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Organon 5, 73-83

1968

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INTRODUCTION

The birth of modern science in the West was no historical accident. The rationality of God was far more emphasized than any other attribute of God in the theology of the Middle Ages. God was conceived as the Supreme Intellect, who could be comprehended, to some extent, by the human intellect. Not only God was rational, but His creation reflected the fullness of His rationality. The Middle Ages gave one long training for the intellect of the Western world in the sense of order. [1] This is important to recognize, since in the Eastern theology the mystical qualities of man and God were far more emphasized than the rational qualities. Consequently, the long training the Eastern mind had was in the sense of mystical union rather than in the sense of rational comprehension. Yoga is the classical example of this. Moreover, there was an increasing interest in the Greek philosophy during the latter part of the Middle Ages, which, in turn, developed an interest in Nature as an end in itself. In other words, Nature became worthy in itself of human intellectual pursuit to know rather than as a mere means to know God through it. This new intellectual status which the Nature received was a key factor in the development of modern science.

Moreover, increasingly various minute aspects within the Nature, rather than Nature in its totality, became worthy of human pursuit for knowledge. For example, the mating of a fly or the germination of a seed would not have been worthy of a philosopher's pursuit for knowledge.

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* The readers of this paper should keep in mind that the author, coming from the Indian intellectual tradition of the East, is looking at the European historical developments from outside. However, every attempt is made to appreciate the dynamic birth and growth of science in the West.

[1] Alfred N. Whitehead, *Science and the Modern World*, New York 1925, p. 18.

But in science it became worthy of the dedicated pursuit for a life-time by a top mind. This ever-increasing status of minute aspects of Nature and the corresponding interests shown by the scientists in them paved the way for the scientific community to be relatively independent from philosophy and theology. Thus, though modern science could be called the child of the marriage between the theology of the Middle Ages and the Greek philosophy, born during the Renaissance, it had not become independent until it developed its own methods, techniques, and the problems to study. This is equally true of any discipline within science too. Until a discipline develops problems and methods of its own for study it is not truly independent from its mother discipline. In this sense, the drawing of a boundary for a discipline is important in its early days to develop a sense of identity and independence, a sense which is essential for the growth of a discipline.

However, it should be noted that the artists (painters, sculptors, *etc.*) served a vital function in the birth of science. The artists by actively participating in and with their materials gave new order and form to their products. This formed the transition from contemplation to experimentation. [2] Moreover, with their daring courage they touched the "untouchables" and thought the "unthinkables" of the Western world, in the name of art. For example, before one could discuss sex, the artist could deal with sex in his art. Artists were the midwives of science. The "allegorical" intellectual weapon of the artists was far more capable of paving the way for science in the hostile environment than any open weapon would have been. Art is the intellectual underground movement of social revolution. The reason for the failure of many social movements in history is their premature arrival openly on the hostile scene.

MODELS

Mechanistic Model

Rennaissance opened the way for science. However, only in the 17th century do we notice the full blossoming of the first conceptual model of science, which has ever since been, known as the mechanistic model. This model was well-suited for the Newtonian science which was eager to discover the eternal laws of the universe. The most popular analogy of the universe was that of a watchmaker and his watch (machine). The universe expressed the order because it reflected the intelligence of its maker. However, the god of the deists, the watchmaker, had very little to do with the functioning of his machine (universe). This conception

[2] Don Martindale, *The Nature and Types of Sociological Theory*, Cambridge 1960, Ch. I. "The Road to Sociology".

of non-interference by the Creator in the everyday functioning of the universe was essential for the birth and devlopment of science, since a universe thought of as being directly controlled by the volitions of a personal deity could not have been the object of scientific analysis. The analogy of mechanism also reflected man's greatest optimism. He was confident to duplicate the intricate mechanisms of Nature to conquer her. There was nothing mystical or romantic about Nature since she was a machine. She was to be explored and conquered.

The mechanistic model is basically materialistic, positivistic and causal-deterministic in its orientation. [3] Even philosophy came under the influence of this model. Matter became increasingly respectful as an object of cognition. Mind was frequently referred to as the "thinking substance". Descartes' idea of the best machine is a classical example. Philosophy became increasingly interested in the problems of perception, evidence, measurement, motion, time, space, *etc.* [4] This union between philosophy and science reached its peak in the 20th century in the form of logical positivism, analytical philosophy, logical empiricism, *etc.*[5]

This model seems to be responsible for the idea of scientism, which was to develop later in the Western world. Scientism not only insisted that everything can be observed, controlled and predicted, but also should be manipulated in line with the "scientific" principles. Scientism demanded the creation of a scientific utopia on earth. It is a paradox of history that most of the greatest determinists of all times had also been the greatest utopians of all times. [6]

The spirit of this model was basically revolutionary, though at times implied wishful thinking on the part of those who subscribed to this model. Science was to conquer the Nature not only intellectually, but also socio-politically. The extreme deterministic view of this model was a reaction against the cosmology of that time. Science was born in an intellectual environment where the concepts such as "mystery", "free--will", "Divine interference", "revelation", *etc.*, played a dominant role. The new-born science had to fight for its survival. Like all young movements or converts in a hostile environment, science also overstated its case. Religion was regarded as a bundle of superstitions, ignorance and fears. Religion was thought to be on its death bed, since science was on its way up, a form of wishful thinking on the part of some thinkers. Tocqueville, Durkheim, Weber, Simmel, *etc.*, opposed this positivistic conception of religion and pointed out that religion was

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[3] Pitirim Sorokin, *Contemporary Sociological Theories*, New York 1928, p. 3.
[4] E. A. Burtt, *The Metaphysical Foundations of Modern Science*, Garden City 1954, rev. ed., Chap. IV, "Descartes".
[5] B. A. G. Fuller, S. M. McMurrin, *A History of Philosophy*, New York 1938, III ed., Ch. XXXVI, "Logical Empiricism".
[6] Comte, Watson, Skinner, *etc.*, are some of the examples.

social in its origin, nature and structure rather than being merely individualistic and cognitive and that was performing a positive social function in integrating the society. [7]

Many are the major contributions of this model. Intellectually, it broke the backbone of the Aristotelian cosmology and Middle Age theology—a teleological view of the universe with reference to man's salvation (destiny). Man learned to look at Nature from a naturalistic perspective. Moreover, once for all, man gave up his search for the Ultimate Cause. Logic, particularly deductive logic, lost its all-important position in our thought-system. Measurement, precision, operationalization empirical verification, *etc.*, gained respect in man's thought-system. Observation, particularly observation under controlled conditions, was brought to the forefront. Both philosophy and theology suffered their worst setback yet. Man, becoming increasingly secular and empirically oriented, developed a self-propelling faith in himself as an active agent to know. Moreover, it put the foundation for a universal discourse of the minds.

Historically, the technological fruits of science had two major effects on man. First of all, the Western man who had tasted the fruits of the tree of knowledge became increasingly interested in science. The technological fruits of science, not the theories of science, attracted the society and once man tasted the fruits of the tree of knowledge, he became increasingly interested in science. The technological fruits of science, not the theories of science, attracted the society and once man had tasted the fruits, he was determined to have more of them. Only after the fruits reached the masses, we find a social demand in the Western world for science. Continued social demand for the fruits of science made it possible for the Western world to regard science itself as an embodiment of her social values. However, it should be pointed out that only in the 20th century did the Western world develop a social demand for social science. The phenomenal job opportunities available for social scientists in academic, political, industrial and other social institutions, are an indication of this development. This is particularly true in the U.S.A. In the 19th century the social science was mostly an academic rather than o social phenomenon, whereas in the 17th century it was mainly an undergound movement. One can notice similar developmental patterns in the history of the physical sciences, too. Once a discipline has become an academic phenomenon in a society, its transition to social phenomenon would depend upon the types of fruits it will produce. The more fruits it will produce for popular consumption, the quicker it moves from the academic to the social phase. At present, the people

[7] Robert A. Nisbet, *The Sociological Tradition*, New York 1966, Ch. VI, "The Sacred".

of the underdeveloped parts of the world have seen and tasted the fruits of the tree of knowledge. They are determined to have more fruits. This is the seed of modern revolutions.

Secondly, the technology not only brought the remote stars and worlds closer to our eyes, but brought us face-to-face to other cultures and civilizations of the world. Both history and geography did shrink before man's technology. Europe, being scattered all over the globe by the help of technology, became quite curious about other cultures of the world. This curiosity to know about other cultures can be treated as the beginning of social science. It is always easier to look at other cultures objectively than at one's own, just as it is easier for man to look at "animal behaviour" objectively than at "human behaviour." Exposed to various cultures, which were highly different from its own, the Western mind began to understand, though painfully, the meaning of cultural relativity. This new orientation was necessary for the development of social science.

It is true that the mechanistic model has undergone tremendous change and its inadequacy is increasingly clear. However, let us not forget that this model is responsible for the very establishment of science itself. It is somewhat doubtful to me whether any other model with less rigorous methods and less oversimplification of reality would have accomplished what it did in such a hostile environment. This model—as all models ought to do—gave us something to grow out of it. Most of our theories cannot grow because they have not formulated anything precisely enough so that we could grow out of them.

The basic concepts and orientations of the mechanistic model are still part of social science, though we no longer call it social physics. Lewin's "psychological space", Bogardus' "social distance", Coombs' "mapping of data," Thurstone's "attitudinal position of an individual," *etc.*, are some of the examples for the extension of the concept called space which was originally used in the mechanistic model. Other concepts such as causality, quantity, time, motion, elements, dynamics, equilibrium, *etc.*, are also part of our heritage in social science from the mechanistic model. The prestige of a model rises or falls with the prestige of the discipline with which it is associated.

Opposition to the mechanistic model came from many sources. The first voice of opposition came from the Church. [8] The popular opposition came from various movements such as "romanticism", "idealism", "rationalism", *etc.* First, in philosophy Hegel represented the spirit of opposition to the static and materialistic notion of reality. Later, in science the field of thermodynamics began to replace the notion of "absolute

[8] Floyd, W. Matson, *The Broken Image: Man, Science, and Society*, New York 1964, Ch. IV, "An Uncertain Trumpet".

certainty" with that of "probability".[9] This model got further belows by Maxwell's "electromagnetic theory", Bohr's notion of the unpredictability of the individual atomic events at the subatomic level, and finally by Whitehead's and Einstein's "organismic cosmology".[10] Not matter but energy became the basic datum of science. Reality was in flux rather than in a state of rest. Time, space, *etc.*, are no longer independent objective entities out there, but relative conceptual creations of the mind. In social science, before Dilthey developed his thesis to dichotomize science into social and natural sciences the monistic view of the content and of analysis had prevailed.

Unlike a biological organism, a model does not have an actual time of birth or death. A model continues to live with us, in one form or other, even after the arrival of other models on the historical scene. Moreover, they do not follow the same time sequence from country to country. In the United States, the evolutionary model had its effect on the social sciences before the mechanistic model hat its effect. The influence of the mechanistic model was most predominant in "environmentalism" and "behaviorism". It is ironic that in the United States where notions such as "freedom", "individualism", *etc.*, were regarded very highly, these schools of thought took deep roots. It was due to their utopian character that these schools of thought flourished in the U.S. The 20th century United States which passed through the Depression was ready for social planning whereas the 19th century United States was mainly for *status quo*. Moreover, the 20th century social science in the United States faced an identity-crisis. Time had come to decide whether sociology was a "science" or an "art". The newly made identification with the science on the part of sociology in the United States was seen in its emphasis on empirical operationalization, quantification, verification, experimentation, *etc.* Both the unit of time and of space in the sociological analysis did shrink. Sociology became, to a great extent, the sociology of the small groups.

Evolutionary Model

The evolution of this model in our thought-system was, as in the case of all models, a product of various internal and external forces. The mechanistic model became increasingly inadequate for the problems of biological sciences. They needed a "developmental" model to analyze their data. Moreover, by the 18th century, the organization of science itself was too complex to be subsumed under one overarching master model as the mechanistic model had done. Historically, science was

[9] Ludwig von Bertalanffy, *Modern Theories of Development: An Introduction to Theoretical Biology*, New York 1962.
[10] Alfred N. Whitehead, *op. cit.*

ready for a "division of discipline" from within, given the variety of the contents, the immensity of the information stored, and the diversity and specificity of interests of the scientists. The biological sciences were quite ready for weaning.

With the rising prestige of the biological sciences, the evolutionary model also gained its prestige. Historically, the interaction between the two models brought them closer to each other. The exact sciences (physics, chemistry, astronomy) became more "historical" and the biological sciences more "natural" in their orientations. The former became increasingly interested in the origin and history of their subject matter whereas the latter became more interested in the natural law of growth and development. For example, the astronomer became interested in the origin of the universe. Geology, paleontology, archeology, cosmology, *etc.*, are the children and biophysics, biochemistry, *etc.*, the grandchildren of the union between the two models. However, from the intellectual aspect, more important is the development of the philosophy of science. Now, given two models and two orientations to choose from, the scientists had to pay increasing attention to the problems of the philosophy of science, and models became analytical tools rather pictorial representations of reality.

The evolutionary model treated the universe as an open and dynamic phenomenon. Probability became a respected notion among the intellectuals. This model is basically functional rather than structural in its orientation. It is basically historical rather than ahistorical in its conceptual framework. Its major interests are in the processes of change rather than in stable structures and elements. The evolutionary model not only brought the concept of dynamism into sharp focus, but also brought the notion of "direction", "goal", "need" "drive", "adjustment", "struggle", *etc.*, something similar to the notion of Aristotelian teleology. The behavior of the organism was seen as goal-directed, acting from within in connection with certain needs or drives. A biological organism has certain basic needs such as needs for food, rest, *etc.* The organism not only shows structural unity as an organism, but also functional (behavioural) unity with regard to the needs of organism. This is where the mechanistic model was found to be totally inadequate for the behavioural problems of the organism. However, the evolutionary model has not been able to solve the problem of causality. The need, function, drive, goal, purpose, *etc.*, are not synonymous with cause. For example, the goal of a behaviour is not the same as its cause. The evolutionary model needs greater conceptual clarity to distinguish between these concepts. It is one thing to say that the behaviour of an atom is different from that of an organism, but it is entirely another thing to point out that we need different conceptual frameworks to study them. The evolutionary model broke the methodological unity of all contents presumed by

the mechanistic model and divided the contents into organic and inorganic worlds.

The evolutionary model treated man at the top of Nature as the most complex animal, whereas the mechanistic model treated man with the Nature as a complex machine. However, ironically enough, the Church opposed the proponents of this model as vehemently as it did in the case of the proponents of the mechanistic model. This model talks about the behaviour of the organisms while the mechanistic model talks about the "motion" of the atoms or machines. Both the mechanistic and evolutionary models implied certain value-orientations. The former was responsible for scientism and the latter for the ideology of *laissez-faire*. The watchmarker in the former became the "unseen hand" in the latter.

Sociology was born at a time when both models were predominant in the western world. As a result, the social science had the problem of choosing between them, a problem of identity, which is still with us. Sociology incorporated both models to a certain extent in its approach called "Organismic Positivism". The notions such as "struggle", "function", "goal", *etc.*, readily acquired sociological meanings. Surviving values, norms, traditions, institutions, *etc.*, were regarded as well-tested weapons of society in its struggle for survival. Man's ability to use symbolic language began to be regarded as the greatest weapon of all. Division of labour was regarded as the process of evolution. [11]

Social Darwinism took deep roots in the U.S. because it gave the theoretical justification for capitalism. This philosophy was consistent with the stable, structured and prosperous social system of the U.S. Who wants change when things are moving fine? Paradoxically enough, the same theoretical background gave the justification for social revolution in Europe. Things were not moving fast enough towards its goal (Communism) by themselves; so revolution had to put the foot on the accelerator of history as Marx would have put it.

Great models, like great men, never die. They continue to live with us. With regard to science itself, we are not only optimistic about its future, but also evolutionary in our perception. We are not only taking the onward and upward march of science for granted, but also imply a belief that free competition of ideas in the open market place of truth is the best mechanism to guard (produce) truth and to destroy falsehood, which is unfit to survive. We often show a naive faith in "structural differentiation and functional specification" in dealing with our institutions.

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[11] The influence of the evolutionary model in psychology and sociology is well explained by Solomon E., Asch, *Social Psychology*, Ch. I., "The Doctrine of Man", Englewood Cliffs 1952.

As the biological sciences focused more and more intensely upon their specific problems, the grand model of evolution was found to be inadequate since it covered historical epochs in a grand sweep of history and prehistory. It takes ages to notice evolutionary changes on a specie. The experimentally oriented biological scientists became less and less interested in the grand model. As they learned more and more about their subject matter, it became increasingly difficult to organize all their data on the basis of structural complexity and functional specificity alone. The linearity of the evolution itself came under heavy aatack. Moreover, the part played by co-operation among the species or aggregates of animals in the struggle for survival became increasingly clear. [12]

The evolutionary model became particularly inadequate for social science. For example, an individual with several biological tendencies or drives has to decide in favor of one, when he could not fulfil all of them at the same time. The individual has to delay the fulfilment of some in favor of one. This involves the development of a criterion, a value-hierarchy, since he frequently faces such situations in his life. The problem of choice is further complicated by the fact that a complex organism like the individual not only has several biological tendencies, but also several avenues to fulfil each one of them, some of which are culturally approved while others are not. Moreover, many are the occasions in one's life when there is no biological guide (need, drive, tendency, *etc.*) to speak of. Man, as a social animal, is dependent far more upon his culture than upon his biological tendencies for behavioural guidance. Durkheim, Weber, Znaniecki, to mention a few, fought vigorously in sociology to treat man as a social animal rather than as a biological animal. However, it should be pointed out that when a new discipline is born, it has to depend upon the conceptual tools developed in other established disciplines. It takes a while before a discipline is capable of developing its own models. In general, when a discipline borrows models from other disciplines it tends to borrow the ones with higher prestige from the disciplines closer to it. Social science is no exception to this general rule.

With the rising prestige of the medical science, a new model, the balance (equilibrium) model came into existence.[13] The theories of justice, balance, congruency, functionalism, *etc.*, can be subsumed under this model. Like all models, this model also had its opponents. However, this model can be treated as the master model of the 20th century in social science. Since it is too early to evaluate the historical impact of this model on our thought system, I am not including a detailed discussion of this model in this paper.

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[12] Peter Kropotkin, *Mutual Aid: A Factor of Evolution*, Boston 1932.
[13] Walter B. Cannon, *The Wisdom of the Body*, New York 1932.

CONCLUSIONS

The evolution of a model is no historical accident. The time has to be ready for its arrival. The Western world had its long training in the sense of rational order, rather than mystic union, due to an emphasis on the rational nature of the universe in Medieval theology. Greek philosophy gave the impetus to regard the natural world with high esteem. The mechanistic model, the first model of science, taught us how to think in naturalistic terms and man's search for the Ultimate Cause was given once for all. Moreover, the technology it produced not only put the stars and heavens closer to him but also his neighbors from other parts of the world. This "technological" proximity to his fellowmen created a new curiosity in man's mind. He became interested to know about other cultures. We can see here the rudimentary beginnings of social science. Moreover, technological fruits of science are responsible for the creation of social demand for science.

As science developed more and more and conquered more territories, new models were needed for the organization of the existing data as well as the generation of new questions. The evolutionary model was born to cope with the particular problems of the biological sciences, the problems of origin, growth, development and death. The interaction between the two models was very fruitful. It was responsible for the new disciplines such as biophysics, biochemistry, *etc.* Moreover, with more than one model in his hand, man had the problem of choice between the models. Here we can trace the explicit attempt of man to develop a philosophy of science. Philosophy began to regain its prestige it lost with the onset of the mechanistic model. At one time philosophy and science had a near-perfect union in the form of logical empiricism, logical positivism, analytical philosophy, *etc.* Philosophy became scientific and science became philosophical.

If necessity is the mother of invention, prestige is its father. The popularity of a model is intimately related to the prestige it is able to gain by identifying with a discipline. In the past, with the rising prestige of physical sciences, the mechanistic model also gained prestige, since they were closely associated to each other. The same is true of the biological sciences and the evolutionary model. The same thing happened with the rising prestige of mathematics, logic, *etc.* Many models became pseudo-mathematical for the sake of prestige. This is called the "identity-crisis" of the disciplines. Social science is no exception in this matter. It had its time of severe identity crisis. It will have a mild form of identity crisis until it is able to develop its own model to study its problems. At present we are heavily depending upon the mechanical, biological and psychological models.

All models had their trials from within or without. The opponents

of a new model often attack it on ideological grounds rather than empirical grounds. A new model is very likely to overstate its case in its early stage, particularly if it is born in a hostile climate. Given several models at our disposal, we had to pay increasing attention to the problems of the philosophy of science. It was in this connection that philosophy regained some of its lost prestige in the scientific circles. The final testing-ground for a model in science must be the empirical confrontation. However, whether a model is formally or officially with us or not, it continues to live with us in one form or other.