very fields of the specific disciplines and determine the extent of their crystallization in scholarship. Outside the natural sciences the

heterogeneity is greater, yet the disciplinary order, control, and training operate on very similar lines. Suitably formalized and reified language provides powerful reinforcement of the existing disciplinary system.

Kuhn has lucidly described how the order of accepted knowledge in science is constantly disturbed by new 'anomalies' of experience, i.e. the type of evidence that does not fit into an accepted system of explanation. 'New' minds (often outsiders to the disciplinary establishment) which somehow manage to escape the security checks of selection and pressures for conformity in the scholarly community act likewise. As a rule the first challenge of new evidence or new understanding does not make much headway either with the practitioners of the discipline or with the laymen. The systems of intellectual and administrative control act here as powerful defences of the *status quo*. Yet, if the pressure grows, the credibility gap between, on the one hand, new insights and more or less formalized evidence and, on the other hand, the accepted knowledge may make the ruling paradigm crumble. Then comes the period of revolutions. In actual fact the ensuing crisis leads first to a variety of compromises and readjustments within the existing conceptual scheme, which may succeed. If, however, the credibility gap is too huge to be bridged and the subversion by nonconforming anomalies and the pressure of 'new forces' too substantial to be contained, paradigms of science collapse in a 'scientific revolution'. The essence of such a revolution is in a 'qualitative leap', an 'epistemological break' – a rapid closing of gaps between evidence and accepted knowledge through basic reconceptualization of reality. The old paradigm may be kept at times as a theoretically degraded but pragmaticly useful approximation of certain situations, while a new and different view of reality becomes generally accepted as 'knowledge'. The extent and 'broadness' of this reconceptualization vary, from overhaul of a sub-branch of scholarship in which 'unanticipated anomalies and strategic data became the occasion for development of new theory',[3] as far as what was referred to as axial stages of human history, when crucial upheaval in social structure meets with and is comprehended through shattering changes in the general *Weltanschauung* of society.[4] Yet whatever the magnitude of change in the paradigms of thought, the post-revolutionary period

seems to display some basic similarities. The new ideas are rapidly welded into a consistent pattern, which acquires once more self-stabilizing defensive characteristics. Many of the rebels of yesterday become 'establishment figures' of today. The disciplines (in many cases newly created by 'the revolution') crystallize, the bulk of their practitioners close ranks and minds, new credibility gaps start to grow, a new qualitative leap is in the making.

The period in which we live has seen a more or less constant crisis of knowledge, a 'permanent revolution', to keep to the somewhat metaphorical language. On the one hand, the immense spread and professionalization of research, the heavy investment in the research business, the developments in communication, the mass production of literature, and the spread of universities, related to constant and rapid social and technological change, have created a ceaseless flood of information and potentially anomalous data. On the other hand, although the existing organization of the scholarly community has in many cases been highly effective in solving the puzzles defined by the existing paradigms, it has also displayed a number of serious limitations. Bureaucratization and outside controls have created rigid disciplinary structures limiting the very creativity they profess to advance. Super-specialization into an increasing number of disciplines and subdisciplines, which come to handle increasingly complex pictures of narrower and narrower aspects of reality, has proved time and again to be counter-productive in terms of better understanding of the broad context of the subject-matter. An unparalleled 'insulation' of 'mature scientific communities' from 'laity'[5] came into being while the comprehension and affirmation of the scientific wonderland through categories of pragmatic knowledge became increasingly doubtful, or impossible. The enormous prestige acquired by science and the scientist aggravated this tension. The problems of conceptualization, now permanent, became related to, and further increased by, the political and moral crisis of the generation of nuclear weapons, Vietnam, the moon race, and race riots. They bring into question the very quality and purpose of rationalism on which Western scholarship was based. Both images and self-images of scholarship moved from the devilish Dr Faustus of the Middle Ages through the benefactor of mankind of nineteenth-century evolutionism and optimism

and back again to that of a fiend, or at least the tortured soul of a contemporary Oppenheimer.

One of the results of the atmosphere of permanent intellectual crisis has been the increasing interest of scholars in knowledge about knowledge, i.e. the full range of methodologies of discipline, psychology of perception and creativity, sociology of knowledge, and epistemology. The history of science and the major modes (or archetypes, or super-paradigms) of scientific explanation have provided here a possible comparative conceptualization in terms of sequences and 'directions of development'. Aristotle's quest for an explanation of nature in terms of purpose has been compared, for example, to explanations in terms of sufficient conditions adopted in later ages. Probably the best known is Bronowski's division of post-sixteenth-century history of science into three major periods in which order, causality, and chance played in turn the role of the central idea of science.[6] However, the contemporary conceptual crisis seems to be much broader in scope than the natural sciences alone on which scientific historiography seems to rest. It seems also 'deeper', for 'unconfident' scholarship has on the whole led to a more general philosophical concern with its own epistemics, to which simple historical relativism seems somewhat insufficient as an explanation. A number of crucial epistemological problems cut across the whole field of contemporary scholarly thought. Among these the relation between theory and experience or data, analytical methods versus the holistic approach (closely related to the issue of reduction) and the problems of levels of knowledge as distinct from those acknowledged by the 'official' methodology, all reflect the more general issue of subject–object relations, i.e. the relation between the observer or student and the object of his observation or study. It is this syndrome of knowledge about knowledge and its particular expression in models of thought that form the focus of our discussion.

II. THE INTERDISCIPLINARY PROBLEMS OF SUBJECT–OBJECT RELATIONS

The first problem is the relationship between theory and fact. The optimistic belief of the nineteenth century in the ability of

scientific induction to close the gap between reality and theory (and to dispose of 'the need of metaphysics') seems in our times naïve if not superficial. Theorizing and empirical research still form separate worlds, at least as far as formalized procedures are concerned. It is the awareness of the depth of this gulf and of an ultimate if partial separateness, that poses again the paradoxes of Cartesian dualism, Hume's scepticism, and Kant's 'gnesology' concerning the basic differences between the 'logical' and the 'real'. In so far as one can judge, this is reflected today in the conclusions of the theoreticians right across the disciplinary boundaries from Heisenberg's 'uncertainty principle' in physics as far as to the discussion of 'theories of middle range' in sociology, with Gödel's theorem in mathematics as a further extension of it.[7] The unending efforts 'to close the gap' by positivist reductions and the post-factum impositions of 'hypothetico-deductive' language on scholarly work are but another recognition of the problem.[8] Several other epistemological issues are related here. First, is reality structured in a way that can be learned by the human mind or, on the contrary, 'since the word unity contradicts both reality and its cognition',[9] is it only the human mind that establishes systematic order? Secondly, can causality be established at all, or is the 'black box' of input–output analysis the only possible object of study? And so on.

The relation between the whole and the parts provides the second major interdisciplinary problem of contemporary scholarship. In scholarly jargon the word analysis has by now become synonymous with thought, study, knowledge itself. The synonymity reflects here the fact that analysis has become the major scholarly supra-methodology. Analysis proceeds through division into simpler components whose interactions are than studied so that we may learn about the whole. Analysis, effective and dominating as it has proved in 'Western' scholarship since 'the Greeks',[10] is, however, but one of the possible methods, and displays furthermore a variety of blind spots. To begin with, the split into subunits causes some qualitative residuum to disappear, and study in terms of constituent parts may mean reduction to something quite different in quality. Furthermore, analysis presupposes a system of subdivision into units that is partly arbitrary and formally prior to investigation. Yet it is selective and has a bearing on the

results. Any protestation of scientific objectivity is therefore particularly suspect here. It was argued in disciplines as far removed as psychology (Gestalt School) and physics (notably D. Bohm) that rather than the parts determining the whole, it is the whole that determines the parts. The critics of strict analytical methodology have recently been particularly active in the social sciences and psychology. Here the phenomenological tradition has challenged the analytical and quantifying positivistic tendencies, claiming the uniqueness and wholeness of human experience and consciousness as a necessary starting-point of a methodology of the 'human sciences'.[11] It may be well to remember that Kuhn's analysis referred to above seems particularly vulnerable when transferred to those fields of study.

The third type of general epistemological problem relates to types of knowledge different from, and possibly superior to, those formerly accepted as the medium of scholarly work. Polanyi's discussion of 'tacit knowledge' as the implicit yet necessary component of research or Baldamus's 'double fitting' and 'categories of pragmatic knowledge' can stand as good examples of such 'unofficial practices' of scholarship.[12] Intuitive knowledge and attempts to explain 'the spark' Popper declared to be the starting-point of scholarly advance, and then neatly left out of his earlier methodological discussion, will also come in here.[13] Lévi-Strauss's insistence on unconscious layers of cognition and Bohm's 'implicate orders' of nature, the uncoding of which must form the real subject-matter of scholarship, will clash here with the good Anglo-Saxon empiricist tradition that dismisses such issues as mystical rubbish. The approach to human behaviour and thought as to a direct response to socialization or reinforcement as well as total cultural relativism are confronted by the claim of innate capacities specific to the human mind, e.g. the linguistics of Chomsky. Again epistemology leads us to issues of human nature and to the basic axis of subject–object relations.

The issue of subject–object relations seems to provide a major unifying conceptual focus for the contemporary problems of knowledge about knowledge. Its historical roots seem to lie in the philosophical reflections of the beginning of modern sciences in the work of Descartes, Leibniz, Hume, and Kant. The first quarter of the twentieth century saw a powerful explosion of neo-

Kantian thought, especially in Germany, Austria, and Russia. Logical positivism, phenomenology, and existentialism alike have their beginnings in that development. The Kantian revival (which at its radical wing should be no doubt called neo-Cartesian) was all but destroyed in the thirties by Nazism and the Soviet purge; state-manufactured truth did not leave scope for epistemological doubt. Yet half a century later Anglo-Saxon empiricism and pragmatism seem step by step to be giving way to similar concerns and solutions. The crux of all this lies in focusing on subject–object interaction as the basis of comprehension in contrast to the idealist assertion of the absolute primacy of the subject or the strict materialist assertion of the absolute primacy of the object. It is in the rapid cross-disciplinary spread of the use of the concept of models that the methodological acknowledgement of the basic axis of subject–object relations finds its major expression. Models can on the other hand be understood only against a more general theoretical background, i.e. the ways of understanding postulated for the basic issues mentioned above. The work of the general systems theory group (von Bertalanffy, Simon, Koestler, *et al.*), attempting to define the character of the whole–part relation as well as a general hierarchical order of nature, may serve as an example of such a theoretical background associated with the use of models.

Models as Explanatory Devices

As with many 'new' concepts, the use of the term model is still somewhat of a fashion if not a gimmick. It looks scientific, illuminating, 'with it'. Yet, as time passes by, the concept has not blurred. If anything, its use has grown in an increasing variety of disciplines. Such persistence seems to result from the particular relation of the concept of model to the epistemological concerns of the permanent scientific revolution and to the subject–object relations axis of knowledge.

The extensive use of the term has been partly related to the simple fact that 'models' mean different things to different people. In further discussion we shall proceed first to peel the semantic onion to arrive at the hard core(s) of the concept of model which plays such an outstanding role in contemporary scholarly work.

To begin with, one has to dispose of two meanings of the word

model which are only indirectly related to the concept discussed, namely the meanings 'ideal' and 'design'. The terminological residium of the word has been used in two major senses, (a) as an exploratory device of scholarship, (b) as a preconception, colouring cognition and comprehension of reality, an archetype, a pattern of thought. We shall discuss the first and return to the second later. The exploratory models can be divided into three major categories.

1 *A Physical Model* – a material representation of an object effected either by keeping all its features of interest intact, while changing the scale (icon or scale model), or alternatively by changing the medium while 'attempting to reproduce as faithfully as possible in some new medium the structure or web of relationship in the 'original'[15] (analog model).
2 *A Logical Model* – a closed set of interrelated entities or definitions which satisfy a number of axioms of formal logic.[16] In such a closed and fully formalized system there will be no definition of entities apart from the axioms accepted, and no definition of axioms but in terms of the entities used.
3 *An Analytical Model* which brings us to the 'hard core' of a concept of crucial significance in contemporary scholarship. The analytical model differs from the physical one by its symbolic form (i.e. language or mathematics) and by the necessarily theoretical framework involved. At the same time it differs from the logical models by its necessary relation to, or representation of, reality, in terms of which its validity can be judged. The analytical models 'carry over from logic the idea of interpretation of a deductive system'[17] while at the same time being rooted in the reality studied by their use. This places them metaphorically 'in between' the other two categories.

Analytical models can be defined as closed systems which provide a meaningfully selective and symbolic representation of reality. A system assumes mutual dependence of components by which change in some produces a necessary and predictable change in the others. The model serves as a purposeful simplification by selecting or isolating a small number of interdependencies under consideration. It is designed in a way that

assumes constant properties and repetitiveness of the system. It therefore reproduces on a theoretical plane the conditions of an ideal laboratory in natural sciences. Selection of properties in a model presupposes both some underlying theory of the nature of the reality studied and an explicit definition of the study's purpose. As a result, in accordance with Black's celebrated dictum, 'only by being unfaithful in *some* respects can a model represent its original'.[18] The symbolic representation of reality gives it a generalized and abstract expression and the possibility of logical and mathematical manipulation. Yet models are both inferred from reality and reapplied to it through human action. An analytical model as a meaningfully simplified statement of interdependence may carry furthermore some surplus meaning and may be suggestive, either by analogy to, or transfer from, another and better-known field of knowledge.

The character of the analytical model, and especially its selective and simplifying aspects, determine a variety of problems and limitations in its use. The first problem is how much to simplify. The formulation of a relevant model (especially a model that is mathematical in form) may be particularly difficult. The greatest of the dangers seems, however, to lie in the implicit tendency to reify models, i.e. to approach them as reality and not as a simplified and purposefully biased representation. In the words of yet another celebrated statement 'the price of employment of models is eternal vigilance'.[19] So is it, of course, with all scholarship.

The basic *function* of analytical models, which explains their extraordinary significance in contemporary scholarship, is their use as the major bridge between the language of theory and that of empirically collected data, between the general and the unique, between the 'subject' and the 'object'.

To quote a recent discussion 'the commonly accepted position is that science contains two distinct languages or ways to define concepts', i.e. the theoretical and the operational. Furthermore 'there appears to be no purely logical way to bridge the gap between the languages. Concepts of one language are associated with those of the other mainly by convention or agreement between scholars.'[20] Thus the Cartesian/Kantian problem of the relation between the theoretical and the real is still with us.[21] The issue is particularly serious when laboratory

controls or 'randomization' are impossible. A usual analytical procedure will be to carry out the exploration of relevant interrelations on analytical models in which the subject-matter is simplified to 'essentials', i.e. stripped of those details which are assumed to be incidental or irrelevant, to make possible 'an overview of the essential characteristics of a domain'.[22] Thus generalization can be expressed in spite of the fragmentation of the actual experience. The qualitative permanence, relative simplicity, and isolation of the system accepted as a model, makes it theoretical and 'unrealistic' as against the unique and unlimitedly complex web of interrelations in reality. Yet the realistic connotations of the analytical model allow its use in inferences about empirical data. Furthermore, the formalization of the model permits its interdisciplinary use, in whole or in part, and opens possibilities for logical manipulation and for utilization of mathematical techniques. Causal thinking can here provide examples of broadly used models that are fruitful despite the critique by empirical philosophers, the growth of probabilistic statistical studies, and the fact that it 'belongs completely on a theoretical level and the causal laws can never be demonstrated empirically'.[23]

In a broader sense models offer a partial solution to the subject–object relations dilemma. The unbridgeable break between the limited and selective consciousness of the subject and the unlimited complexity and 'richness' of the object is negotiated by purposeful simplification and by transformation of the object of study inside consciousness itself. The problem of subject–object relations is of course not 'solved' but only transferred from a relation between the student and his data to a relation between, on the one hand, consciousness and models, and, on the other hand, models and empirical data. Some additional illumination is, however, gained by that stratagem. The crux of the matter seems here to be the 'isomorphism' between the model and the field of application, which enables one to evaluate the 'fit' of the model in each particular case while at the same time providing for the possibility of deductive and generalized logical manipulation. It furthermore pre-assumes a process of inquiry in which the model's approximation to the objects of study improves through the mutual impact of accumulation of knowledge and sophistication of models and their use.

III. THEORY AND THE CATEGORIES OF ANALYTICAL MODELS

In some treatments the term model is used synonymously with theory or even with any general proposition. Such overwhelming broadness does not seem to be very useful and blunts the selective capacity of such conceptualization. Theory as a concept seems to be broader, more self-sustaining, and of a deeper epistemological significance than that of model. The analytical model seems to rest on some broader theoretical definitions of the character of the field of study, of the relative significance of its components, and of the question asked. In that sense, and in contrast to a theory, the terms 'true' and 'false' cannot usefully be employed in the evaluation of models, while 'appropriate', 'stimulating', and 'significant' will probably do for both.[24] General theory in its broader sense is furthermore charged with the task of recognition and separation of qualitatively specific levels of reality and types of interdependence that are of strategic value in terms of comprehension. (See, for example, the paper below by Arthur Koestler.) On the other hand, models are used to concretize, clarify, and check more general theory. Theory seems, therefore, to provide a concept of more general range and epistemological depth, analytical models acting as its subordinate and partial exposition.

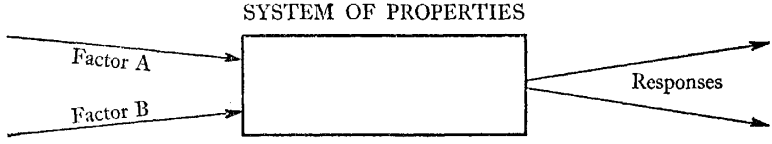
Various categorization systems for analytical models have been proposed. The division of models into descriptive, i.e. expressing internal structure, and predictive, i.e. defining possible results of a determining impact, can here provide an example. (In accord with the tendencies of contemporary scholarly thought, the analytical models tend to focus on dynamics rather than on statics, on interdependence of 'events' rather than that of 'things'.)[25] The extent of information expected about the character of the process studied may provide a further diversification between the causal models and the 'black boxes' of a restricted input–output analysis, in which the 'interior' of the 'black boxes' is disregarded. Most interesting and important, however, seems to be the categorization of analytical models in accordance with (i) the type of causality assumed and (ii) the type of formalization used.

A typology based on the character of the causality assumed will

begin with a division between models of *linear causation* and systems of *mutual causation.* Models of linear causation assume a simple scheme in which some factors, by influencing a known set of properties, produce a predictable response. A clear division between factors (cause) and responses (effects) is accepted, negotiated by the properties of the model (the following simple diagram may help to express such interdependence). Any reverse influence of the response on its determinants is not considered, and the possible mutual impact of the factors is treated as nonexistent.

A monistic model of linear causation as against a multifactorial one will have the additional property of assuming only one operating factor, from the knowledge of which all the possible changes in the system can be deduced. The relative simplicity and clarity of the monistic models made them play a positive role both in the solution of partial problems and in breaking new paths of thought. On the other hand, those particular types of simplification for the purpose of analysis are in particular danger of reification.

Linear causation model



Systems of mutual causation assume and represent a more complex interactive quality of reality in which feedback plays a major role. Such a model presents a 'system' in which the division into causes and effects is transcended and a structure of simultaneous and highly interdependent relations is assumed. Models of mutual causation may therefore be considered of a higher order (in terms of complexity and the extent of their self-articulation) than models of linear causation. The models of mutual causation can be in turn divided into *equilibrium models* and *models of cumulative change.* Equilibrium models assume a negative feedback which controls deviance within certain limits and therefore stabilizes the character of the system and its components. The issue of stability of the equilibrium, i.e. of the strength of the deviance-controlling

negative feedback, will here be one of the consequent issues. In the context of biology and the social sciences such self-adjusting systems have been assumed as 'perpetuating their own structure and neutralizing determining environmental pressures'[26] while a constant circulation of energy (and 'information') takes place. Technologies of industrial control and biological organisms provide extensive examples of such a system of interaction and have displayed a powerful influence on model-building.

Systems with positive feedbacks have remained less popular and less well known, though understanding of their importance has grown recently in a variety of disciplines. The cumulative nature of many processes ('vicious circles', 'circular causations') is particularly important for better understanding of structural change, i.e. changes leading to the creation of a different system of interdependencies and for the explanation of the qualitative jumps and sudden breaks in continuity.[27] Qualitative changes and runaway processes destructuring the existing system of interdependencies have been analysed in those terms. Again, the strength of the feedback and the thresholds of structural change will here be of major importance. (It is, by the way, simplistic to assign equilibrium systems to the study of statics while claiming models of cumulative change for dynamics. Equilibrium models assume on the whole *non-structural* changes and can be used also to assess conditions in which structural change will occur, i.e. the system will give way. They cannot, however, illuminate the character of such a structural process. It should also be remembered that simultaneous changes do not imply mutual causality if the size of the change of one variable is independent of the size of the change in another, or if change in both is caused by a third factor.)[28]

The typology of formalizations used provides another important division of analytical models. The models can be divided first into those using language, and those using mathematical formulae as their major media of expression. The rapid spread of the use of computers has created additional powerful pressures for the 'mathematization of conceptual thought'. The mathematical models can be deterministic or probabilistic (stochastic) in form, with the use of the second rapidly spreading as a result of the advances in contemporary statistics and in empirical studies. A

serious conceptual issue is here provided by the so-called non-pictorial models in contemporary physics.[29] The models typical of nineteenth-century physics represented as a rule an integration of mathematical formalization and pictorial content and drew some illumination by analogy to more familiar systems. The contemporary models of quantum physics seem to be rapidly losing their representational pictorial content. The questions of how far such phenomena still lie inside the conceptual province of model-building as usually accepted, as well as of the epistemological and social results of types of knowledge, which are by definition inaccessible to laymen, must here be left open for further studies.

One can also proceed here to explore the other end of synchronic cultural diversities by comparing contemporary scholarly models with the myths of tribal societies as different forms of 'analogical thought'.[30] Needham's *magnum opus* on Chinese scholarship can provide a major framework for such a comparative exploration along synchronic lines.[31]

The criteria for selection of analytical models as explanatory devices are heterogeneous and can be grasped once again only within the framework of subject–object relations. Formal definitions of use tend to stress practical instrumentality, 'truth content', and at times also social acceptability and/or facilitation of creativity as the reasons for their adoption. Predictability, especially in pragmatic use, is at times acclaimed as the only criterion of substance. The evidence of scholars themselves strongly contradicts such a narrow interpretation.[32] To begin with, models are used not only to predict but also to secure coherent comprehension, to 'make sense' of experience in more general terms. The importance of that aspect seems far in excess of any pragmatic uses such knowledge could possibly provide. Models are used, therefore, not only to comprehend a structure or to estimate the future, but also to retrodict, i.e. to illuminate the past. To a degree surprising to laymen, models have been, furthermore, selected by what can be described as aesthetic criteria, e.g. symmetry or neatness. Pragmatic use, the wish to comprehend, and such aesthetic preferences have moreover to be considered within socially defined frames of reference, and this determines both the avenues of social acceptability and the paths of rebellion. People do 'make their

own destiny' but they do not make it as they please. They face a ready-made world of material conditions, of power relations, and of cultural structures. Furthermore, they act and comprehend in terms of a cognition that is limiting in ways that are selective and consequential.

IV. MODELS AS PRECONCEPTIONS

Specific and selective cognition and comprehension means simply being human, or at least being human in terms of a given pattern of consciousness and social organization. No explanation can be understood outside such a human frame of reference. Even the primary issue of what do we mean by explaining things makes this clear. If indeed to explain is 'to reduce a situation to elements and correlations with which we are so familiar that we accept them as a matter of course so that curiosity rests',[33] then it is our preconceptions that determine when such transformation is considered sufficient.

The predominant images and concepts seem to have their definite intersubjective and extra-theoretical 'truth content', elements of which emerge from beneath the formally unlimited flexibility of conceptualization. As the analysts know, some data are 'stubborn'. In this sense, knowledge is doubtlessly isomorphic with the cognized reality with the 'fit' constantly re-established and tightened up by both pragmatic knowledge and scholarly inquiry. Yet at the same time no extension of simple induction of facts will suffice to explain cognition and comprehension. Once again, it is the framework of subject–object relations that cannot be disregarded without severe distortion in our understanding of the process of knowledge. Consider, for example, the reason for the overwhelming tendency for monistic patterns of comprehension, in which full understanding is achieved by tracing the phenomena studied to one major factor approached as a 'prime mover'. Such an image may form a useful analytical simplification, but its broad spread and its unquestioned acceptance as a correct and total image of reality seem to need further explanation.

The explanation may lie in the nature of the object of study, i.e. in the 'monistic' nature of the world. It may lie alternatively in the characteristics of the human mind. By such an explanation the

pressure of an unlimitedly complex reality on a limited capacity to comprehend the world produces anxiety resolved only by the adoption of simple schemes of comprehension. It may also reflect social pressures for total centralization and bureaucratization, expressed in the distorting mirror of ideologies. It does in fact probably reflect a complex interrelation between a variety of such factors.

The term 'model' has been used to depict alternatively a conscious analytical device, or a preconception which selects, determines, and colours our cognition or comprehension of the nature of the object. In terms of the latter one can speak of perception through given models (or archetypes) in both scholarly and pragmatic knowledge. The specific physiological make-up of human sensory organs and the human brain seems to provide us with such a major selector of stimuli, images, and types of generalization. In J. Z. Young's words, 'Homeostats have no means for recording an "unbiased" view of reality.' His comparison of the operation of the octopus and human brain may be used as a good example of physiologically determined different cognitive worlds.[34] Furthermore, not only the capacities of the human mind but also the characteristics of social structure have their influence on cognition of reality. Issues of subject–object relations cannot be limited to the interaction of a single mind with external reality. Human beings are social, and the impact of a whole cultural apparatus – communication, reification, socialization, and control – must be part and parcel of any study of cognition.[35] Man displays unique ability to create and transfer complex symbolic systems which are the essence of human culture. These provide us with explicit and ready-made images, categories, and symbolic models of reality which then influence our comprehension, cognition, and action. The sociology of knowledge has attempted to define the nature of these influences on our minds.

A major problem of preconditioned and structured human consciousness seems to lie, however, with those parts of cognition and comprehension that appear to be neither simply 'reflections' of intersubjective reality nor sheer resultants of human physiology, nor again factors which can be self-evidently related to conscious theorizing or to social pressures to conform. Those seem to be the entities described by Black as the 'submerged models operat-

ing in authors' minds';[36] McLuhan's 'linear thinking' postulated as typical of the 'typographical man' of the sixteenth to nineteenth centuries (as opposed to the 'loose-knot' comprehension in the time of mass communication) may act here as an example.[37]

Bronowski's historiography of sciences, already referred to, and Piaget's typical stages of child development provide such examples in terms of development sequences.[38] All these tendencies will probably have to be explained in terms of interrelation between the basic characteristics of human nature and the way society is structured, though such an explanation will have to be much more complex than that which the contemporary sociology of knowledge tends to express. Eliade's explanation of the difference between the cognition typical of 'archaic' and 'modern' man in terms of different ways of solving dilemmas of time, order, suffering, and death can here be used as an example. The explanations of Lévi-Strauss, Carl Young, and M. Scheler of the preconditioning of mind in terms of group subconsciousness are relevant here. Chomsky's discussion of the innate qualities of the human mind approaches the issue from a different angle.[39] Whatever the explanation and whatever the weight we give to societal influence as against the inborn influence of the individual mind, patterned preconditioning of human cognition and comprehension must mean also the existence of 'submerged models' – unconscious or not fully conscious and yet influencing profoundly the process of our thought. Furthermore, analysis of human thought and action will have to consider not only the human capacity for 'rational judgement' but also 'irrational' components of thought, and these will have to find expression in any relevant model-building. Indeed, a generation earlier, Pareto attempted to define empirically as 'residiums' those types of human preference and action that cannot simply be treated in terms of pure logic or as the shortest cut to the declared aims.[40]

Some relation between model as an explanatory device and model as a preconditioned (or even programmed) pattern of thought exists without doubt. Yet the actual character of this relation is anything but clear, mainly as a result of the ambiguities surrounding the use of models in the latter sense. Concepts created by man have proved much easier to tackle than the issue of the investigators' own biases, lurking at the back of their minds.

In the few existing discussions 'submerged models' have assumed radically different identities and significance. At times they were treated as lower in rank than those explicitly stated, i.e. as 'half-baked', partial, or 'emerging' models of an explanatory type. The scholar's work would, therefore, consist of the clarification and tightening-up of the logical structure of the 'submerged models' with the aim of turning them into explanatory devices. On the other hand, models as explanatory devices have at times been approached as subordinate to 'deeper' preconceptions with the relevance and fruitfulness of the first determined by the second. The task of scholarship here is consequently seen in breaking the codes of the deeper layers of human consciousness in the attempt to reach types of knowledge more profound than those represented by explanatory devices of the more explicit type. Construction of models of model-selection can possibly form here an important subsequent stage to guide us through the perplexities of simultaneous and conflicting models referring to the same reality. Thorne's discussion below of definite systems generating infinite solutions may have some broader relevance here. A systematic analysis of the mutual interdependence of both types of model will have to await further developments in the study of human comprehension and of subject–object relations.

V. MODELS AND SOCIETY

'Between consciousness and existence stand meanings and designs and communications which other men have passed on, first in human speech itself and later by the management of symbols. Those received and manipulated interpretations decisively influence such consciousness as men have of their existence.'[41] Models are firmly rooted in this territory, which ranges between consciousness and 'existence', and derive their significance from this fact. This relation operates both ways. On the one hand, 'existence' is cognized through models. On the other hand, the explanatory model adopted not only represents selected aspects of reality, but also shapes it, i.e. has bearings not only on human comprehension but on human actions. Indeed, in the philosophy and theory of the sciences the very split between ontology and epistemology is rapidly growing narrower. Bohm's as well as

Bauman's and Brittan's treatment of knowledge as a 'subtle order of being' may be one of the major messages of our generation.[42] Furthermore, models play a crucial role in mobilizing, triggering off, focusing, and controlling human energy. It is in terms of 'new models' that policies are nowadays described by scholars, governments, and the press alike.[43] Models seem, therefore, to influence profoundly our consciousness and consequently our life and action. Not surprisingly they reflect the two poles of human cultural history – creativity versus formalization and control. Men live in 'second-hand worlds' determined by the cultural apparatus of socialization and of mass media, which have provided them with ready-made symbols and concepts. Gramsci's idea of 'egemonia' as against domination of men by means of coercion is deeply relevant here. Egemonia means control of men through the control and manipulation of symbolic schemes which determine human cognition. It is this insight that has grown so powerful in the mass society of our time and has made Marcuse's *One-dimensional Man* into the Bible of a whole generation of students. Reified models and language operate as determinants of cognition and as codes of behaviour defining the degrees of freedom of the individual. Control of the mass media, and mass production of models 'sold' to the masses, have become a major form of the domination of men by men. At the same time, the main scholarly elites of model-producers retreat step by step into a world of their own creation, the complexity of which makes for a seclusion greater than that of a Trappist monastery.

And yet, on the other hand, models represent time and time again the height of human creativity, liberation, and imagination. Much of the struggle for human liberation has been shaped by 'utopias' – models of a better world, capable of mobilizing masses of people for political action.[44] In scholarship, the imagination aspect of models was made particularly clear by the comparison with metaphors. 'A memorable metaphor has the power to bring two domains together into cognitive and emotional relation by using language directly appropriate to the one as a lens to see the other . . . to see . . . in a new way.'[45] *To see in a new way*, with all its intellectual and emotional undertones, is indeed the essence of whatever we call creativity, and worship as the highest expression of the human spirit. As with all other human tools and

constructions, models can be used for the sake of freedom and enslavement alike. It is up to 'us'.

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