A
Sociological Critique of Science, Society and Development.

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C E R T I F I C A T E

Certified that the Dissertation entitled **"A SOCIOLOGICAL CRITIQUE OF SCIENCE, SOCIETY AND DEVELOPMENT"** *by AVIJEET KUMAR, has not been submitted for a award of any degree to this or any other University. We recommend that this Dissertation may be placed before the examiners for the consideration of award of* **DEGREE OF MASTER OF PHILOSOPHY** *in Educational Studies of Jawaharlal Nehru University, New Delhi.*

K Ahmad
(KARUNA AHMAD)
Chairperson

K Ahmad
(KARUNA AHMAD)
Supervisor

For ....

Ma, Papa and,
my sweet joint family
of which I am proud of.

CONTENTS

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Avijeet Kumar

(AVIJEET KUMAR)

Chapter I

An Introduction to Science

Whenever we first run into the concept the question of what science is, most of us either surmise that we understand the answer or anticipate a very straightforward answer to it. The multiple facets that science represents has very conveniently allowed itself to be toyed in many different ways. A comprehensive and scientific understanding of science however, calls for a complex answer.

MEANING AND STRUCTURE OF SCIENCE

If we look science from a sociological point of view, the term is understood from its two main dimensions, 1). as a body of knowledge, which takes into account the meaning, philosophy, structure of science among other related issues, 2). as a social institution, which is essentially concerned with the organisation and control within science.

The conventional definitions of science basically tend to emphasize four quite different features of it - the instrumental, archival, methodological and vocational - depending upon the view point of respective metascientific disciplines.[1] Science when viewed as closely connected with technology as a means to solving problems emphasize its instrumental aspect. When it is viewed as organised knowledge where information about natural phenomena is acquired by research and technological applications that are organised into coherent theoretical schemes and

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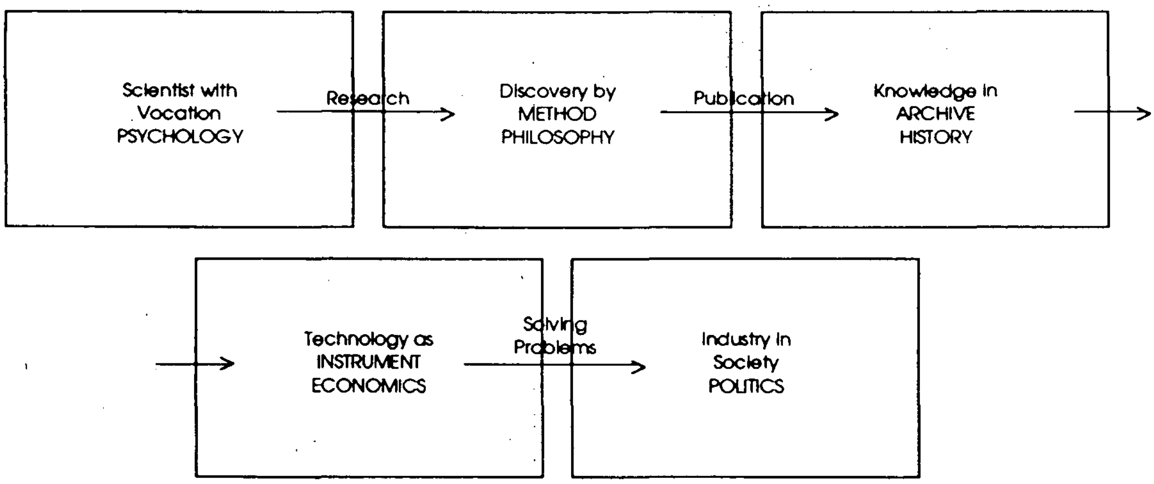
1 Ziman. John., **An Introduction to Science Studies**, Cambridge; Cambridge University Press, 1984, p.2.

published in books and journals, its archival aspect is highlighted. The methodological aspect is emphasized by the old philosophical tradition which considers the procedures of experimentation, observation and theorization as a special method for obtaining reliable information about the natural world. Lastly, the vocational aspect of science also needs emphasis that draws attention to such important aptitudes as curiosity and intelligence and suggests that scientists should be recognised as members of a distinct profession.



(The Chain of Discovery)

These points would be dealt in detail later. Presently, it would be interesting to note how these four conventional definitions of science have been inter-connected in what Ziman[2] it calls the "linear discovery model of science". The model shows the discovery in science and how

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2 Ziman. John., op. cit., p.3.

through different metascienctific disciplines (which emphasize one aspect of it) it is processed and passed until it consequently merges with society and Industry.

This model, however, is too simple and neglects two very significant realities.

1. It assumes that the information flows only in one way along the chain as if there were no technological demands on basic scientific research.

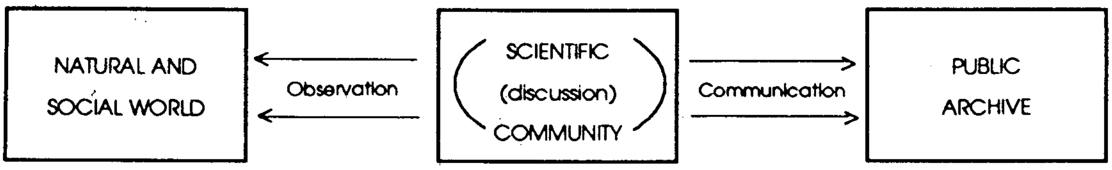
2. It does not account for the communal endeavour of the scientists whose actions are strongly influenced by social goals and norms.

Having been aware of these four aspects of science, it should be acknowledged that science, in truth, is all these things, and perhaps many more. It is indeed the product of research, it employs characteristic methods; it is a body of organised knowledge, it is a means of solving problems. It is also a social institution; it needs material facilities; it is a cultural resource; it is required to be managed; it is a major factor in human affairs. Thus, any explanatory model of science must relate to and reconcile with these diverse and sometimes contradictory aspects.

With such varied facets, it is recognizable now that in neither of the sense is the meaning of the word science perfectly clear cut and holistic and it would be a mistake to pretend otherwise. But it would be equally misleading to pretend that there is not a fairly widespread consensus of opinion as to what science really is. Thus, science has been accepted and understood as "a method of approaching the empirical world as a mode of analysis based upon the hypotheses presented under the form, 'if ...then ...' and leading to a system of generalized propositions, that are derived from rigorous experiments and demonstrations, are constant and verifiable and have the sole aim of arriving at objective, rational explanations and unrefutable truth and hence absolutely neutral and free from ideology and cultural bias".[3]

Science, generally refers to the rational knowledge of some aspect of 'the world'. This means that it takes the existence of the internal world for granted and assumes the rational belief as justified.

The sociology of science, has two schemes to treat the scientific knowledge. The internal scheme which treats scientific knowledge as if it



(ACADEMIC SCIENCE AS SOCIAL SYSTEM)[4]

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3 King. Kenneth (ed)., **Science, Education and Society**, IDRC 1985.
4 Ziman. John., op. cit. p.9.

were accumulated 'solely for its own sake', without any thought for its possible applications. Its programme is to account for what goes on within this region philosophically, sociologically and psychologically, without reference to the wider world. Thus, academic science or pure science, as it is often called, is the characteristic model for the 'internal' sociology of science.

The 'external' scheme of sociology of science assumes science as the black box and concentrates on the technological effects of knowledge that percolate outward from 'pure' science and is applied for the solution of practical problems (eg. Industrial Science). what is regarded here as paramount is the services that this 'applied' science, as it is often referred to, renders to political, military or commercial forces.

At a purely descriptive level, science has been represented naively as a community of individual scientists observing the natural and social world, discussing their findings and recording their results. This makes a social institution devoted to the construction of a rational consensus of opinion over the widest possible field.

An important question which may be asked at any stage of argument is whether 'science' which refers to the study of natural phenomena by objective techniques should be extended to the interpretation of the social system and the psychological events where 'subjective' factors cannot be avoided? Or, the differences that undoubtedly do exist between the major types of sciences - physical (natural) and social - are they those of kind or those only of degree?

It can be said here that both the understanding of natural and social world is an effort to understand reality. Karl Mannheim has described the different aspects of this reality under the labels of 'objective', and 'evidential', levels of meaning. The important feature of the objective meaning of a social phenomena is that it can be grasped without specific knowledge of the intentions of the individuals taking part in the social process. This implies that objective meaning is essentially based on shared meanings and understandings. Thus, for Mannheim, any dichotomy between the subjective and objective approaches is ultimately false dichotomy sine social reality for him has both subjective and objective meanings. Weber, too, has rejected such a distinction. He conceived of science (both natural and cultural) as an aspect of the process of rationalization that is the characteristic of modern western societies and saw them as characterized by essential incompleteness and objectivity.[5] Just as in natural sciences the phenomena under study is done through intermediary of mathematical propositions and observed constants and

5 Aron. Raymond., **Main Currents in Sociological Thought**, Part II, London; Penguin Books, 1982, p.189-98.

laws, similarly in social science the social phenomena is studied via the human intrinsic intelligibility, consciousness and shared behavior verifialility, which is inseparable aspect of objectivity in natural sciences, can be attained in social sciences too when socially constructed reality is understood in terms of the shared meanings assigned to the social phenomena or behaviours by the individuals (actors) themselves.

Luckmann and Berger[6] (The Social Construction of Reality) harp on a similar note when they mention that society has both objective and subjective reality that exist in a dialectical relationship - an individual confronts structures and processes which appear external and beyond his control and at the same time internalizes and reproduces these structures in the process of finding personal meaning and identity in the world. These structures and processes are not as empirical an object as material things are for physical sciences, but they are nonetheless, real things. They help to understand the otherwise disconnected series of unrelated social events and make them meaningful in a conceptually constructed and structured world.[7]

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6. Luckmann. T., and Berger. P.L., **Social Construction of Reality — A Treatise in the Sociology of Knowledge**, Harmondsworth; Penguin Books, 1976, p.72.
7. Jagtenberg. Tom., **The Social Construction of Science: A Comparative Study of Goal Direction, Research Evolution and Legitimation**, Drodrecht, Holland; D.Reidel, 1983, p.14-15.

Two familiar criteria for the distinction and hierarchical arrangement of sciences - physical, biological and social - has been in terms of

1. generality of their subject matter and
2. the degree of certainty of knowledge.

According to the first criterion, physics occupies the most exalted position because its subject matter is universal i.e. the fundamental physical properties of all materials. Biological sciences are less broad in scope as they are preoccupied only with those bodies that are alive. They merge gradually into the social and behavioral sciences through the agency of psychology. In a science such as sociology the scope is significantly limited by its concern with only a small fraction of the world, namely human societies.

In so far as the criterion of the degree of certainty is concerned, it can be mentioned here that we have come far since the 17th century when Galileo could say with such confidence that : "The conclusions of the natural science are true and necessary and the judgement of man has nothing to do with them." Far from this belief that science was the final expression of human spirit, we have now reached a new condition of doubt and uncertainty in which the only thing that appears to be certain is that our understanding of the universe and our place in it, is necessarily limited. Theories of modern physics, coupled with the growth of relativism and the recession of `objectivity' in philosophy of science, have left the impression that the world so successfully discovered by science is not the world as it really is. Science can, of course, tell us a great deal about the world, but it cannot, seemingly, give us the whole truth.

One of the most arresting discoveries with a particularly disconcerting impact on our overall conception of what the world is 'really' like, is the "principle of uncertainity".[8] The principle states the limitations of the concepts of classified physics in a precise mathematical form. In the minutest world of elementary particles, events do not always follow the strict causal sequence of our normal experience. This was extraordinary, in the sense, that even in physics which is considered as the archetypical 'hard' or exact science, one finds that the results of events can also be not predicted according to the deductive model, but can be specified only in probalilistic terms. Similarly, the incompleteness theorem (Kurt Godel, 1931) showed that no set of logical relations can be established that do not also imply the existence of still other relations with which the set itself cannot cope. The point that has been tried to bring home is that earlier there was this belief that physical sciences with their particular interest in the invariable laws, that it seek to establish, aimed to achieve scientific

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8 Heisenberg. W., **The Physicists Conception of Nature**, London; Hutchinson, 1958, p.102.

knowledge that were universal, independent of time and space, held in with a consensus, objective and logical, and one which could predict the future course of action. This belief has been proved to be a misconstrued one (Heisenberg, 1958 Godel 1931).

Social sciences, on the other hand, have been accused of unscientific nature, lack of causality and generalizations; unpredictability and personal bias, basically because of the sheer complexity of human life that dooms to failure any attempt which aims to be genuinely scientific. Complexity is undeniably a problem in seeking a clear causal sequence, but this is also a problem in biological science (eg. ethology and ecology etc.) Experimentation is another problem in behavioral science, but these are also a problem in natural sciences (geology and biology), yet they have given extensive bodies of scientific knowledge, with laws and theories.

Hence, any area of human social inquiry in which complexities exist and in which the opportunity for controlled experiments are rare cannot be disqualified from the ranks of science on this account alone. Lately, there has been also the growing response that social science is desirable as it takes into account the subjective and 'value impregnated' aspect of social phenomena that are present because of the very nature of purposive human actions. Any attempt to exclude subjective interpretations, or ask for a genuine detachment from the social scientists on delicate human issues would inevitably mean the elimination of a genuine social fact.[9]

It has been seen till now that irrespective of the types of science, the difference and between them is not of kind but of degree. Rationality and intelligence which are the prime human source of scientific method can be seen to be operative in different sciences with of course varied degrees. To this extent, Bridgman said -"I like to say there is no scientific method as such but rather only the free and utmost use of intelligence."[10] Let us look a little more closely at what is the relationship between human rationality, intelligence and science. In most general sense by "rational thought" is meant any thought which is in accord with the cannons of Aristotelian logic, or, for certain cases, with modern non-Aristotelian logic.[11] It means that rational thought keeps nonidentical things separate (A cannot be both A and non-A). Thoughts are rational in this fashion whether men who use it are explicitly aware of these logical cannons or not.

Science exists only when rational thought is applied to "empirical

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9 Richard. Stewart., **Philosophy and Sociology of Science An Introduction**, p.36.

10 Bridgman. P.W., "How far can scientific method determine the ends for which scientific disconeries are used?" **Social Science**, Vol.22, US; Chapel Hill, 1947, p.206.

11 Rapoport. A., **Science and the Goals of man**, New York; Harper and Brothers, 1950.

ends, i.e. ends which are available to our several senses or to the refined developments of those several senses in the form of scientific instruments.

In all societies, rational thought is however, applied to both kinds of end, the empirical and non-empirical. Non empirical realms where the rational thought applies are those which follows moral norms and certain norms of aesthetics. It is an important fact to note here that the degree of interest in these two different kinds of end varies widely among different societies. For example, Hindu society places relatively greater emphasis on the non-empirical ends than does the modern western society.[12] Though all non-empirical ends in society are potentially reducible empirical, they do have a margin of autonomy and are not wholly reducible now to proper empirical science.

What is usually thought as human intelligibility or common sense constitutes in fact that "embryonic" science; out of which more mature science grow. Both common sense and science have in part a common origin in human rationality, but unlike science, common sense is based on some implicit, particularized kind of abstraction that fail to make it a field of reliable and determinate knowledge.[13]

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12 Barber. Bernard., **Science and Social Order**, London; George Allen and Unwin Limited, 1953, p.8-11.

13 ibid, p.21-22.

Development of Science

The roots of modern science may be traced back to the time of Renaissance, to the practically oriented philosophy of Bacon and to the experimental method of Galileo. By 1600 William Gilberts 'De Magnete" included substantial sections on the use of magnets in nautical instruments. The process of industrialization occurred first in Britain and then German later took the credit of having the first superbly organised, economically - motivated industrial machines. In the 19th century one saw the large scale convergence of science and technology in Germany, USA and UK and the emergence of well equipped industrial R and D laboratory.

As late as the 1920's science was viewed as 'pure' by which was meant that it was entirely uncontaminated by the workings of social factors. But later periods saw the events such as the economic depression of 1930's with its frustration of science, the rise of Nazi Germany, with its preachment of an 'Aryan science' and its violence towards Jewish scientists, the world war II culminating into the explosion of atom bomb, brought home to scientists and others that there is an important social influence on science. (This relationship between science and society would be dealt at length in further appropriate section of this chapter). Social view of science now became the subject of study among intellectuals. German social scientists in their study of the sociology of knowledge tried to show how science as well as other forms of knowledge, were directly affected by social factors.[14] Marxist oriented scientists and scholars have produced a spate of historical studies which sought to demonstrate what they often referred to as "social roots of science." (B. Farrington, 1949, B. Hessen, 1931, J.D. Bernal, 1939).

There is another quite differently put explanation of the growth of science which treats it in terms of quantitative aspect.[15] Price 1963 took the parameters of measures of science such as the number of people practicing it, the amount of money spent on it, the quantity of knowledge it produces etc. and points that the normal mode of growth of science is exponential. That is to say science grows at compound interest, multiplying by some fixed amount in equal periods of time.

Let us now examine the growth of the oretical knowledge in science for it is only with the rational and reliable acquisition of knowledge that science as a body develops. Such an analysis would bring us into the domain of the 'philosophy of sciences' where again the main thread linking the various accounts of science is rationality. In short, what we will be looking at present is how is the science as a body of knowledge, its

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14 The summary and critical review of the sociology of knowledge is given by Merton. R.K., **Social Theory and Social Structure**, Glencoe; The Free Press, 1949. (Chapter VIII).

15 Price. Derek de Solla., **Little Science, Big Science**, New York, Columbia, 1963.

growth, acceptance or rejection, its content and methods, in general, the nature of science is understood from a philosophical plane?

It is to Aristotle that we owe the invention of logic, whose method was conceived as a procedure which moved by rigorous argument from self evident premises to incontrovertible conclusions. The method was essentially inductive - observation followed by generalization. For him, appropriate questions when asked revealed the description an definition of the true nature of phenomena.

Akin to Aristotle, the kernel of Bacons Method, the first major philosopher of science of modern period (1561-1626), was aimed to unveil the fundamental laws or 'forms', of nature for the benefit of man. His important single advance on Aristotle was his belief in the use of experiments designed to facilitate the discovery of facts. J.S. Mill's (1806-1873)[16] conception of scientific method was based on the belief that it was the purpose of science to reveal causes and find general laws. For this he gave his cannons of induction that still are impressive rules for reasoning and growth of Knowledge.

Our Century is significantly characterized by frequent heated debates on the nature of science that have played an important role in shaping

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16 Mill. J.S., **A System of Logic**, London; Rongmans Green, 1879.

the concepts of science. The earlier period of this debate was dominated by logical empiricism or logical positivism where mathematical logic formed the central construct of this school in its formulation and dealing with problems. Such an approach meant that the "philosophy of science was to deal with the form - the logical form of scientific statements rather that with the content."[17] As a result the logical structure of a statement, expounding scientific theory or explanation of an objective phenomena becomes the problem instead of actual theory or the explanation. The supposed task of testing theoretical construct against the actual scientific practice was increasingly dispensed with. The conclusions of philosophy of science were therefore supposed to be applicable only to the most highly developed scientific theories which had reached the stage of articulation and sophistication and "permitted treating them as precisely and completely formulated axiomatic systems with precise rules of interpretation."[18]

This logic demands a system to be perfected to a stage where it becomes idealized, leading to a position where there is no notion of logic of discovery. If at all the development of knowledge is considered, it is in a sense of ever increasing accumulation of facts and theories to already

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17 Shapere. Dudly., "Meaning and Scientific change" In Hacking. Ian (ed)., **Scientific Revolutions**, DUP; 1981, p.29.

18 ibid., p.30.

axiomatised system. It considers science to be an attempt to find one final truth about one real world, generating thoughts which are value-free and neutral, regardless of how and by whom they are produced. Since such a philosophy gives no importance to the subject matter, it fails to make distinction between subject and the object and therefore ceases to be at all objective. Built upon an idealized hence an unchanging system, it develops an inherent dogmatic character reducing science itself to dogma.

As a reaction to inductivism and logical positivism there grew another radically new approach for the prodigious advance in the growth of scientific knowledge-the hypothetico-deductive method-where the collection and analysis of information was guided by a pre-conceived idea.

The most influlential exponent of this methodology was Karl Popper, (1962-1963)[19] who elaborated his ideas in what is known as the theory of falsificationism. According to him hypotheses are to be developed and attempts made to falsify them through empirical research. In his own words, ".......there is no more rational procedure than the method of trial and error, of boldly proposing theories; of trying our best to show that

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19 Popper. K.R., **The Logic of Scientific Discovery**, London; Hutchinson, 1962.

these are erroneous; and of accepting them tentatively if our critical efforts are unsuccessful."[20]

Popper's singular contribution has been his sharp distinction between the attempts to prove and disprove scientific statements. For him to prove a theory true is logically impossible, what is possible is to deduce the falsity of theories from singular disconfirmatory statements. Thus, there are no fixed number of confirmatory observations that can permit us logically to verify the universal statement "all birds can fly" and a single observation of a flightless bird would permit us to conclude that it is not the case that all birds can fly.

The most profound philosophical reaction to the idealistic philosophy embodied in logical empiricism came from the historicist school of thought. According to Thomas Kuhn (1962), noted philosopher of science, there exist two major phases in the development of science and there is a sharp distinction between these two phases called normal science and scientific revolution. The normal science is the traditional, conservative, problem solving activity with ever increasing sophistication of techniques and theories. By contrast, scientific revolutions are "non cumulative episodes

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20 Popper. K.R., **Conjectures and Refutations,** London; Routledge and Kegan Paul, 1963.

in which an older paradigm is replaced in whole or part by an incompatible new one."[21]

Despite the title of his book, the most characteristic feature of the scientific enterprise as depicted by Kuhn is its conservatism, which is seen as the consequence of the prolonged 'indoctrination' that scientists receive. This is an indoctrination within the confines of what he calls a 'paradigm' - which for him meant a great tradition, a whole way of thinking and acting within a given field. It is not merely a set of rules, laws etc but is something from which all images, concepts, methodology are drawn. It is or could be "some implicit body of intervened theoretical and methodological belief, that permits selection, evaluation and criticism."[22]

The paradigm represents, thus, the totality of background information, the laws and theories which are taught to the aspiring scientists, as if they were true, and which ought to he accepted by him if he in turn is to be accepted into the scientific community. The work of the community is likened by Kuhn "puzzle solving" and the sum of these activity constitute his normal science.

Normal science which works within the paradigm without questioning

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21 Kuhn. T.S., **The Structure of Scientific Revolution**, 2nd edition, Chicago; Chicago University Press, 1970, p.91.
22 ibid., p.16, 17.

its authority is cumulative, stable and successful within its own terms. Here, stability and success are to be seen as the limiting function of the paradigm, for the latter exerts its control by ensuring that normal science tackles only problems which it has every expectation of solving. (This is neatly encapsulated in P.B. Medawar's famous description of science as 'the art of the soluble')[23]

Kuhn has mentioned that the major concern of normal science is not to search for substantive novelties, but to refine the paradigm which is never perfect. A Kuhnian scientist is not concerned with the refutation of theories and explicitly rejects falsificationism as a methodology. Popper has acknowledged the existence of 'normal science' but reject it in turn as merely bad science. The paradigm, for Kuhn, thus is the determinant of the success, stability, maturity and more importantly scientific nature of any discipline.

He identifies the path of the advancement of scientific knowledge in the revolutionary shift of the paradigm. But this fall of paradigm are traumatic, in much the same way as are political upheavals, because of the earlier tremendously strong psychological commitment of the scientific

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23 Medawar. P.B., **Induction and Intuition in Scientific Thought**, London; Methnen, 1969.

community and researches towards it.[24] Kuhn believed that in science "the reception of a new paradigm often necessitates a redefinition of the corresponding science. The (new) normal scientific tradition that emerges from a scientific revolution is not only incompatible but often actually in commensurable with that which has gone before."[25]

Although Kuhn's attempt is the first to give science an organic character and the viewpoints reaches much nearer to reality, it is weak and inadequate. The process of science cannot be viewed but as a historically continuous process. "The posing and resolving of conceptual problem continues unabated throughout the life of an active research tradition."[26] Scientific revolutions, for Kuhn, occur in discrete and non-coherent steps - though this approach tries to realistically articulate the development of science, it poses the problem of building a theoretical framework that would reflect the historical continuum. However, the analysis of historical developments in science shows that conflicting research traditions, theories and viewpoints in science have always co-existed and helped in mutual sharpening, leading to a more progressive tradition, theory or view point, thus making science essentially a dialectical process.

24 Cohen. Bernard., **Revolution in Science**, UK; Belknap Press of Harward University Press, 1985.

25 Kuhn. T.S., op. cit., p.102.

26 Larry. Laudan., **Progress and its Problems : Towards a Theory of Scientific Growth**, London; University of California Press, 1977, p.134.

Another important weakness of this school of thought is its misleading over-emphasis on the concept of incommensurability between the successive scientific theories. If this logic is accepted to be true it means that there is no particular language of science and it is impossible to establish or discard any belief of theory from rational point of view. Science, thus, can not make a "particular claim to our cognitive loyalties."[27] Such a science is indistinguishable from whim and caprice and the logic of this school of thought reduces science to a realistic, ahistorical and non-dialectical process.

MODERN SCIENCE IN SOCIOLOGICAL THEORIES

Looking at the nature and dynamics of modern science most sociologist have tried to observe it as an autonomous subsystem, isolated from the socio-economic and political forces of the society[28]. They are functionalist who over emphasized the functional system of science and technology in a concrete social framework. On the other hand, the structuralists or the Marxist critique challenged this internalist view point and propounded that science as a form of social activity cannot grow in isolation. It is always shaped and conditioned by the social processes. Functionalist agree for a pure science or academic science which Marxist

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27 Ibid., p.14.

28 Blume. Stuart S., **Toward a Political Sociology Of Science**, London; The Free Press, 1974, Chapter 1.

reject and propagate for a utilitarian science. Furthermore, the orthodox Marxist have tried to put science at the infrastructural level and have put a great deal of emphasis on science as an instrument of production process. For them scientist stand themselves as abbreviated workers in the society. They could hardly realize that science could also be a dominant ideology to serve the interests of the ruling elites of all societies and could also be placed in the superstructure.[29]

The later Marxists have corrected the position and have shown that science can be both an ideology and a force in the means of production and therefore can be placed both in the base and superstructure. Even they could not realise that the scientist can be a bureaucrat and a manager, a man in the decision making process helping in the structural maintenance of capitalist apparatus and can associate with the ruling class and meet a worker alone.

However, an attempt would be made here to review the debate between both the schools very briefly. Systematic thinking in the social perspectives of science became pronounced in the 1920's only.[30] During this period an intense debate between the two different schools of

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29 Rose. Hilary and Rose. Stevan (ed)., **The Political Economy of Science - Ideology in the Natural Sciences**, London; MacMillan, p.XVII.

30 Berry. Barnes. (ed.)., **Introduction of Sociology of Science**, London; Penguin Books, 1972.

thought took place on the social studies of science. The functionalists were concerned with the "interactional", "institutional" and "cognitive" aspects of science. Science to them is a "leisure class activity" and they believed its "value neutrality". Whereas the Marxist critics were advocating the social responsibility of science and scientists science must be a planned social activity with a commitment to society. They argue that the process of cognition was a reflection of societal situation and as such socially and materially determined.[31] In this context, socialism and scientism was on their side. The major breakthrough which Soviet Russia has made is a pointer to this fact.

At the infancy of the social studies of science, there were British association such as International Council of Scientific Unions, Society for study of Relations of SCIENCE and the Committee on the Science and its Social relations, which were leading the movement of science and social responsibility, considering essentially the general nature and character of science in society.

In this intellectual milieu the social studies of science began in 1930's. The late start in this branch of enquiry may be attributed to the low intelligibility of its beliefs and culture, and the inaccessibility of the social

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31 Shennin. Y., **Science Policy: Problems and Trends**, Moscow; Progress Publishers, 1973.

scientists to the system of scientific establishment, that kept them away from entering in.[32]

However, science as a social activity was first of all perceived by Max Weber. He could see "science" and "science environment", influencing each other in an interactional process. In this essay "science as a vocation", he points out on the social environment upon which the scientists interact and carryout their research. His focus was limited only to the university scientist and their material prospects which is conditioned by the distribution of authority within the university system.

He was perhaps the first thinker to give science a professional status and recognized scientists as a professional group or community. For him, "science is a calling" and scientists always respond to this inward calling.[33]

Another notable contribution to this idea came from Karl Mannheim. His views are somewhat different from Weber. His emphasis is on the cognitive aspects of human knowledge, which is rooted in the material plane of human society. He points out that knowledge or truth is socially determined, the idea which he derived from Marxist philosophy. He took a step forward, rejected the Marxist view that class position is the sole

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32 Berry. Barnes (ed.)., op. cit. p.63.

33 Weber. Max., "Science as a Vocation", Gerth. H.H and Mills. C.W. (eds.)., , **From Max Weber: Essays in Sociology**, London; Routledge & Kegan Paul Limited, 1957, p.129-156.

determining factor of everything. To him an organically integrated group can conceive of history as a continuous movement towards the realisation of its goal and whereas socially uprooted and loosely integrated groups spouse historically intuition which stresses the fortuitious and imponderables.[34] He maintains that there is an existential basis which corresponds to variety of perspectives and real knowledge.

With Robert Merton the sociology of science as a discipline grew with a systematic and comprehensive treatment of science society relationship. He emphasized on the institutional pattern, norms and its characteristic ethos of science as a social enterprise. These preceding norms are; unversalism, organised scepticism, communality and disinterestedness.[35] To this Bernard Barber adds another four norms, namely, rationality, utlitarianism, individualsim and progressiveness.[36]

Hagstorm joins the Mertonian scheme, acknowledges the normative guidelines and further adds the "reward system" which he discribes as very essential for scientific activities.[37] The reward system provides an incentive for research work of the scientists. Scientist's freedom and

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34 Mannheim. Karl., **Ideology and Utopia - Introduction to the Sociology of Knowledge**, London; Kegan and Paul, 1940.

35 Merton. R.K., "Science and Democratic Social Structure", **Social Theory and Social Structure**, Chapter 16.

36 Barber. Bernard., op. cit. p.60-82.

37 Hagstrom. Warren. O., **The Scientific Community**, New York; Basic Books, 1965, p.104.

independence to choose their area of research is an important factor in this field, as he saw it.

The central theme in the writings of the Mertonians in 1930's and 40's were to identify science as a social institution and its cultural norms and ethos which can only flourish in a liberal democratic social structure.[38] To them, pure scientific activity is only possible in an ideal democratic society where the scientific norms can be adhered. Properly, being free from any internal constraints further, Merton could locate a causal relationship between protestant Ethic and the use of modern science and capitalism.[39] Their emphasis lies in the internal stratification' and the reward system in the scientific community. The hierarchical arrangement within the community, the systems of internal control and functional interdependence also figured in most part of their writings. Later, their attention shifted mostly to the institutional patterns and various linkages in the scientific enterprises. The broader socio-economic and religious influence upon scientific organisation came to their main focus. They also tried to define the scientific roles in a society. However, many of these works are purely descriptive in nature and do not have a systematic sociological perspective.

With the writings of Kuhn the functionalist analysis took a new

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38 Barber. Bernard., op. cit., p.110.
39 Merton. R.K., "Science, Technology in 17th Century England", op. cit., Chapter 15.

dimension. He laid emphasis on the problems of social structure and organisation and in the internal dynamics of pure science. The progress of science through ages was an important subject matter in his writings. The growth, continuance and the transmission of science received a comprehensive treatment which gave a new impetus for sociologists to enquire into this field.

Kuhn rejected Mertonian normative prescription for the growth of science. To him the norms of organised scepticism, rationality and individualism deny any kind of methodological tolerance, science as a progressive social activity cannot be founded upon either total scepticism or pure individualism. One admits the place of rationality and scepticism but not in the way Mertonians overemphasized it.[40] Merton's norm of universalism also received a set back with the growth of the so-called "Aryan science" or racist science in Nazi Germany and Soviet science in stalinist Russia. Mulkay reaffirms Kuhn's thesis of the rigidity rather than the flexibility of the scientist in his attachment to paradigms and indicate that it is this rigidity rather than the Mertoniam imperatives which guarantees the growth of knowledge.[41]

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40 Sklair. Heslie., **Organised Knowledge: A Sociological View of Science and Technology**, London; Hast-Davis, MacGibbon, 1973, p.112.

41 Mulkay. M.J., **Science and Sociology of Knowledge**, London; Allen and Unwin, 1979.

In retrospect, it can be said that the Functionalist writers were influenced by the Weberian general theory of society while formulating their assumption in sociology of science. Mertonians and Kuhnians further developed these ideas which dominated the intellectual arena in the West and their colonies. The newly independent, developing countries were influenced by the theory because of their colonial hang-over. Their main concern was on the management of scientific affairs within the university system. They fail to recognize that the major scientific and industrial complex exists more vigorously outside the university corridors. Moreover, they were busy with the individual scientist, his achievement and recognition. The scientific community, the culture within it and their relation to government and policies found no place in their writings.

They put scientific creativity and individual scholastic excellence above the objective situations of the social reality. They put it as something original by itself. But this so called originality is based on the socio-economic and intellectual milieu of any society. Science as a body of organised knowledge continues to flourish in specific and historically determined society.

Even their treatment of science as an autonomous activity is somewhat ahistorical in nature. Science was never a free leisure class activity as perceived by these critics. In the fedual world, science was controlled by state through church. It was freed for a brief span of time in history only after Renaissance; but was again subordinated to the industrial capitalist class and its production process.[42] Science today has become heavily dependent upon the politico-economic aspiration of industrial enterprises. For funds it depends heavily on government exchequer or its private sponsors who direct mostly the search processes.

The Marxist critics have taken care of the lacunae that exist in the functionalist problematics and provided a more comprehensive framework. They draw their main inspiration from Marx's ideas that it is the social existence that determines one's consciousness and not vice versa. Ideas emanate from the concrete material conditions of the society and not in a vacuum. The change in his consciousness and ideas are bound to occur with any change in the material conditions of life. They attacked the ideas of autonomy, free leisure class attitude which persistedin the minds of functionalists while viewing scientific activities and scientific organisations. The protagonists in leading this movement were Bernal, Haldane, Borris Hassen etc, who exposed the unrealistic assumption laid by the functionalists. Their writings concentrated mostly upon the abbreviation of scientific

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42 Ramasubban. R., "Towards a Relevant Sociology of Science", Blume. S.S., (ed.)., **Pespectives In Sociology of Science**, New York, John Willey and sons, 1977.

workers and on how science and technology operates as means of social production.

The Marxist sociology of science derives from the general philosophical writings of Marx and Engels. The theory of social development, historical periodisation, the class structure and antagonistic class relations and the social formation on the material basis are the main guidelines in their theory construction. As a matter of fact these things figure very prominently in their writing:

1. The mode of production and corresponding class structure,
2. The ideological super structure, and,
3. Social revolution.

Science is a socialised knowledge, and a major tool which man progressively perfects in order to increase his own material development.[43] There cannot be any rigid compartmentalization between pure science and applied science. It is essentially subservient to historically determined social forces. However, this "historical-relative" approach to the development of science is the defining characteristic of Marxian sociology of science.

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43 Sklair. Heslie., op. cit., p.116.

Another guiding factor is the Marx's theory of infrastructure and super structure relationships within a society. Knowledge arises out of man-nature interaction process, and his need to master social and economic environments. Technology is born out of this process and conditions for the mode of production in a society. This subsequently helps in moulding or shaping a superstructure of ideas based on the production process. The conceptualisation of scientific problem is, however, influenced by socio-economic and cultural conditions of the scientists in their own society. For example, Darwin's theory of natural selection was modelled after the prevailing notion of competitive social order, which is grounded on the economic reality of capitalism. To sum up, observing the impact of the mode of production and its corresponding super structure of ideas upon the development of science at each stage of history is what is the Marxian sociology of science all about.

Both Marxist problematic and the functionlist problematic have their limitations so far as certain phenomena remain unexplained in their study on sociology of Science. But this inadequacy can never result in an over all rejection of their basic framework. The general significance of theory in the explanation of trends and pattern in the development of science and technology in a social framework is universally recognised. Thus, these theories prove important in so far as any inquiry into this branch of academic discipline is concerned.

In this chapter an attempt was made to understand the meaning and structure of Science. It also took into account the growth of theoritical science and analysed the place of science in the sociological theories. Against this background, the next chapter discusses the existing interrelationship between sicence, society and development with particular reference to the science education.

Chapter II

A Critical Analysis of Science, Science Education, Society and Development

Science and Society

Contrary to the prior-conceived notion of science as a 'monolithic' entity whose purity can be preserved only when it develops in a vacuum, the relation between science and society has today become mutually influential. It has now become one important area of study in sociology of science where science is understood as that ongoing social activity which give rise to cultural and civilizational products and the environing social structures.

Before moving on to this dialectical relationship between science,science education and society, one point which we had also noticed earlier in our discussion on rationality and growth of science should be brought to focus here that is, the ubiquitous nature of science irrespective of the type of society. Malinowski[1], in this respect observes : "If by science be understood a body of rules and conceptions, based on experience and derived from it by logical inference, embodied in material achievement and in a fixed form of tradition, ... then there is no doubt that even the lowest savage communities have the beginnings of science, however rudimentary." Thus, with differences in degrees, rational empirical knowledge is understood to have been operative in every society. Our

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1 Malinowski. B., **Magic, Science and Religion and Other Essays**, London; George Allen Unwin Limited, 1948, p.17.

discussion will, however, he restricted to the relationship between modern science and modern society.

Talcott Parsons[2] notes : "Science is intimately integrated with the whole social structure and cultural tradition. They mutually support one another - only in certain types of society can science flourish, and conversely without a continuous and healthy development and application of science such a society cannot function properly." Another very significant point, as examined by Bernard Barber,[3] is the degree of relative favorableness which different modern societies present for science. He has shown how certain 'liberal' societies like the United States and Great Britain are more favorable in certain respects to science than are 'authoritarian' societies like Soviet Russia. Bernal's book, 'The Social Functions of Science', is another good demonstration of the relation between the liberal character of British society and its excellent science.

The relation between science and society can be examined through two dimensions that have been attached to science, (1) as a social institution, and, (2) science as a body of knowledge. The mutually influential relation between science as a social institution and society operates at two levels:

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2 Parsons. T., **The Socia System**, Glencoe; The Free Press, 1951, Ch. VIII.
3 Barber. Bernard., **Science and Social Order**, London; George Allen & Unwin Limited, 1953, Ch. 3.

a) Science needs resources for its development and thus it has become a major social investment which justifies it self in terms of social needs and aspirations,

b) science engenders certain cultural values (rationality, highly specialized division of labour, utilitarianism etc.) which depending on the degree of their permeability, affect the society very deeply.

The reciprocal and effective bond between science as a body of knowledge and society, first and foremost brings one imperative and obvious fact into light and that is the scientific knowledge which is attained are approached through social concepts which are deeply, though may be unconsciously, embedded in the outlook of the society. Such a knowledge stamped with prevailing social consciousness becomes a conscious knowledge. As Levy puts it, "Before man could act in his capacity as a scientist he has first to be a social being; there can be no science without social background".[4] This experience as a social being provides "images and concepts which, when pieced together as a pattern provide the conscious theoretical groundwork of each period. On this basis, therefore, any scientific theory is necessarily a specialized development of a general social view, even though those who initiate the theory may be profoundly unaware of its connection".[5]

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4 Levy. H., "Introduction" Caudwell. C., **The Crisis in Physics**, Second Edition, Baulman Prakashan, 1989 p.ix.
5 Ibid., p.ix.

Science as a body of organized knowledge and as a process of knowledge has today penetrated deep into human life. It is imperative therefore to look at it from social standpoint. Yet there is a strong reluctance to engage in such a critique. Science seems to be outside the preview of such criticism. So far as it is understood, little attention is paid towards analysing "rejection and acceptance of ideas within and at the boundaries of science from sociological framework. It is in the most cases taken for granted by sociologists that in respect of the esoteric content of science, scientists knew best."[6] This unshaken belief restrict sociological inquiry into the explanation of the content of science itself.[7] It has been discussed later in this chapter that such a situation, however, has now started to change.

Another point to be noted here is the uneven attention that the enquiry into the reciprocal relation between science and society have got. Whereas the impact of science on society has received much notice the impact of society on science has elicited little attention. Most historians, too, have been prepared to see science having an influence on society, but not to admit that society has influenced science. They have liked to think of the progress of science solely in terms of the internal and

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6 Wallis. R., **On the Margins of Science : The Social Construction of Rejected Knowledge**, University of Keele, 1979, p.5.

7 Ibid., p.5.

autonomous filiation of ideas, theories, mental or mathematical techniques and practical discoveries, handed on like torches from one great man to another.[8]

Merton[9] has listed two reasons for this reluctance on part of scientists to pay attention to the diverse influence which social structure bears on the content of science as:

1) Their mistaken belief that to admit sociological fact would be to jeopardize the autonomy of science. They fear that when science is viewed as an organic social activity, the value of objectivity which is so central to the ethos of science would be threatened.

2) Another equally mistaken belief is that once the correlation between science and society is recognised, it would call into doubt the disinterested motives of the scientists. And that to consider how far social structures would channelize the direction of scientific research is to put into trial the scientists for his motives.

Lately, however, this area of inquiry has received attention from the Marxists who see the features of autonomy and non-utilitarianism disappearing from science and science getting fully dependent upon the whims of political and economic policy (Boris Hessen, 1931, J.D. Bernel

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8 Needham. J., **The Grand Titration-Science and Society in East and West**, London; George Allen and Unwin, 1979, p.215.

9 Merton. R.K., **Social Theory and Social Structure**, New York; Amerind Publishing Company Private Limited, 1968. Part IV, p.586-587.

1939); from the Feminists, who view the nature and content of science and its working, typically biased towards the male dominated society, consciously or may be unconsciously keeping the women out of it, shaping and in turn getting shaped according to the whims and fancy of the 'masculine world' (Cole 1975, Kelly's 'The Construction of Masculine Science'). Others have in the light of rapidly increasing role of government in scientific R and D since Second World War accept and propound the view that a society today is getting the science it is willing to have and is able to pay for. (Galbraith, 1966). Freeman[10] has referred to the inevitability of state involvement in science and technology research with thrust on national defence giving rise to the military industrial complex.

The point that is evident as daylight is the reciprocally effective relations between science and society. In order to study any aspect of the society scientifically, including that of science as a discipline, it is essential to understand the underlying world-view of the society. On the other hand, the bearings that science has on our society and daily life is so strong that today any philosophy of development of a particular society is seen and believed to be inevitably linked with its philosophy of science.

Against the backdrop of this discussion on science-society relationship, let us now examine the role of science education in it.

10 Freeman. C., **The Economics of Industrial Innovation**, London; Penguin, 1974.

Role of Science Education in Science and Society Relationship

The analysis of the role of science education in science and society relationship becomes important because education forms one process through which the society, in its mutual conditioning with science and scientific knowledge, define and redefine the value of its various modalities. The task becomes more urgent in case of science education, through which "the fundamentals of world views and environmental understanding and changes are laid".[11]

As science is the method of cognizing the material world, science education essentially becomes a process of training into this method. Science education cannot be regarded merely as a learning of established laws of nature and some basic information. Essentially, it is training in how to participate as a rational being into a process primarily aimed at producing a world view which is more rational and scientific along with being humane.

The fundamental issues relating science to its educational function emerged with the development of science of the 19th century together with the development of the systems of mass education. In the European countries, scientific education were schooled to challenge the traditional

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11 Dias. Patrick V., "Introduction : Conceptions on Science, Society and Science Education" Dias. P (ed.), **Basic Science at Elementary Level**, John Wolfgang; Goethe University, 1987 p.7.

dominance of the classical literary curriculum.[12] The second world war transformed the role of science and science education in the industrialised societies. Science and technology were harnessed, as never before, to the economic, defence and other interests of the state and the importance of scientifically literate population was widely recognised. These concern, and in particular, anxiety over an enduring shortage of qualified scientific personnel, prompted a wave of science curriculum development that amounted to something of a revolution[13] Olive Banks and Schelsky have talked about the changes in the nature and amount of labour force which came in essentially because of the increasing role of science and science and science education which equips it with the required professional and scientific manpower.

As science is the part of larger social process, education and science education, too, are embedded in an inescapable mechanism of most basic and dominant paradigmatic social value system, together with its extremely crucial role in shaping of consciousness and stratification of the society.

The present system of mass public education which is an outcome of

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12 Jenkins. E.W., "History of Science Education", Husen. T. and Postlethwaithe. N.T (eds.)., **International Encyclopaedia of Education**, New York, Pergamon Press, 1985, p.4453.

13 Lockard. J.D., **Twenty Years of Science and Mathematics Curriculum Development**, U.S.A.; University of Maryland, 1977.

the industrial era replacing the old system of apprenticeship has brought with itself a social growth whose essential precondition is unfettered freedom at all levels of human relationship. Education was conceived of that road which would lead to the popular dominant social ideals of democracy and equality. A most anticulated social demand for education called for equal popular education to be carried out in a total academic freedom existing outside the play of political forces, "dedicated to the free and unprejudiced search after truth.[14]

Inspite of these cherished goals, the critics have accused science education as a rote learning and uncritical acceptance of not only a few laws of nature but entire social value system, producing and perpetuating the dominant ideology and stratification of the society for its survival.[15]

However, even in the grossest sense of being status-quoist, the, education is liberating. As the spread of mass education out of the necessity of the system increases and more and more people are being brought into its fold, they come to know things which were unknown to them so far. The production of science based knowledge tends to become scientific at every step, forcing people to adopt a more scientific

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14 Rubin. Barry., "Marxism and Education—Radical Thought and Educational Theory in 1930's", **Science and Society**, Vol.1, 1973, p.171.

15 Ibid., p.201.

outlook, helping them to comprehend new things thus furthering steps in the process of social change.

SCIENCE EDUCATION AND DEVELOPMENT

Against the background of our discussion so far on science, science education and society and their dialectical relationships, now the assumptions which posit a relationship between them and development would be examined at length.

Development which might at first sight appear to be a neutral expression is, in fact, a multifaceted phenomena and may be understood as political, social, economic, spiritual, emotional, physical and intellectual, in accordance with its use and expanse. Among these, it is the socio-economic aspect which has invariably occupied the pivotal position and has influenced all other aspects.[16] (Seers. 1979). Coleman (1965)[17]. Rostow (1960)[18] have looked at the term development and its differential nature, and have explained how it assumes shape according to the discipline concern and the perspective in question.

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16 The intricate issue involved in expounding the meaning and interpretation of development has been succinctly discussed in , Seers. D., "The Meaning of Development", Letiman De (ed.)., **Development Theory**, London; Frank Kass, 1979. p.2-29.

17 Coleman. J., **Education and Political Development**, Princeton; Princeton University Press, 1965.

18 Rostow, W.W., **Politics and the Stages of Growth**, Cambridge; Cambridge University Press, 1960.

Development commonly refers to a stage reached by some national societies which are characterised by the ability to increase systematically, the amount of goods and services available to its population through the application of science and technology for production. The concept was later enlarged to include an equitable distribution of wealth created among the different groups involved in productive effort, participation by the people in the process of deciding about goals of development and preservation of the cultural identity of the community. The concept of development also implies reorganisation, modification and innovation of the existing institutional structures. Each dimensions of development involves raising issues relating to values and patterns of conduct which produce a variety of impact and the institutional structures.[19]

The level of development that a country achievs is measured in terms of the value of their productive output or GNP (Gross National Product)[20], though this method has its known problems. The method which treats development in terms of qualitative and structural change, has been accused of providing partial data in many ways. One that it usually is a national average which in itself don't say anything about the distribution of resources among the population. It omits certain activities that have an

19 Shukla. K.S., **The Other Side of Development : Social Psychological Implications**, New Delhi; Sage Publications, 1987, p.8.

20 A discussion on the level of development in terms of GNP is provided by Mabogunje. A.L., **The Development Process**, London; Hutchinson, 1980.

economic value and it also implies that development can be measured in straightforward qualitative terms (example-money)[21].

A CRITICAL ANALYSIS OF THE CHANGING CONCEPTION OF DEVELOPMENT AND ITS RELATIONSHIP TO EDUCATION AND SOCIETY

The original conception of development was born out of the realization by some social scientists of the industrialized by some social scientists of the industrialized societies that a small group of national societies had acquired the ability to increase systematically, year by year, the total amount of goods and services produced and therefore were able to improve the living conditions of their population in a sustained fashion, without changing the social structure. The ability was linked to the systematic recourse made to an evergrowing pool of scientific knowledge in order to derive from it new and more efficient ways of producing or to invent new ones, and to the institutionalization such recourse in the public and private sectors of the economy. Since scientific knowledge is universal and institutious can be modelled after those in the developed societies, it was concluded that any underdeveloped country, having the necessary political will, could acquire the ability to grow economically in a systematic and ordered fashion, and in a reasonably short period of time.[22]

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21 Webster. A., **Introduction to Sociology of Development**, London; MacMillan Publishers Limited, 1984, p.26-28.

22 Hoselitz. B., **Sociological Aspects of Economic Growth**, Glencoe, Free Press, Ulimois, 1960.

This initial conception of development considered education as a $prerequisite for the attainment of the derived goal of becoming a developed society. The so called traditional education of the underdevloped countries was to be replaced by an entirely new form of education that would emphasize the acquisition of practical skills and ability. In concrete terms, this notion of development led to a global reorganisation of the educational institutions of the developing countries with an emphasis on scientific, technical and vocational education. The vastness and complexity of the task of reforming the whole educational system of a society made it necessary to rely on the superior knowledge and experience of the already developed societies, which were asked to provide technical assistance.[23]

Towards the send of the 1960's, however, doubts arose about the conception of development underlying developmental policies and educational reforms in particular. The first line of criticism was raised against the assumption that economic growth will favour all sectors of the population equally. It was argued that current development restricted fair distribution of wealth in which small minority enjoyed at the cost of vast majority.

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23 Harkison and Myres., **Education, Manpower and Economic Growth : Strategies of Human Resources Development**, New York; Mc Graw Hill, 1964.

A second line of criticism was directed at the lack of participation by the population at large in the decision making process of development policy. The implication of this line of thought for education was that the population at large should be educated to participate. The schools were then examined with respect to their ability to do this and were found inadequate. Furthermore, it was argued that the schools were preparing people to obey instructions from authority and not to participate in the process of decision making (Freire 1970, Illich 1971).

A third line of criticism was directed at the loss of cultural identity of the society concerned in the process of becoming a developed society. It was argued that the cultural tradition of a society is a available asset and should not be lost in the attempt to reproduce the development of societies of North America and Western Europe. On the other hand the cultural tradition condition elements that are easy to redefine in terms of the prerequisites of development and therefore is of positive value to the society. The proponents of this line of thought are unhappy about the curricula of the new educational institutious set up under the influence of the original motion of development. They argue for reform of the curricula to give more emphasis to the cultural achievements of the society and to their academic study.[24]

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24 Mazrui, A.A., **A World Federation of Cultures**, New York; Free Press, 1976.

A plea to re-examine the issue of the misconceived belief that apeing the path of development of the modern western Societies will essentially lead to a similar development is other concerned societies has also been made.[25] Countries which ought to be regarded as "maldeveloped" are called developed on account of their elitist consumerism, military power, and technology for maximum exploitation of war and nature. It has been argued that widening inequalities, high rates of crime and suicides, pervasiveness of broken names, delinquency etc. do not detract these countries from their status of advancement and modernity. It is the false acceptance of this superiority that has created illusion in the poor countries that in order to develop, they should also seek to achieve and adopt these standards.

Another limitation that the changing conceptions of development share in common is their preoccupation with the economic, material and physical dimensions of human existence with the result that the socio-cultural quality of life remains a missing dimension. Hence, it has been argued that the existing development thinking which is premised upon the erroneous conception of human nature and social should be based on socio-cultural foundations.[26]

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25 Ghosh. ShailandraNath., "A Plea for Re-examining the Concepts of Development and Re-orienting Science and Technology", **International Symposium on Sciece, Technology and Development**, Netherland, D.Reidel, 1987, p.32.

26 Sharma. S.L., **Development - Socio - Cultural Dimensions**, Jaipur; Rawat Publications, 1986, p.91.

Yet another line of criticism on development views science as inefficient, dysfunctional and even as a cause of different social problems and political difficulties. As Seers puts it: "Social crisis and political upheavals have emerged in countries in all stages of development. Moreover, the economic growth (may) not merely fail to solve social problems and political difficulties, certain types of growth can actually cause them."[27]

The present concern about development while acknowledge its inevitability and importance, also encompases anxiety over the considerable amount of waste and destruction that it carries along in terms of exhaustion of non-renewable resources, atmospheric pollution, dwindling oil and coal reserves, nuclear and chemical holocaust, armaments, global warming, threat to world peace etc. Development is now seen as a factor which brings more quantitative than qualitative changes in human life. On the one hand, it recommends the application of a Science, oriented and planned to suit the specific social milieu of a country, on the other hand, it recognizes development as a global process and advocates that both the developed and the developing societies should find ways to co-operate in order to balance benefits.[28]

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27 Seers. D., op. cit., p.9.
28 Brandt. D., **North - South : A Programme for Survival**, Cambridge; MIT Press, 1980.

CRITICAL ANALYSIS

The various elements, identified in the discussion till now, within the complex entity called science have led in recent times to almost equally varied chorus of criticism. Inspite of its growing dominance over our lives, by means of a uniquely efficient method and by its innumerable applications in technology, the scientific attitude to the world has not proved to be the panacea that some nineteenth century optimists thought inevitable. Moreover, the price paid in terms of the decline of ancient and traditional attitudes has been in many connections excessive.

Inspite of the sustained belief even till now that science and its application leads to development of societies, the criticism of science, especially of its more mechanistic and material conception of the world, is not new. The hostile attitude towards science has been consistent ever since the Renaissance mainly because of its esoteric nature and a strict privilege of the few. In the 18th century Rousseau described the act of scientific inquiry as one of the principle causes of alienation of man from nature and himself - a point which was later taken up by Marx who explained alienation in the capitalist system of production. Rationality, which have been seen as the prime key to forward scientific enquiry has also been consistently put in doubt. As Rene Dubois says: "Pure rationalism degrades wisdom,[29] and technocratic thinking reduces man into a

29 Mentioned in Marcos, Imelda, R., **Paths to Development**, Manila; NMPC, 1981. p.10.

machine". Paul Feyerabend[30] points an "irrationalist" picture of science and denies that is or even have been an objective scientific method and claims that if any progress is discernible in science it is the result of scientists having broken every conceivable rule of rationality.

Another line of criticism states that science and technology which were considered as the most powerful and ultimate tools of mankind to liberate it from all kinds of subjugation and natural limitations are being utilized predominantly as tools of extreme subjugation of man by man and with overwhelming power capable of leading to a complete destruction of mankind. Underlying this is the most fundamental paradigm which is a world view that is mechanistic, existing on a desire to gain an absolute control over the world. It has been pointed out that in order to perpetuate such a worldview an encompassing mechanism is created (by science) which in a real sense turns man into machine.

The other fundamental ground of attack has been the deinstituionalzation and politicization of science[31] and the subsequent emergence of a scientific power elite. These elites, it has been argued, function much like the church did in former times, the men in white coats

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30 Feyerabend. P.K., **Against Method — Outline of Anarchists Theory of Knowledge**, London, New Left Books, 1975, p.46.
31 Weingart. P., "The Scientific Power Elite" **Sociology of Sciences Year book 1982**, Holland; D. Reidal, p.71.

have become the modern spokesmen for an absolute, incontestable authority, advocating not just non-science but nonsense.[32]

But this is just an opinion inspired towards the reality which otherwise is different. In fact these elites by virtue of their scientific, technical and professional knowledge have assumed considerable functional importance. A striking example of this is the bombing of Hiroshima and Nagasaki which, however, exposed one false characteristic of science that was hitherto believed, that it possessed - its independent, universal and humane feature. It also brought the point beyond doubt that there is a close and practical interrelationship between philosophy, science and politics. It dissolved the hitherto existing lines of separation between science and politics, the priority of politics triumphed over the so called humanistic values of science and regrettably science slipped into the iron-grips of politicians and these scientific power elites.

To the relationship between science and development, it can be asserted that considering the concept and index of development as it is, its inevitable link with science can not be refuted. But the other unfortunate side of it cannot also be neglected. In fact, now there has been a growing realization amongst scientists, environmentalists, peacemakers, politicians

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32 Feyerabend. P.K., op. cit., p.53.

and others, towards the pressing problems and maleffects which the present idea of development is bringing along with it. The threat to world peace as a result of massive escalation of armaments, nuclear and chemical weapon production, frightening uncontrollable techniques etc have taken mankind as a whole to a gunpoint. Another such problem has been hunger. Inspite of the technlogical breakthrough in the field of agriculture, provision of food remains a main problem in developing countries of Asia, Africa and Latin America. Of late, there are these environmentalists who have made a lot of hue and cry to preserve world environment from devastating effects of development (global warming, deforestation, exhaustion of non-renewable resources, environmental pollution etc.)

All of these have basically proved one thing and that is the dwarfness of man in front of the might of science. It was in the 19th century that Marie Curie once asserted :"Science deals with things, not people". But contemporary our own day science has started to deal, directly or indirectly, with the people, as has been seen. What has become even more apparent is that people themselves have now started to be treated by science as if they were only things — and there lies even more the dangers of science.

An altogether different line of criticism has come up from the feminist scholars who have been articulating their demands not only for equal and just representation within the existing organisation of science (as students and professors) but also for the establishment of a "Feminist Science". Feminist analysis of science have pointed out how science, as we know of it today, has developed a masculine tone with its continued evolution in a patriachal society and has eventually been distorted by pervasive male bias, systematically excluding women from training and participating in science.[33] The objective of "Feminist science" is to translate knowledge on specific feminine ways of living and thinking into an adequate science.

Criticism from the feminist stand point is varied. At the individual/ psychological level i.e. socialisation of girls in scientific communities, on the economic level, i.e. women and in labour force, on themselves of communication i.e. language; on the scientific level i.e. reconceptualization of science distilled of any male bias in it.

When science is viewed as a socio-cultural institution, several distortions and bias in its assumptions, methodology and interpretation are revealed. Our culture is fundamentally structured socially, politically, conceptually

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33 Namenwirth. M.,"Science From a Feminist Prism", Bleier. R (ed.)., **Feminist Approach to Science**, Madison; Pergamon Press, University of Wisconsim, 1986, p.18.

and ideologically by considerations of race, class, gender etc. These dominant categories of cultural experience are reflected within the cultural institution of science itself - in its structure, theories, concepts, values, ideologies and practices.[34] Beliefs are not always derived on scientific lines and it has been pointed out how the belief of the biological inferiority of women is reinforced by the scientific community of men justifying woman's subordinate position in home and in laboratory.

Bacon has accepted and established male authority as integral to the practice and philosophy of science. He has elaborated the metaphors of science in sexual and gender terms-science as male and nature as female (the mystery that needs to be unveiled). Women as reproductive human being embodied the natural, the disordered, the emotional and irrational traits whereas man who was epitomised as a thinker, with the traits of objectivity and rationality led to the structuring of science as male.

The construction of masculine science and the process involved in it at the school level has also been studied.[35] Here the numerical dominance of boys in science classes, the images of scientists (mostly male) available to the secondary school children, the textbook representation (with a few female references in them) and classroom interactions between students

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34 Bleier. Ruth., Introduction, op. cit.

35 Kelly. A., "The Construction of Masculine Science", **British Journal of Sociology of Education**, Vol.VI, No.2, 1985, p.132-153.

and teacher and among students have been understood as the main reason for the emergence of the elements of masculinity in science.

It has also been seen that there was a remarkable polarization of subjects interest between pupils in mixed school than in single sex school at least in relation to physical sciences and modern languages.[36] Boys are seen to prefer physics and physical science to Biology and dramatics in a mixed school. There is a clear preference for language amongst the boys educated in single sex schools. Similarly, girls in mixed school prefer the strongly female subjects (French and English).

The science as conceived by feminism negates elitism, male bias and authoritarianism and aims to make it accessible physically and intellectually to all who are interested. It also seeks to reconceptualize science - its methods, interests and goals without the language and metaphors of control and domination - the first step being to radically introduce gender as an unavoidable category of analysis.

CONCLUSION

In this chapter, an effort has been made to understand the dialectical relationship between science (education), society and development. The critical analysis have proved beyond doubt that science, which was

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36 Stables. A., "Differences between Pupils fro Mixed and single sex school in their enjoyment of school subjects and in their attitudes to science and school", **Educational Review**, Vol.42, No.3. 1990, p.41.

earlier conceived of as 'friendly' and for the betterment of humanity as a whole, now needs strict questioning and vigilence.

While some see in science the solution for all the troubles that beset us, others see in it the source of most evils. Thus, on the one hand there is a talk of "the frustration of science" and of "the need for planning science", and on the other hand, one demands "a moratorium on invention and discovery". Science has become for many of us a "social problem" and men want to do something about it".[37]

The question we are facing today is whether we are going to take for granted the widespread view of science as an instrument of enlightment, rational behaviour, and technical progress within the perspective of a seemingly universal, historically valid, technical-industrial civilization model. Or within the perspective of the diachronic development, one should take into consideration the creative potentialities and the indigenous demands of the developing countries and search for a more appropriate relationship between science, society and development.

This, in fact, forms the crux of the investigative, analytical discussions that will follow in the subsequent chapters.

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37 Barber. Bernard., op. cit., p.208.

Chapter III

An Analysis of Science,Science Education and Development in India

It is interesting and thought-provoking to understand and analyse the interrelationship between science, society and development in India since, in this age of modern world, inspite of having a proved past of scientific quest and admirable advance, our all country is still hitherto identified and accepted more as a land of gripping sprititualism, flourishing religious dogmas and numberless superstitions.

This chapter attempts to study the interrelationship between science, society and development in India. It begins with a description of the sociology and philosophy of science in India. It will then take into account the genesis and growhth of modern science and science education in India and evaluate it in the light of related government policies. This will be followed by an examination of the various perspectives relating to science, society and development in India.

SOCIOLOGY AND PHILOSOPHY OF SCIENCE IN INDIA

The earliest efforts to inquire into, and give a cogent account, of scientific development in India were not broad in scope and most of the studies had a bias in favour of science discovered from technology which has also been the trend in the west. (Seal, 1915; Ray 1956). This was essentially because of 1) the meditational and revelational direction of Indian science which implied activity of mind divorced from the activity of hands, 2) encouraged experimental work which required such adequate facilities that Indians surely lacked, 3) the lack of considerable attention given to the study of inter-relationship between the scientific and technological tradition in India.

Against this background the legacy of the philosophy of science till date finds it difficult to fully develop both in the academic world and outside it. The major reason why philosophy of science has rarely been introduced into the philosophy curriuculum is because of the tremendous grip which trditionalism has on Indian universities.[1] This traditionalism comes from the philosophy of 'Nishkam' or disinterestedness of Gita. It has been argued that to maximize efficiency among philosophers the need should be not to pay heed to such recommendations of Gita. For "how could any one achieve anything by being disinterested"?[2] In the meantime A. Rahman, et. al, voice their complain that even teachers of science are usually pencil-and-paper scientists.[3] The actual preparation of some of these scientists is close to being merely literate. Behind this lackadaisical approach to philosophy of science and science itself stands in Indian society controlled by conservative political parties.[4]

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1 Gill. R.S., "Recent Development in the Philosophy of mathematics", In Mittal. K.K (ed.)., **Quest for Truth**, Delhi, 1976, p.74.

2 Ibid., p.77.

3 Rahman. A, Sen. N, and Rajagopal. N.R., "State Support to Scientific Research in India — An analysis to Trends", CSIR, New Delhi, 1966, p.9.

4 Rahman. et.. al., op cit., p.9.

Inspite of these difficulties, the philosophy of sciecne in India has developed slowly but surely. This section will briefly take into account a thumbnail sketch of the direction and claims of philosophers working in this field. Before we turn to them, it will be helpful to gain an insight into the ideas of Sri Aurobindo, a notable Indian mind.

Aurobindo's works essentially bear a thrust on spiritually accumulated knowledge and simultaneously demonstrates a insistent litany of scorn, if not palpable hatred, for the scientific enterprise. What he says indicates in a more intimate way his attitude towards science and his hatred of anything that smacks of naturalism or materialism. To this extent, Autobindo says, "....spiritual seeking has its own accumulated knowledge which does not depend in the least on the theories or discoveries of science in the purely physical sphere....(my) attempt is a reaction against the illegitimate attempts of some scientific minds in the 19th century... who took advantage of the march of scientific discovery to discredit or abolish as far as possible the religious spirit and to discredit metaphysics as cloudy verbiage, exalting science as the only clue to the truth of the universe."[5]

Another fundamental and inseparable issue, which has allured the philosophy of scientists in India, is the alleged conflicting relation between

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5 Letters of Shri Aurobindo (Second Service), Aurbindo Circle, Bombay 1939, p.572.

religion and science. Aurobindo does not accept this conflict between theology and science. As he says, "....) I think that attitude is now dead or moribund; scientists recognize.... the limits of the sphere. I may observe that the conflict between religion and science never arose in India (until the days of European education) because religion did not interfere with scientific discovery and scientists did not question religious or spiritual truth because the two things were kept separate but not on opposing lines."[6] Similarly R.G. Collingword, in his classic work "Faith and Reasion" (1948) demonstrates that both science and religion have their respective spheres of influence, the former dealing with the finite while the latter deals with the infinite.

The history and development of science or civilization, for that matter, is explained by Aurobindo as a temporary rise of materialism whose duration and faith gradually subsides giving way to old religions or grouping for something new. Aurobindo is concerned more about free will Versus determinism and stresses on the invisible forces behind visible events in the world. Since invisible forces are generally not knwown, being invisible, we are left with visible forces, which is precisely what scientific method points out. But, Aurobindo says that: "All that has nothing to do with predetermination. On the contrary, one watches how things develop

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6 ibid., p.572-3.

and gives all that to contrdict a dictum of the great scientist (scientists are great, when they can be quoted for spiritual propaganda), C.V. Raman said once that all these scientific discoveries are only games of chance, he is merely saying that human beings don't know how it works out. It is not rigid determinism, but it is not blind inconsistent chance either."[7]

In our attempt to understand the nature of philosophy of science in India, let us now briefly look into some of the studies contributed by few representative figures from this area. One major intention amongst many of these studies, is to tie together traditional Indian philosophy and certain trends in modern science.[8] Reyna, believes that the way to do this is to point out the idealism in both. Though it is not a small tasks to expound physical science in the frame of idealistic philosophy, Reyna continues with admirable clarity when she says :"The total point of this work is to testify to the idealistic validity of the vedantic concept of "Maya" as an explanation of the relationship between appearance and reality, in which the phenomenal world is held to be neither real nor unreal and at the cosmic level is non-existent."[9] For her "the world (things) has neither being nor non-being. It is, in another words, inexplicable. And that is just what science is presently saying."[10]

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7 ibid., p.567.
8 Reyna. Ruth., **The Philosophy of Matter In The Atomic Era**, Asia, Bombay, 1962, p.vi.
9 ibid., p.x.
10 ibid., p.3.

Another work in the area of philosophy of science in India impinges on the epistomological problems of science and is concerned with the problem of objectivity and subjectivity involved in the deductive systems which forms a strong part of the Indian philosophy (Pandey, 1965). Pandey opines that one cannot know the real world of material processes and must rely upon subjectivity for most of the Indian philosophies ends up in solipsism, the ultimate home of idealism and subjectivity.[11]

Next area of concern among the philosophers of science in India has been to emphasis the pre-eminence of spiritual necessity to fight against the evils of science and technology. It has been opined that philosophers must be on guard against the organisation which follows from industrialisation since it will lead to the weakening of traditional values and thus undermine the older philosophical positions and in addition enfeeble traditional religious positions. Their other task is to prepare themselves against any charge that hails economic necessity and treat them as more basic than the spiritual necessity.[12]

Abdur Rahman, another noted scientist-philosopher of India maintains that in any synchronic study of science, one finds two simultaneous processes in operation. The first is the extension of a theoretical outlook

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11 Pandey. R.P., **The Problem of Fact**, Shanti Niketan; Centre of Advance Study in Philosophy, 1965, p.150.

12 Raju., P.T., "Influences of Industrialization and Technology on the Philosophies of India", **Prabuddha Bharta**, Vol.62, No.7 and 8, p.253.

through its applicability to new areas. The second process involves the rejection of already accepted outlook.[13] He also points out India's legacy of colonialism which left a situation where modern science was divorced from national thought, specially separated from ancient and medieval scientific tradition. Consequently, Rahman maintains, "....the thought of our antiquity, inspite of its materialistic content, has only its idealistic exponent. Science, being divorced from rational-historical traditons, looks to Europe for its theoretical guidance.[14] This European influence on Indian thinkers cannot, however, be overstated. It has been pointed out that since the second world war, North America has been closely asssociated in the west with many Indian phlilosophers in a constant stream.[15]

Furthermore, India has not only imbibed colonial traditions in science, but due to the historical factors of its birth considers science as eventually emperialistic, European in nature. Indian scientists themselves as well as philosophers of science have been victim of pseudo-religious traditions which can be overcome partly when these workers begin to understand their own history and its tradition. Rahman insists upon a serious re-

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13 This theme has been expanded in his work, **Science, Technology and Economic Development**, Delhi, National Publishing House, 1974, p.198, 214.

14 Rahman, A., "Approach to Science" in **Society and Revolution**, Essays in honour of Engles, People's, New Delhi, 1971, p.179-180.

15 Rubel. W. and Rostau. L., **Mainstream**, Vol.XIX, No.20, 17 January 1981, p.32-34.

appraisal of attitude towards science in India and cause for hightening the consciousness of scientific community and the community surrounding scientific work.[16]

In conclusion, Indian philosophy of science can be said to be idealistic and subjective. It uses western European and American paradigms which are for the most part positivistic and idealistic, hence static, rigid, metaphysical and non-dialectical. In addition to these qualities, there are inherent attachements to classical Indian conceptions such as supermentality, spiritual evolutionism and a defensive attitude regarding religion. Beyond these difficulties are these which Western philosophy of science also shares, such as the separation of theory and practice, fact and value, hand and brain as well as a swing disregard of historical conditions, philosophy of history, social sciencs outside of logic and statistics and dialectical philosophy.

Inspite of these limitations, it can be said however, that there is room for consderable work for the future.

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16 Rahman. A., op. cit., p.180.

Genesis and History of Modern Science in India During Colonial and Post Independence Period — A Critical Analysis

One single salutory point which comes out of a sociological analysis of the nature of science is that science is a relevant and meaningful in relation to its historical and social context. This suction attempts to study the development of science in modern India.

Together with our observation that science in a sense is a supernational activity (Price, 1968) which has its own laws of growth, it must be added that this process of growth is mutually and effectively linked with the degree of diffusion of science and its value in a country. It has been pointed out that value judgements on criteria of choice, diffusion of science, autonomy and creative powers and continuity versus discontinuity of traditions are the sociological factors which determine the relationship of science to a particular country.[17] The diffusion may not be widespread and may be limited only to an elite which may be responsible for decision making in a country. This diffusion depends on the scientific group within a country, its connection with international groups, national decision making groups and others which exist as pressure groups. To put it briefly, science is supernational with regard to theories and facts but is a part of the social framework of a country with regard to its national development.

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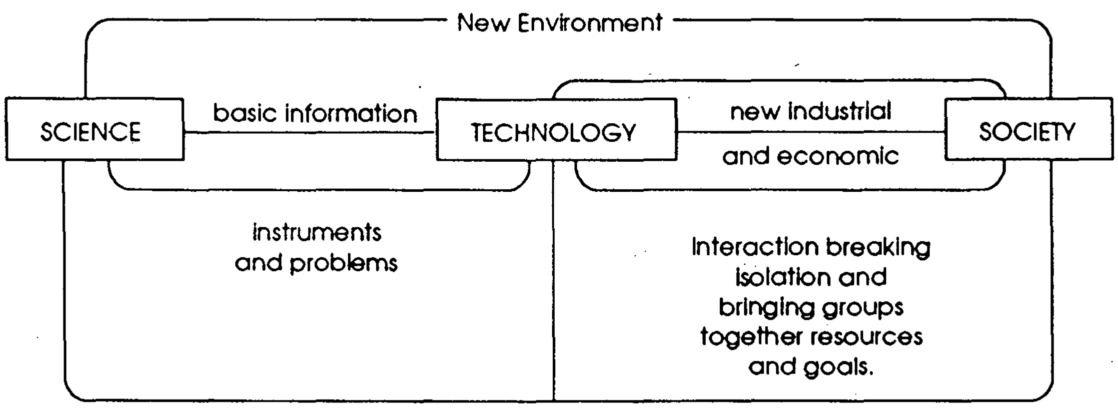
17 Czartoryski. Pawal., **Organon**, Three (1966), p.173-80.

The task of looking into the genesis and growth of science in India is not an easy one and a clear-cut account of it is difficult to have, owing to the vast complexities and diversiveness in the character of Indian Society. Secondly, compare to the large number of books written on Indian religion, metaphysics and mysticism, there is a sad neglect of the tradition of science in Indian history. However, any attempt to trace the development of science in India, need not start from scratch. Contemporary scholars have presented sufficient illuminating works that form a solid base and satisfactory guide to further investigations.

As already mentioned, scientific activities have their roots in the pre-historic days that started with man-nature interaction. But the history of modern experimental science began only in the 17th century in Europe.



Symbolic Interaction Between Science (Modern) Technology and Society [18]

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18 Rahman. A., **Trimurti-Science, Technology and Society**, New Delhi; People's Publishig House, 1972, p.12.

The emergence of modern science brought with it a science combined with rapid innovations. It now aimed at having a symbiotic relation with society in combination with technology. It's esoteric formulations were institutionalized and as a form of intellectual activity science was more publicly recognized with far reaching autonomy.

It is interesting to understand here why modern science developed in Europe and not in Greek or India, both of which had historically healthy, advanced and flourishing traditions of ancient science? To this end, it has been pointed out that the Greek science and ancient Indian science were founded on the then religious ideas and were more a quest for philosophy and aesthetics. There was a close and inseparable link between nature and the existing religious beliefs and thus the possibility of changing the nature or experimenting on it did not enter the minds of the scientists-philisophers of those times.[19]

This flourishing scientific tradition in the ancient and medieval periods gradually died down as a result of unstable political conditions and repeated foreign invasions[20] and other historical factors.

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19 Ben-David. Joseph., "Scientific growth; a sociological view", **Minerva**, Vol.2, No.3, 1964, p.455-76.

20 The point of rapid advances in science under political stability has been mentioned in Chattopadhyaya. Debi Prasad., **History of Science in India**, Vol.1, New Delhi; Editorial Enterprises, 1982.

Modern science came to India at a stage of its development that is characterised by a radical change from the ancient and medieval sciences. The science introduced by British was in opposition to the earlier traditions and had a foreign language. To this extent it represented a sharp break with the earlier tradition.[21] Modern science grew with the gradual conquest of the country by the British. Consequently, there was an unevenness of impact of science in the country. Industrial technology hardly developed and the overall development of India was also patchy and unsatisfactory. Only such technology developed which helped in the exploitation of the natural resources of the country for the development of the colonisers. Thus during the British period, India science, after its discontinuation from the early scientific tradition, developed more as a second fiddle to colonial science.[22]

The basic features of science in India during the British period could be briefly listed as follows:

1. Modern science was introduced to India by the British and a base was created over the years in terms of educational institutions, research centres and a cadre of professional scientists. The first learned society devoted to science was established in Calcutta in

21 **Report on National Committee On Science and Technology**, DST, 1973.

22 The disastrous consequences for science in India as a result of the introduction of European sceince has been discussed in Bernal. J.D., "Social and Historical Factors in Science in India", **Science and Human condition in India and Pakistan**, Rockfeller University Press, 1969, p.73.

1784 and was named the Royal Asiatic Society. The first scientific journal was 'Asiatic Researches' (1799) began by the Asiatic Society of Bengal also located in Calcutta. For the purpose of knowledge which the Britishers needed several scientific departments were established such as Botanical Survey of India (1899), The Geological Survey of India (1851), The Marine Survey department, (1874), India Meteriological department (1875). The first meteriological observatory was founded in Madas in 1792. Special mention may also be made of the Indian Institute of Science, Bangalore, founded in 1911, The Indian Association for cultivation of science, Calcutta (1876). The Indian Science Congress was inaugurated in 1914 and the Academy of Sciences established in 1935. These foundations gave a fillip to the basic and academic science in India. But the industrial technology continued to be neglected. The base of these institutions were also narrow in terms of manpower, investment by the government and were not at all in consonance with the requirement of the country.

2. The base was in reality an extension of science and technology in Britain, and leaned heavily on "mother country" for direction and control, on the one hand, and experience and organisational pattern, on the other.

3. The role of science and technology was understood to be strictly limited. For original and new developments one looked to Britain, while only such developments were put into practice in India that did not conflict with the political policies of the imperial masters. As a consequence of the policies followed, for instance in the field of industry, very little industrial research was carried out to further

promote the industries which had developed in India or to create new ones.[23]

These limitations had certain far reaching consequences for the growth of science in the country. Science was isolated and became merely a discipline to be taught in the universities, or to be pursued as a research hobby. Later, as a result of political and other developments, efforts were made by the government to prepare blueprints for the promotion of science in the country, such as Holland Commission Report of 1918, the report of Prof. A.V. Hill, the Chetty Committee report etc. The mission of Prof. Hill and his report[24] had a major effect in influencing policies of the British government and the developments in science, both before and after Independence.

Thus science, before 1947 had a very narrow and limited role esentially as an appendage to the governmental machinery and overall political policies. The small number of institutions and professional workers and the fact that the language of science and the language of the people were different further constricted its role. The lack of any machinery for collection of data and its analysis marginalised the role of science in the decision making machinery. These significant factors, thus, arrested the role and development of science in British India.

23 Rahman. A., op. cit., p.78-79.
24 Hill. A.V., "Scientific Research in India", New Delhi, 1945.

As a result, science failed to penetrate the social psyche and the masses continued to be tradition bound. A little impact that science did have was on the tiny Indian intelligentia. Though many eminent leaders of the national movement were indifferent to the possibilities of science for the development of India and were mostly anti-scientific in their attitudes.

After this brief discussion on the growth and genesis of science and science education in India and its subsequent relationship to development, a brief overview of educational development in India during the British rule and post independence period, will now be made. For any investigation of the development of science, science education and development is doomed to be a failure and incomplete, if it is not comprihended against the existing nature of the educational system. This discussion will in its' course take into account the different educational policies and try to find the place of science in them.

An Overview of Educational Development (Science Education) in India during the British and Post Independence Period

A meaningful overview of educational development in India calls for firstly an identification of the main characterstics of the inherited structure of colonial education and, secondly, a critical assessment of the nature of transformation of this inherited structure since independence in response to identified tasks.[25]

History of science education in India is closely linked with her overall history of education. Education that existed in medieval India underwent complete change under the British imperialism. The objective and functions of education were fixed by the British imperialism in consonance with its objective of exploiting India's wealth. In laying the foundations of British education in India Lord Macaulay saw to it that: 1). it was completely divorced from the socio-cultural and historical reality of Indian society and 2). that it served the cause of the British empire well.[26]

In a word, the British education sought to make the educated Indian subservient to British rule in such a manner that Indian masses remain ignorant. The British government set up schools, colleges and universities onstensibly for spreading education in Indian society. It was under such conditions that science education grew.[27]

Quite a number of research organisations were set up in the field of science and technology as we have seen earlier, were set up by the British

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25 Raza. Moonis., **Education, Development and Society**, New Delhi, 1990 (Introduction).

26 Mentioned in Thomson. Edward, and Garratt. G.T., **Rise and Fulfillment of British Rule in India**, Allahabad; Central Book Depot, 1958.

27 Dubey. S., "Science Education, Scientific Organisation and Creativity", Ghosh. S.N, and Chaubey. N.P. (eds.)., **Impact of Science and Technology on Society**, Calcutta; Naya Prokash, 1980, p.107.

with a view to facilitating their scientific and technological development.

- Science education and technological development during the British Raj were solely concerned with colonial interests and had nothing to do with the well being of the Indian people. However, a very small section of the Indian population which acted as tool of British imperialism succeeded in harvesting fruits from the development of colonial science education and research. The British imperialism also saw to it that Indian scientists and technologists remained cut off from the mainstream of Indian society. Rahman (1969) observes that "Science in India was really an extension of the science in Britain. The Indian scientists who became a part of the scientific establishment have their training abroad (with very few exceptions), they looked for honours and awards (without exceptions), by way of membership of societies, distinction, etc. from outside India. Their research programmes were essentially an extension of the work done abroad. They also tried to copy institutional models from overseas."

Some of the characteristics that were inherited in colonial education system can be listed as:

1. The system was quantitatively a miniscule, influencing only a marginal section of the Indian population,

2. It responded to the needs of British administration rather than to those of socio-economic development of India. The aim here was to

produce graduates and other educated persons who could fit into the British administrative machinery,

3. The socio-economic base of education in colonial India was extremely narrow and hence the economically and socially deprived people found it difficult to enter the gates of educational institutions,

4. The education was essentially teaching orinted rather than "learning" oriented,

5. It was intended to weaken the forces of national integration. Curiculum was used to inject the virus of communalism, casteism and regionalism.[28]

With independence new priorities in education and other spheres of national life emerged. Science education and technological development required an altogether new orientation in the changed conditions to serve the democratic aspirations of Indian people and to be socially useful in solving social problems, and facilitating rapid development of Indian society.[29] Another related task was to remove the infirmities of the educational system handed down by the Britishers, and to transform it into a social force geared to the socio-economic transformation of the Indian polity from colonial underdevelopment to self-reliant development.

The political leadership had also realised the need for a revolutionary approach towards the educational situation, aiming to change the

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28 Raza. Moonis., op. cit.
29 Dubey. S., op. cit., p.108.

objectives, structures, processes and organisation of education. For instance, in his address to the national educational conference convened by the ministry of education in 1948, Pandit Jawahar Lal Nehru said "Whenever conferences were called in the past to form a plan for education in India, the tendency as a rule, was to maintain the system with slight modifications. This must not happen now. Great changes have taken place in the country and the educational system must be in keeping with them. The entire basis of education must be revolutionised. This hope was unfortunately never realised because of the failure to attack the educational problem in its totality and talking resort to ad hoc and peacemeal fashion to expand and improve education".[30]

It is in consonance with this realisation that the political leadership that a changing situation in independent India requires a change in its education system. Three commissions have been set by the government to suggest what ought to be done. Among them was the Kothari Education Commission (1964-66) which became the basis for the 1968 National Policy on Education.

The Kothari Commission recommended the need for an exclusive emphasis on the development of science and technology and the cultivation of moral and social values. The educational system should be

30 Nehru. J.L., quoted in Rahman. A., op. cit., Chapter 1.

geared along in such fashion that it produces young and committed men and women towards their role in national development. In so far as science is concerned, the commission evaluated the teaching of science and technology in our universities and colleges and did make suggestions* and modifications, but as is well known, these recommendatins were never really implemented.[31]

The New Education Policy of 1986 was specifically designed to equip the country both scientifically and economically to enter the 21st century. This policy is a comprehensive statement and includes all the important ideas, ideals to reform and transform education in India. In so far as science education is concerned, the policy stresses that science education would be strengthened so as to develop in child well defined abilities and values, such as the spirit of inquiry, creativity, objectivity, the courage to question and aesthetic sensibility. The programmes of science education would be designed such that it enables the learner to acquire problem solving and decision making skills and to discover the relationship of science. A health sponsored scheme for improvement of science education in schools was started to improve quality of science education. It also

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* One significant achievement of the recommendations of the Kothari Commission, however, was that science education was made an integral part of general education till the end of the school stage. This has been pointed out by Kashyap, S.C., **National Policies Studies**, Published for Lok Sabha Secretariat, New Delhi, 1975.

31 Dubey. S., op. cit. p.109.

aimed to give assistance to voluntary organisations in the field of science education for undertaking innovative projects in science, agriculture, industry and other aspect of daily life. Regarding the strengthening of science teaching in schools, a detailed scheme was prepared in 1988. During the year 1987-88, central assistance amounting to Rs.29.27 crores was sanctioned to different states to improve library and laboratories facilities and produce books on science and mathematics. Similar provisions have made in subsequent years.[32] In the same year, a centrally sponsored scheme of improvement of science education in schools was started to improve quality of science education and promote temper. it also aimed to give assistance to voluntary orgnisations in the field of science education for undertaking innovative projects in science.

The social impact of these policies on science and education in India and the perspectives on its embeddedness in society would be discussed later in this chapter.

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32 NPE 1986, Implementation Report, Department of Education, Ministry of Human Resource Development, Government of India.

Table (1) shows in detail the targets and achievement on education since 1951.

Achievements at different levels of Science Education

		1950-51	1960-61	1968-69	1978-79	1979-80	1982-83	1984-85	1986-87	1987-88	%change
1	No. of pupils at the university stage arts, science and commerce (lakh)	3.6	8.9	17.0	38.2	31.38	49.34	30.3	32.1	30.9	58.33%
2	Percentage of students reading science at university stage	37.8	28.9	23.0	18.0	23.03	23.35	26.6	21.1	23.5	37.8%
3	No.of arts, science (including research) and commerce colleges	542	1,122	2,141	6,343	6,514	7,350	4,067	8,856	4,378	707.74%
4	No. of universities	27	45	92	125	128	141	147[1]	157[1]	176[1]	551.85%
5	No. of teachers in university, art andscience colleges	18,648	41,759	91,069	2,49,399	2,59,745	3,07,242	2,02,958	N.A.	N.A.	988.36%

Source: India 1990-a reference annual, Ministry of I and B, Government of India, p.79.

1. Includes deemed-to-be university and institutions of national importance.
2. N.A. stands for Not Available.

It is because of the continuous expansion of the educational institution and the increase in the decrease of achievements at different levels of science education, that India is to be ranked as the third largest country in the world in terms of scientific manpower and institutions. Subsequently one also notes rapid innovations and developments are continuing here with a promising pace.

Science Society and Development in India — Sociological Analysis of their relationships

So far the discussion has been confined to the study of the nature of science and education in India, their development and performance since the British period. The thrust of this discussion so far has been more on the historical dimension. We noted that the political leadership on the eve of independence believed and accepted the model which presupposed that science and science education necessarily lead to the socio-econimic development of a society. They made deliberate efforts to cultivate science and education and fit them according to the objectives of development. The achievements which the data highlight compel one to surmise that science has in true sense, lived up to its assigned role and expectation of transforming the society. This, however, is not the true and complete picture. This section will try to expose the parallel dimensions that have brought implicit and unforeseen effects along the process of the operation of this "science and development" model, in India.

It is true that gains have come from science, but a sociological probe into these gains and the overall situation that it has created is confronted by the degree of permeability which science has shown in Indian society. To this end, it has been mentioned that science, inspite of its logic and might, has remained confined to the urban, industrial, metropolitan areas and has failed to touch the common man. For almost eighty percent people who live in villages in India, science is not yet a reality.[33] The process, however, has now started and several efforts are being made by the government bodies and voluntary organisations to bring science from closed confines of laboratory to the people. It is true that the present situation still demands much to be done but it cannot also be refuted that the situation is not the same as it was during the time of independence.

There is another line of arguement which says that whereas the spread of science in the west has changed the values, ethics and codes among the people there, its effect in India has been marginal.[34] There is also a mismatch between the traditional collective psyche of the masses and the attitudes and values which science demands in order to develop. This is not to say that cultural and value system of Indian society has not gone or is not undergoing any change. In fact, science has played a significant role in changing old values of familialsm, traditionalism, fatalism to individualism, modernity, self-help, economic betterment, nuclear familism and time conciousness.[35] Singh (1965) notes how the qualitatively ascriptive features of traditional Indian cultural system are being replaced

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33 Lalwani. K.C., "Sociological Perspective of Development of Science in India", Rangarao. B.V, and Chaubey. N.P (eds.), **Social Perspective of Development of Science and Technology in India**, Calcutta; Naya Prokash, 1982, p.132.

34 ibid., p.134.

35 Khan. S, Punia. R.K, and Sharma. M.L., "Impact of Science and Technology on Social Cultural Values of Indian Society" in **Management of Indian Science for Development and Self-reliance**, SYS symposium, New Delhi; Allied Publishers, 1980, p.343.

by pragmatic and utilitarian values of science.[36] Indra Dev (1978) points out how the traditional folk culture and folklore are decaying under the forces of modern technology and ideology.[37] Inspite of the authenticity of these studies, a holistic glance on the society of India, show that the grips of traditionalism, religious dogmas, superstitions etc. on the Indian masses are still tight.

Closely reldted to this is the broader issue of science, education and social change in India. And here the concept of social change is assumed to be a change from traditionalism to modern norms and values. Though, science has affected Indian society, it is argued that, it has failed to bring about any radical transformation. Indian society has been said to be standing in a continuum of tradition and modernity.[38] Thus, one sees in India, the metropolis representing the relatively secular, egalitarian and modernised picture, whereas the villages in India still maintain a hierarchical, religious and rigid social structure. This difference is mostly explained in terms of the relative accessability of modern education, which, it is believed, impede traditionalism and brings modernity. However,

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36 Singh. Yogendra., "Traditional Culture Pattern of India and Industrial Change", Shah, A.B., and Rao, C.R.M (eds.)., **Tradition and Modernity in India**, Bombay; Manaktalas, 1965, p.41-59.

37 Dev. Indra., "Must Folk Culture Die", **The Eastern Anthropologist**, 31(4), 1978, p.575-588.

38 Singh. Y., **Modernization of Indian Tradition**, Delhi; Thomson Press (India) Limited, Publications Division.

"experience shows that education has not necessarily promoted 'modern' attitudes nor has 'tradition' always hampered growth of modern education."[39]

Another feature, and which is a very significant one is that the arguements which the feminists have voiced against science (discussed earlier in chapter one) seem to operate in Indian social situation as well. The age-old concept of women of India which described and accepted them as mother, daughter or housewife, and the social values attached to it, forms the root cause of different impediments in the path of women entering into the field of science and science education.[40] The male model of work and the perpetuation of sexual division of labour is implicit even in the government policies.[41] It has thus been suggested that the education policy ought to be designed in such a manner so that it reduces the existing male-female disparities ensuring the system to remain free from bias and prejudice.[42]

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39 Quote from Ahmad, Karuna., "The Dialectics of Tradition and Modernity and Women's Education in India", (Paper) unpublished presented in **National Seminar on Reconstructing Theories of Modernisation and Development**, JNU, New Delhi, 22-23 March 1991, She substantiates this point with reference to women's education in India, p.5.

40 The reason for educational backwardness amongst girls and the imbalances and barriers in the educational sytem is discussed in Chanana. Karuna., "Education of Girls — A Sociological Perspective", **Kurukshetra**, Vol.XXXVIII, No. 12, New Delhi, Sept. 1990, p.23.

41 Swaminathan. P., "Science and Technology for Women — A Critique of Policy" in **Economic and Political Weekly**, Vol.XXVI, No.1-2, Bombay, 5-12 January 1991, p.59.

42 Chanana. Karuna., op. cit., p.25.

Another situation that has taken shape in the interaction between science, society and development in India, is pointed out by B. Sarkar, who says that the development of science education is so fast that a lag has been created between it and the socio-economic development of the country. He adds that blind and rigourous pursuit of academic science, without proper utilisation corrosponding to the needs of the society is further encouraging this trend.[43]

Serious and realistic doubts have been raised about science, per se, in Indian society. These are as follows 1). Science which was often made out to be a panacea of all ills of the society at large, is now being blamed for not only its inablity to solve them but also for creating a few more.[44] 2). Issue groups have now come up on environment, ecology, pollution, energy etc. which counter the present model of development associated with science.[45] 3). The notion of development has also now got confused — there has been this tendency seen in India that those who are benefitted by this "science and development model look towards Europe and USA and adopt their life styles, whereas those who do not get the benefit start to look into the past. This has created a tremendous amount

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43 Sarkar. B., "Social Perspective of Development of Science and Technology Education in India", Rangarao. B.V, and Chaubey. N.P (eds.), op. cit., p.160.

44 Bhargava. P and Chakrabarti. S., "Position of Science and Technology in the Hierarchy of Problems", **Yojana**, Vol.33, No.14-15, 15 August, p.66.

45 Swaminathan. P., op. cit., p.59.

of social tension.[46] Rahman says, "Society as a whole in India is faced with a series of crises. It is not the crisis exclusively of economy, production, culture, values and ethics, but it is the crisis of the whole system."

Conclusion

This chapter undertook an analytical effort to examine the interrelationship between science, society and development in India. The development of science and science education was discussed alongwith the analysis of science, society and development in India.

How post independent India adopted with firm faith and high expections the model of Western science and development as also being reviewed.

It can be accepted that by adopting this model success has undoubtly come in the way of four decades of growth, but the fact cannot be overlooked that is has simultaneously given birth to an ever increasing social tensions, crises and anxieties. Why did it all happen? Where has science in India gone wrong? What are the problems and constraints in the effective utilisation of science in India? Can the entire complication be remedied and an alternative be sought? These issues form the subject matter of what is discussed in the next chapter.

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46 Rahman. A., op. cit., p.75.

Chapter IV

A Critique of Science, Society and Development in Post-Independent India

Development of Science in Post-Independent India

Science in independent India got a very healthy, optimistic political environment to grow and get nourished. One is reminded here of Pandit Jawaharlal Nehru's statement when he said that "there is no way out of the vicious circle of poverty except by utilizing the new sources of power which science has placed at our disposal."[1]

It was as early as 1930's that Prof. J.D. Bernal in his work on social functions of science pointed out that science in India is unlikely to develop unless she attains her political freedom. Events in India since independence bears testimony to the remarks of Prof. Bernal. Nehru shared the general ideas of socialist scientiest like Haldane, Blackett, Bernal who had advocated that science is the key to solving problems faced by the society and plays a significant role in liberalising the human intellect and giving new demensions to human thought and feeling. Nehru even went a step further in saying that scientific value and outlook should be a part and parcel of society.

To see that this "scientific temper" is generated amongst the large masses of illiterate and superstitious people of India, he tried to extend the base of science through government agencies, tried to involve scientific thinking and methodology in the governmental structure, personally

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1 Nehru. J.L., quoted in Rahman, A. op. cit., Chapter I.

endeavoured to inject science into social content and at the same time reminded scientists of social goals and objectives.

Nehru's singular laudable effort to promote science in India was the drafting of the Science Policy Resolution (SPR) of 1958. This was a unique step. The resolution not only declared the government's faith in science and technology but also suggested active steps for its promotion. The evidence comes from a few opening statements of SPR which says: "Science has developed at an ever-increasing pace since the beginning of the century so that the gap between the advanced and backward countries has widened more and more. It is by adopting the most vigorous measures and by putting forward our utmost effort into the development of science that we can bridge the gap. It is an inherent oblgation of a great country like India, with its traditions of scholarship and original thinking and its great cultural heritage, to participate fully in the march of science, which is probably mankind's greatest enterprise today".[2]

The specific steps as proposed by the Resolution included:

1. "to foster, to promote and sustain by all appropriate means, the cultivation of science and scientific research in all its aspects - pure, applied and educational;

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2 **Science Policy Resolution**, Government of India, March, 1958.

2. to ensure an adequate supply, within the country, of research scientists of the highest quality and to recognize their work as an important component of the strength of the nation;

3. to encourage and initiate with all possible speed programmes for the training of scientific and technical personnel, on a scale adequate to fulfil the country's needs in science and education, agriculture and industry and defence;

4. to ensure that the creative talent of men and women is encouraged and finds full scope in scientific activity;

5. to encourage individual initiative for the acquisition and dissemination of knowledge, and for the discovery of new knowledge, in an atmosphere of academic freedom; and

6. in general, to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge."[3]

Steps were also enunciated to promote the development of science, and the utilisation of results of research for the development of society and what is more important for its utilisation in the decision-making system. The resolution also indicated that in order to achieve this objective the scientists of the country were to be given teir due place. In other words, the development was aimed at both the intellectual and cultural growth as well as material progress.[4]

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3 ibid.

4 Rahman. A., "Science and Technology in India's Development", **Mainstream** (Annual) New Delhi, 22 October 1990, p.77.

The Resolution recognized the role of technology and development and the commitment to its acquisition was first enunciated in it. As the opening paragraph of Resolution states; "the key to national prosperity apart from the spirit of the people lies, in the modern age, in the effective combination of three factors - technology, raw materials and capital, ***of which the first is perhaps the most important.*** Since the creation and adoption of new scientific technique can, in fact, make up for deficiency in natural resources and reduce the demands on capital (emphasis added).[5] Thus technological development was delinked from scientific development. Technology was to be imported for the first time on a short term measure and it was expected that once the infrastructure is established it would produce the necessary technology and India would have a self-genarating and self-sustaining scientific and technological system which, in turn, would help in creating and developing industries and generate economic growth.[6]

More recently in 1983, the government enunciated the technology policy statement the purpose of which was to give a clear direction as regards the growth of indigenous technology and the acquisition of technology from outside.

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5 **Science Policy Resolution**, op. cit.
6 Rahman, A., op. cit., p.79.

The various positive benefits from the implementation of these resolutions are: India was able to establish a first rate scientific infrastructure comprising educational and R and D institutions. As a result of these establishments an appreciable growth in the scientific personnel was seen, as shown in Table I.

Table I: Growth in the Stock of Scientific and Technical Personnel 1950-85.

Stock at the end of the year in '000

Catogory of Personnel	1950	1955	1960	1965	1970	1980	1985
1. Engineering and Technology							
a) Degree	21.6(100)	37.7(173.6)	62.2(2880)	106.7(494)	185.4(8583)	211.4(1025)	266.3(1233)
b) Diploma	31.5(100)	46.8(148.6)	75.0(2404)	139.9(4441)	244.4(7729)	329.4(1046)	429.9(1365)
2. Science							
a) post-graduate	16.0(100)	28.0(175)	47.7(298.1)	85.7(535.6)	139.2(870)	217.5(1359)	273.0(1706)
b) Graduate	60.0(100)	102.9(171.5)	165.6(276)	261.5(435.8)	420.0(700)	750.3(1251)	956.5(1594)
3. Agriculture							
a) post-graduate	1.(800)	2.0(200)	3.7(370)	7.7(770)	13.5(1350)	96.5(9650)	414.1(1654)
b) graduate	6.9(100)	11.5(176.9)	20.2(293)	39.4(136.2)	47.2(684.0)	—	—
4. Medicine							
a) post-graduate	18.0(100)	29.0(161.1)	41.6(231)	60.6(336.6)	97.8(543.3)	167.6(9311)	198.7(5483)
b) graduate	33.0(100)	30.0(112.9)	34.0(103)	31.0(94)	27.0(81.8)	N.A. —	N.A. —
Total	**188.0(100)**	**292.7(156)**	**45.0(239)**	**732.5(386)**	**1174.5(625)**	**1782.70(942)**	**2238.5(119)**

Table II, shows the capability and trends in the growth of science and technology infrastructure is the country. The progress in quantitative terms is an impressive one. 89 percent of inhouse R and D centres are in the private sector which shares 54 percent of industries R and D expenditure. Past trends indicate that nearly 79 percent of S and T trend stock of manpower is economically active in the country, 11 percent of which is engaged in R and D. Even among those employed, only 35 percent are engaged in R and D while 33 percent are in administrative routines and Rest in auxiliary services. This has weakened effective utilisation of scientific manpower in India.

Table II: Trends in the Growth of S and T Infrastructure in India

Sl No.		1977	1986	Change
1.	Universities and Indtitutions of higher learning	115	160	1.4X
2.	Colleges offering science and general education	4,317	5,723	3 % growth rate
3.	Intake of students in science and general education colleges	24,32,000	35,71,000	1.5X
4.	Colleges offering engineering and technology courses	155 (1982)	236	11.1 % growth rate
5.	Colleges offering health and medical science (1982)	272	320	1.2X
6.	Professional and technical college	510 (1982)	651	6.3 % growth rate
7.	R and D institutions under central and state government	-	560	-
8.	In-house Industrial R and D centres	-	876	-
9.	Stock of S and T trained manpower	1,88,000 (1950)	11,75,000 (1970)	10X
10	Economically active S and T trained	1,32,000 (1950)	8,23,000 (1970)	6X
11	S and T trained manpower engaged in R and D	15,000 (1950)	2,42,000 (1986)	16IX

Source: *R and D Stat 1986-87, DST, New Delhi (1988).*

The changing pattern of distribution of R and D expenditure by the Socio-Economic sector during the VIth and VIIth plan is shown in Table III

Table III: Changing Pattern of Percent Allocation of R and D Expenditure by Socio-Economic SEctor during 6-7 Five Year Plan Periods

		(Percent)
Socio-Economic Sector	6 FYP	7 FYP
Science and technology	62	61
Agriculture	15	12
Industry	10	9
Energy	5	7
Transport	1	2
Communication	2	3
Social service	4	6
Irrigation and flood control	1	1

Source: *R and D Stat 1986-87, DST, New Delhi (1988), 39.*

Science and technology appears here to be the major socio-economic sector. Added to this, the smaller share in R and D expenditure by other socio-economic sectors give the impression that they are not conscious of the polential of S and T in enhancing productivity.

If one looks at the trends in national expenditure on science and techonology activities (Table IV), one finds a sharp decline in the share of R and D expenditure by major civil research organisations in the country. This is due to two reasons

Table IV: Trends in National Expenditure on S and T activities

Year March end	S and T Expenditure (RS. crores)	As Percentage of GNP
1951	4.68	0.02*
1956	12.14	0.12*
1959	28.81	0.23
1966	85.06	0.39
1971	173.37	0.47
1976	397.99	0.60
1981	1,003.45	0.66
1986	2,223.91	0.96
1988	3,303.55	1.10

Source: *R and D Stat 1986-87, New Delhi (1988), 43 and 44.*
*Note: * Estimated figures using Power Law Model.*

1. Many new science and technological agencies have come into existence in the last four decades,

2. There has been a general shift in investment priority from civil research to military applications.[7]

7 Govindarajulu, V., "India's S&T capability", **Economic and Political Weekly**, Vol.XXV, No.7 and 8, Bombay, 7-24 February 1990. p.36.

This fact is coroborated by distribution of science and technology expenditure in terms of objectives during 1984-87 (Table V)

Table V: Changing Pattern of R and D Expenditure by Major Objectives

S and T Objective	Percent Distribution 1984-85	1986-87	Change
Defence	21	25	(+) 1.25X
Agriculture	17	16	(-) 1.06X
Industrial Development	18	17	(-) 1.06X

Source: *Derived figures from primary data contained in R and D stat 1986-87, DST, New Delhi (1988), 54.*

Another significant estimation in the area of the development of science in independent India is to see the distribution of R and D expenditure in different fields of science (Table VI).

Table VI: Changing Pattern of Distribution of R and D Expenditure by Field of Science

S and T Field	Per Cent Distribution 1984-85	1986-87	Change
Natural sciences	35	31	(-) 1.13X
Engineering and technology	44	49	(+) 1.12X
Medical sciences	5	5	(+) 1.0X
Agricultural sciences	16	15	(-) 1.07X

Source: *Derived figures from basic data contained in R and D stat 1986-87, DST, New Delhi (1988), 55.*

The Table clearly shows a higher share of expenditure by the engineering and natural sciences. This highlights the positive belief that concentrated R and D efforts will lead to measure S and T breakthrough in future by unfolding the basic laws that govern the development of nature, society and human thought. The Table also shows an imbalanced trend in fund allocation among the different fields of science which might lead to a mutual exclusivity between them, each running parallel to the other without any fruitful linkages.

The last and perhaps the most important information is the outcome of these governmental investments in science, in forms of how our own country is farcing as compared to similar related areas in the international scene (Table VII).

Table VII: S&T Indicators: India Compared with Some Developed Countries

S & T Indicators	Unit	India	Countries			
			Japan	USSR	USA	UK
1. Per capita G.N.P.	$	270	9,717	4,550	14,175	9,282
2. R & D expenditure	Percent GNP	1.1	2.6	4.7	2.7	2.3
3. Per capita R & D expenditure	$	2.78	254.14	117.88	376.10	212.25
4. S & T trained personnel	Per 1000	3.43	309.19	116.10	14.90	—
5. S & T personnel	Per 1000	0.20	5.25	5.32	3.09	2.92

Source: R and D Stat 1986-87, DST, New Delhi (1988), 68-69.

Table VII based on some science and technology indicators compares India with some developed countries. It has been estimated that while the world average of R and D expenditure in developed countries was 2.5% of GNP, it was only around 1.1% of GNP in India. In the 80's the developed countries spent an average of $159 per capita on R and D, as compared to $2.78 in India. The average of Science and Technology personnel in India is 44.3 times lower than the average of developed countries and the average person employed in R and D in India is 20 times lesser than the average of the developed countries. It is thus seen here that though India spends 1.1% of GNP on Scientific Research and Development which is much above the average for developing countries, its impact on national science and technology indicators, when compared to the international scene is poorly reflected.

A close look on the governmental expenditure and policies, gives the picture that in the four decades of planned growth and liberal funding has resulted in achievements. But it is also clear that these outputs are nowhere near the progress made by the developed countries. Thus, we need today a model different than the existing one, which may make the Indian science make a visible impact on the world map. It has been suggested that large scale investments are needed, than hitherto provided by the government, keeping in view the vast size of the country as well as the variety of problems faced by her. Also there is a need to achieve new peak of excellence, at least in certain fields to match with the progress in the world. Identifying true areas of priorities in science before allocation of funds is another significant consideration, in so far as investment needed for the development of science in India is concerned.[8]

The above statistics very clearly gives us a satisfactory picture of the development of Science in Post-Independent India. This however, is only the outward appearence, the reality of the situation presently is very significantly different. This will become more clear in the discussion that follows next.

Critique of Science, Society and Development in Post-Independent India

Science in post-independent India, as we have seen before, was based on a similar paradigm that has shown its worth and effectiveness in bringing about socio-economic development in the west and other European countries. Unfortunately in India, during the four decades of its growth, science has betrayed this belief of bringing a similar kind of development. The socio-economic development, here, has been more a jugglery of statistics than the actual resolution of the problems of hunger, poverty, illiteracy, superstition and dreaded customs and traditions that

8 Sikka. Pawan., "Investment For Science In India", **Yojana**, New Delhi, 1-15 November 1990. p.11.

persist till date. A few of the significant questions that we are going to look into in this section are,how far has this model of development linked to the wider social reality?, what was the role assigned to scientific community in particular and science education within this paradigm and whether or not they have lived up to the expectations? In short, what we are going to analyse in the background of the visible failures of modern science, is where exactly, how and why did the Indian science go wrong?

We have seen that the march of science in any particular historical epoch depends upon the prevailing social milieu.[9] To this extent, it can be mentioned here that the social environment and collective traditional psyche of the people of India at the time of independence was not suitable and prepared to accept the philisosphy, rationale and logic of modern science.

As a result of the imposition of modern science in the developmental policiies which was antithetical to the existing social psyche, several unwanted effects were seen. It has been argued how modern science, by inducing blindness to our own environment, caused misdirection of development, that it has snapped our links with traditional knowledge, that it has increased our reliance on industrially advanced countries and

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9. Ghosh. Kunal., "Democratization of Scientific Milieu in India", **Management of Indian Science for Development and Self Reliance**, Proceedings of the SYS Symposium (6-9 February 1980), New Delhi; Allied Publishers, 1980, p.237.

has sucked our country into the vortex of their power game and business.[10] Looking at this argument it can be seriously doubted whether the national policy for scientific and technological development ever had its roots in the soil of our country.

Though this thin and rather inappropriate link between modern science and the existing social context of India is the main cause of why science in India has not fared too well, there are other significant and related issues as well, which has adversely affected its satisfactory performance.

Let us first take into account the scientific community in India, which to my mind, is the major structural determinant on which the entire edifice of science depends. Today, as has been mentioned in the previous chapter, India is ranked third in the number of scientists and technologists and scientific and technological institutions in the world. Despite this the contribution of India to the world science has been deplorably low. It has been pointed out that out of every forty discoveries made in the world, only one is made in India.(Derek Price, 1969). One hardly finds any significant increase in the creativity of scientists or technologists in the post independent India. Ghosh(1980) argues that in pre-independence days

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10 Ghosh. S.N. and Chaubey. N.P (eds.)., **Impact of Science and Technology on Indian Society**, Calcutta; Naya Prokash, 1980, Chapter 2.

our scientists displayed high order of creativity. But no such creativity has been displayed by them after 1947. Thus, though there has been growth in the scientific output after independence, spectacular Indian contribution comes only from the pre-independence period—the rest though substantial are not essential in that even if they are omitted, world science will not set back significantly.[11] It has also been pointed out that the output of an individual scientist is only a third of the world average, but when the same individual is working outside India, it is increased to one and a half times that of the world.[12] The reasons for this will be discussed later.

Presently, let us see the nature and role of scientific community in India. One necessary corollary of the growth of science is the scientific attitude. In India, one notices the rapid growth of antiquated ideas and beliefs which are the very antithesis of science. It is not uncommon to see or hear an astronomer doing a "tapasya" during an eclips, practice of "puja" in laboratories or scientists talking of spiritualism.[13] There is a general tendency amongst scientists not to bother about these as would be evident from a cursory glance of scientific journals etc. There was this interesting case reported about the controversy which was raised against

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11 Sundarshan. E.C.G., "Science in Indian Society", **Economic and Political Weekly**, 9(12), Bombay, 1974, p.465-67.

12 Rangarao. B.V., Article in **The Statesman**, New Delhi, 10 June 1972.

13 Mentioned in Rahman. A., **Trimurti - Science, Technology and Society - A Collection of Essays**, New Delhi; People's Publishing House, 1972, p.195-196.

decision of the Department of science and technology to contribute ten thousand rupees for a "yagna" that was organised in Mathura in May 1988 to induce rain.[14] These instances bring to the fore one common fact that the scientific outlook which is demanded by the modern science is still lacking in India. Scientists as individuals of the wider society imbibe such attitudes, quite naturally,in their process of socialisation and in fact live with them. These anti-scientific attitudes affect the growth of modern science and science activities.

The lack of scientific outlook is not the only disability that the scientific community in India exibit, there are others too.The community is highly politicised, hierarchical and bias ridden. Professional "casteism" exists even among the scientists. The scientists seem to consider themselves superior and above others. This brahminical tendency never lets them open the doors of knowledge to others. Not only in terms of transmitting knowledge to lay public but even amongst themselves their prejudice has not allowed them to have an inter-disciplinary approach to solve specific problems. Individuals who work in the direction of popularizing science are looked down upon by the scientific community.[15]

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14 Reported in **The Times of India**, New Delhi, 3 May 1988.

15 Bamezai. R, and Bamezai. G., "Science and the Role of Scientist", **Management of Indian Science for Development and Self-Reliance**, Proceedings of the SYS Symposium (6-9 February 1980), New Delhi; Allied Publishers, 1980, p.322.

Next important issue of grave concern is the migration of the scientists to other countries and other more lucrative professions.The signs of pessimistic drift and demoralisation among significant sections of the scientific personnel has often been reported. The most acute manifestation of disquiet have surfaced among the nuclear scientists, large number of whom are on the verge of throwing up their job in strategic sectors of the country's developmental effort for more promising assignment far away.[16]

Those who are here in the country are now showing keen preference towards administrative and bureaucratic jobs than to their profession. For instance, there are several unemployed chemistry graduates who do not go for an area like soil analysis in preference to jobs like the I.A.S. or I.J.S. etc.These attitudes, implicitly, affect and so far as getting a science related to the needs of the society is concerned. For example, it has been pointed out that there are thousands of physicists in our country but not a single degree holder in rice-technology—and that too in a country where for more than half of the people, rice is the staple diet.[17]

One fundamental reason for the lack of interest and professionalism is the continueing dissatisfaction among scientists over working conditions, favouritism, politicisation, corruption etc. that are prevalent in this area. D.

16 Mentioned in **The Hindu**, Madras, 14 September 1978.
17 Chawla. J, and Jain. A.P., **Whither Indian Science?**, New Delhi; S.Chand and Company (Pvt.) Limited, 1973, p.125.

Mohan laments at this sad lack of prime scientific ethos-honesty-which is the pre-requisite for scientific discovery and advancement.[18] Such processes do not only retard the scientific progress but also affect those who are genuinely interested. To this end, a very striking observation was made which pointed out the case I.I.T. Kanpur that averaged one suicide each semester.[19] Year after year, it is said, scores of promising scientists continue to take their own lives all over the country because of frustration, harassment from their superiors, and the politicisation of academic and scientific life.

Thus, we see that the scientific community which projects a very polished exterior is at the core embedded with such institutional problems that demand immediate resolution. The ultimate bearing which these factors have is on the quality of the output of scientific researches.

During the post-independence period, and more particularly since the late 1960's, there has been a continuous increase in the ratio of mediocrity to excellence in respect to the quality of scientific and technological researches. We have earlier noticed the dismal performance of scientific researches in India.It has been mentioned that not a single Indian scientist's name was listed among the thousand world scientists

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18 Mohan. D., "The Waterloo of Indian Science", **Management of Indian Science for Development and Self-Reliance**, Proceedings of the SYS Symposium (6-9 February 1980), New Delhi; Allied Publishers, 1980, p.242.

19 Mehra. Achal., "Who is Killing Our Scientist?", **Sunday Standard**, New Delhi, 9 November 1980, p.4.

whose works were recognised during the period 1965-1978.[20] Various reasons can be given for this decline in the quality. It could be because the contents of the researches have now changed from fundamental issues to more technique oriented. It could also be because of the low emoluments on research activities. It could also be because the lack of encouragement from the industrial establishments, in the invention of new processes and products or, it could also be because of the iron grip that politics and bureaucracy has on Indian screen. Whatever be the reason the irrefutable truth is, and as Rajiv Gandhi also told in the 74th science congress (Bangalore), that the curse of mediocrity has been the root cause to retard a faster scientific growth.[21]

Apart from this mediocrity, one other weakness of scientific research in India that has been pointed out, is the lack of interaction between the research outputs and the industry. It has been said that the science and technology research in India has not been able to interact with industries, and people engaged in these activities are troubled and perplexed due to the lack of any appropriate relationship between their professional role and their social context.

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20 Gupta. Y.P., "Scientiest in Search of Fame", **The Times of India**, New Delhi, 31 October 1982.

21 Reported in **The Patriot**, New Delhi, 9 January 1987.

The social relations in science in India has failed to gain a scientific recognition and through policy decisions, the leadership in science further undermines the community structure and contributes to making the system of scientific production marginal to the social system of which it is a part. The regrettable part is that scientists in India are aware that their researches do not link up with the needs of their society, yet they neglect often the primary consideration of relating the function of science to the agricultural and industrial development and not, as is linked today, to the needs of the industrialised countries.

Not all the blame, however, can be given to the scientists for such a situation. This negligence is partly a tributed to their absence in the decision making processes. M.G.K. Menon while acknowledging vital potential, that this scientific community has and also appreciating the magnificent role that the agricultural scientist played in making the country meet its agricultural demands, suggests that the phrase "scientists on tap"-implying those on the periphery of the decision making process should in fact be appropriately changed to "scientists on top".The situation should not continue, as it is today, that those concerned with policy formulations call for suggestions and consultations and later assign to them the same role after decision making. Thus, in order to generate a new and proper sense of participation there is the need for a proper two way dialogue between scientists and policy makers and secondly the administration of science should be placed in the hands of the scientists[22]

Another significant reason for a mediocre output of researches is our present system of education which has failed to inspire our students and instil in them the spirit of scientific enquiry.[23] Science education in our schools, colleges and universities was patterned by the British policy of education. After independence scientific institutions, bodies, laboratories etc. were also modelled after their British counterpart (e.g. Council for Scientific and Industrial Research, University Grants Commission;Defence Science Organisation etc.) As a result of this unthinking limitation of the West, we failed to introduce in the country a science oriented educational system which could have matched our social contexts.

Science education in our universities and colleges is far from what it should have been. It is fragmented and repetetive. It is not linked to the social reality. An honest appraisal of science education in our educational system reveals 1) that the knowledge of any branch of science being imparted to our students is at least fifteen years behind the current knowledge of science, 2) that it is incapable of equipping the students

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22 Menon. M.G.K., "The Scientific Community in National Development and its Involvement in Policy Formulation and Decision Making", **Indian Journal of Public Administration**, Vol.XV, No.3, New Delhi, July-September 1969, p.509-520.

23 Kurup. V.S.P., "Scientific Societies Need Revamping", **The Times of India**, New Delhi, 26 March 1982.

with better understanding of nature and society, 3) that it is hardly conducive to the origin and growth of scientific creativity in younger generation [24]. Three thinkings and calls for immediate reform clarity of concepts, pedagogic unsoundness, i.e, right pedagogic tools have to be used and substandard text books, that is teaching in science ought to be backed by availability of good, standard and reasonably priced text books.[25]

Science may be universal but the process of science learning is culture specific. Thus there is the need to introduce an educational system with the kind of rationality, curriculum and syllabi that would be most suited for us. The need of the hour is to fully recognise and understand the link between education and science, that the two, when developed hand in hand can suitably guide Indian science and development. If this is not done then the creativity and potentialities of the scientific community will continue to get blunted through the perpetuation of colonial and socially redundant organisations, wrong policies and faulty education.

This does not mean, however, that there is no creativity or potentialities. But here again there is a paradox seen. The large numbers of qualified scientists and graduates face the problem of rampant unemployment. It

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24 Dubey. S., "Science Education, Scientific Organisation and Creativity", Ghosh. S.N and Chaubey. N.P., (eds.)., op. cit., p.113-114.

25 Prasad. C.S.G., "Sorry State of Science Teaching", **New Times**, 25 September 1985.

was reported that fortythree young science graduates, unable to find a job, worked as "malis"(gardner)[26] On the other hand, the best known scientists are so bussy that a major part of their lives they have to spend outside the laboratories. Most of them leave the country, those who stay here maintain such esoteric, rich, elite and inaccessible personality that the young researchers find it difficult to communicate. It was with the intention to bridge the communication gap between the scientists, themselves,and the wider society that Indian Science Congress was started. These Congresses were also more a ritual than any productive and socially beneficial proceeding. In the analysis of one such meeting , it was mentioned that even this largest gathering of scientists in the country took no note of any of the current trends in the government's attitude towards science and technology and the concept of self-reliance , problems of research and the spread of non-scientific temper in the country, sometimes with the aid and abetment of respected public leader.[27]

Another different and equally important area to study the factors affecting the Indian science is its relationship to the government. We have seen that the most immediate and obvious drive that science gets is

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26 Reported in **Indian Express**, 5 January 1978.
27 Sharma. L.K., "Top Scientists Fail to Face Realities - Annual Meet a Ritual", **Indian Express**, New Delhi, 13 January 1978.

through government's policies and plans. The Science Policy Resolution has been a significant step towards this direction. It has been pointed out that planning for science in India has been, de facto if not de jure, peacemeal and not integrative. They have not been free from shortcomings. In Science policy there is the visible absence of a rational guide in the decision making for allocating funds on the criteria of urgency and social necessity. Then,there is the lack of a system for continuing assessment and evaluation of the appropriate use of these financial resources.[28] Another deficiency lies in the set of policies relating to the performance of our scientific institutions. There is a continued negligence in the reformation of organisational, administrative and personal policies. Moreover, the values and methods of decision making in the majority of institutions continue the subordination of scientist to the bureaucrats.

It is also essential to gear up the scientific capacities in such a way that they can displace imported technology and promote indigenous technology. Import of technology has adversely affected the growth of indigenous researches. It has been pointed out that any indigenous research on the product or process once imported, make a built in bias against research for those in the country. The proper way suggested is to

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28 Rahman. A., **Mainstream** (Annual), op. cit., p.81.

buy the technology for once and develop on the basis of the patents. Collaborations with multinational corporations have also restricted industrialisation on indigenous lines. We talk of colonial exploitation of our resources by British imperial power, but free India has opened her door wider to those who bring their own technology and care a fig for capital saving and labour intensiveness which are our socio-technological needs at present.

In so far as development is concerned the attempt in India was to consciously use science as an instrument of social change.The whole situation and problem of misfit emerged because of the ignorance on our part to think that this model in the west was not consściously worked out by there scientists,but it evolved in the most natural way[29] Moreover,ours was a hurried approach towards achieving our national goals. It involved leap frogging from a state of economic backwardness and social disabilities, attempting to attain in just few decades a similar change which has historically taken centuries in the west.[30] The effects of this blind imitation has been more regrettable than anything else, as we have seen.

We tried to adopt and follow an erroneous conception of what constitutes "development". We have adopted-whether implicitly-

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29 Jha. S.K., "What is Wrong with Indian Science?", **The Illustrated Weekly of India**, New Delhi, April 1972, p.32.

30 Sarabhai. Vikram., "Science and National Goals", **Indian Journal of Public Administration**, op. cit., p.316.

the"Stages of Development Approach"more particularly the unilinear model (Rostow 1960) which takes the position that, the advance of all countries including the poor countries of today like India,can be completely and satisfactorily described, not only in terms of a single set of social, economic,political and cultural indices,but by a set whose dynamics constitutes an evolutionary sequence.[31] It must be simultaneously re-appraised here what has been perhaps the most significant perspective that natural scientists and technologists have brought to the Development Game, that is,the possibility of developing countries using science to "leap-frog" one or more of the socio-economic stages through which the most industrialised countries of today have passed. Indeed it is this possibility that is the source of much of the excitement of "science for development" today. But,if this science is to be used in conjunction with economic and social policies of a "traditional" kind, to bring about development styles which are imitative of those of highily industrialised countries today,then there is an equal possibility of falling into a dangerous trap.[32] This is the trap in which the science, society and development of India is,today. And the scientists are in a fix and confused state. As Atmaram, former Director of CSIR, once aptly revealed: "....either we do

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31 Rostow. W.W., **The Stages of Economic Growth: A Non-Communist Manifesto,** Cambridge; Cambridge University Press, March 1960.

32 Parthasarthi. A., "Meeting the Indian Challenges", **Mainstream** (Annual), New Delhi, 28 October 1989, p.106.

not know what we want from science or we donot know how to get what we want from science"[33]

It is at this juncture that now some young scientists have started to question the very model of development. Experiences of Gandhi, Kumarappa, and others have clearly brought out the possible alternative models, where man is at the centre of planning, rather than "development" itself.

So far our concept of development had been stated to be our capabilities to start big industries, raising plants and big concrete structures, providing people with the latest luxuries. In other words, development had been made synonymous with increased production of "modern" facilities rather than our capability to fulfill the basic needs.

An alternative approach to development, therefore, requires a re-examining of the criteria for development itself. The targets of development will have to be achieved not necessarily by building super-structures with foreign technologies but by exploiting the developments in science as suitedto our own needs which could be fulfilled with available resources.

The model will have to be based on the vast agro-industrial potential of this country. It should emphasise on the distributive justice as compared

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33 Quoted in "The Relevant Science", **Tribune**, Chandigarh, 1978.

with the quantum of development or its quality. The production and the distribution system will have to be more decentralized.[34]

CONCLUSION

In this chapter it was tried to explore areas in which Indian science has run into the rough weather. It is now understood that the social milieu that exists in India is not equally conducive to the growth of science here as in the west. As a result of this difference in context the science in India has failed to develop as an integral part of the socio-economic and cultural system. This is not because the scientific inputs are missing but because the type of social institutional forms that can induct such science are missing. In the light of the existing social realities, and attempt was also made in the chapter to suggest an alternative to the very concept of development. This has been done because of the growing anxiety felt everywhere for a change in the present situation so very essential for the growth of Indian science. And this change has to be in tune with the national aspirations of democracy,secularism and socialism. For it is only with these values that science will emerge among the masses. Till this happens, science would continue to be "unfriendly" serving the interests of the industrially advanced western societies at the cost of the interests of the society and development in India.

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34 Mehrotra. N.N., "Development: An Introspection for Alternative", **Management of Indian Science for Development and Self-Reliance**, op. cit., p.17.

Conclusion

CONCLUSION

For any society which today aspires to develop, its linkage with science is irrefutably a necessary if not a sufficient condition. Science and the development of society go hand in gloves. Science has the tendency of being "friendly" or "unfriendly" depending upon the manner in which it is dealt with. This precisely demands two things, one is to exuviate the presupposed notion of science as an esoteric and monolithic entity and view it more as a social activity, and second is to shake off the belief that development is true and worthy only when it is achieved along the lines similar to those in the West.

A creation can never be so great that it starts to tyrannize the creator. Science which is the brainchild of human being, with its giantness and might has turned out to be a threat to the whole of humanity. The need is to change this alarming situation. Benefits of science can be attained only when it is oriented towards the social realities and nurtured along more appropriate needs of the concerned society.

An example of a mismatch between science and society is seen in the context of development in India. The four decades of post-independence have failed to give India a society that science was supposed to give.

The study also reveals that the supposed interrelationship between science and development does not bring in a similar pattern of change in all societies. Improvements in material culture can be achieved, sooner or later, but its degree of permeability in non-material culture is impatiently slow. This inevitably affects the nature and character of development.

In the context of India, the adopted model of development has today created situations of economic roll down, political authoritarianism, dependent development, cultural dominance and immiseration. Since material development is encompassed and supported by a society's culture and values - the non-material aspect, which is inevitably linked with the uniqueness in space and time in which the society is situated, any alien development pattern and scientific paradigm will have the deleterious impact of cultural dominance, disarticulation and alienation. Hegemony and violence is inbuilt in this particular pattern of development that seeks to impose uniform socio-economic political and cultural structures and the underlying values and thus a deadening uniformity that ends up in reducing all pluralities and distinctive identities of every socio-cultural groups at all levels, as the cogs in the monolithic world structure.

Every ethnic group has its own socio-cultural set up in which the economy is a significant if not a determinant aspect. Hence, if science is accumulation of knowledge its vital imput is the immediate reality of those whom it touches.

The positivist regime of science that is subsumed in the Western eschatology ends up with a singular definition of what constitutes knowledge, the rationality of which is determined by the base of a particular scientific method. Modern science, seeks to universalize this definition of science that was essentially European (18th Century) in its content and form and capitalistic in its mode and outcome. The dominant thesis of development was based on the unrelenting growth of science and was conceived as a scientific project. In this paradigm every non-Western society was backward unscientific and undeveloped.

It is here, that the cultural context becomes important. And if culture is nothing less than the dialectical interplay of man and nature which produces the knowledge system, then this knowledge system is also nothing less than science and nothing less distinctive than the distinctiveness of the culture itself. Seen thus, every culture becomes an expression of the identity of society and every science becomes the code which encapsulates the socio-economic and political experience of that society. Indigenous science is therefore inextricably related to the survival of every indigenous group, and linked with the efforts towards a satisfaction of the needs and wants of its members.

In India, the failure of the development model that was to be motored by the relentless implantation of Western science is a pointer to this ignorance of the real nature of science. If India of today is in the throes of abyssmal poverty, crippling economy, political dependence and a threatening disintegration then the way out is not a more relentless pursuit of the same model of science and development.

During the last few years a number of mass movements (People's Science Movements, Feminist Movements, Ecological Movements etc.) revolving around some crucial issues have emerged drawing up new parameters of development in India as well as in the Western societies. Sustainable development, ecological balance, mass knowledge based science and production the satisfaction of mass needs and wants are the leit motif on which these movements revolve. Their work has ranged from a conceptual outline of the nature of development and its most viable strategy to mass education of the public and kindling of awareness of needs and wants, with the appropriate way the satisfy it. Finally they seek to mobilise science for mass action to counteract the hold of official, elitist brand of development and clamour for the upliftment of the masses from the morass of poverty and ill health.

In India, notable amongst the movement which have achieved a degree of success are: the Chipko movement that has been aimed at the reckless felling of the trees in the ecologically sensitive areas of the Himalayas; the Kerala Shastra Sahitya Parishad (KSSP) that has succeeded in forcing the government to rethink about the silent valley project in Kerala and the Baba Amte led 'Narmada Bachao Andolan' that has been fighting tooth and nail to make the government abrogate the potentially destructive Sardar Sarover Project. At another level some of the movements have been doing commendable works in relating science to the people's needs basing it on the knowledge system and thus bridging the gap between the esoteric science and the teeming millions. Obsolescence of the masses within the elitist development strategy, dispensibility of their needs and the culture in the pursuit of the urban based industrial development and the social triage of the backwards, tribals and the poors, which the People's Science Movements have highlighted.

The alternative becomes clear. If India has to survive, if every non-Western society has to develop, then it has to look inwards for answers. Indigenous science and development is the only of this impasse. It is this that is closer to the needs and the values of the people and is ecologically sound. Indigenous science however does not mean an insulation from the outside world instead it only seeks to integrate and assimilate the knowledge acquired from without with those derived and time tested from within. In fact knowledge without the appellation of science — as we have come to know — is universal and its application can only be particular in consonance with the pluralities in this world.

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