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The Need for Study of History & Philosophy of Science & Technology

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Abstract

*Science today has become an institution. But it can also be taken **(i)** as a method, **(ii)** as a cumulative tradition of knowledge **(iii)** as a major factor contributing to production of goods & services and **(iv)** as one of the most powerful influences moulding beliefs and attitudes to universe and man. And also, science has a social function. These points were raised and studied thoroughly by J. D. Bernal. Recently P. Fara has explained how science belongs to the real world of war, politics and business. She explores the sociological angle, arguing 'that being right is not always enough; if an idea has to prevail, people must say it is right.'*

The study of History of Science helps us to go beyond the definition: 'Science is experiment, observation and inference'. From a study of mankind's progress – we go beyond. From organisation of laboratories to public perception of science & technology to national politics, all are now studied in the broad discipline of history of science.

Understanding science is crucial to our understanding of nature and civilization as a whole – but there still remain questions unanswered. It is also important to distinguish between the various methods of arriving at truth – logical positivism, deduction, inductive method, falsification or paradigm shift. In many countries, science teaching is being deeply studied by philosophers of science.

The present world is at a crossroad. To create a knowledge society, to create innovative minds – it is important to understand the structure of scientific method. This paper explores these in some detail. Also, it is argued, history & philosophy of science have to be studied concurrently.

Introduction

This paper attempts to outline the needs for study of History of Science concurrently with Philosophy of Science. Partly, technology, whose growth is assisted by Science is also considered here, because, "Technology is used to conquer & control nature and make use of her for human welfare". It must be mentioned here, that this is where mankind failed partially. It is true that life expectancy has increased, food production and consumption has decreased starvation deaths, communication and travel have become faster , making networking among societies faster. But we are yet to resolve the conflicts among human beings leading to war, problems of unsustainability or the problem of greed leading to economic disorder. Are we paying the price for violating Francis Bacon's dictum, "Nature can be conquered only by obeying her"?

It is concluded that for innovations leading to knowledge societies without gender and culture bias and for a living planet with high sustainability index, studies of history & philosophy of science can be of immense help.

Science: The Meaning

In texts, science is defined as knowledge based on experiment, observation and inference. Historians of science have defined science integrating it with nature and society. Dampier defines science as ordered knowledge of natural phenomena and of the relations between them. It can be observed that the idea of interdisciplinary of subjects was inherent in most of those definitions.

For innovation, sustainability and transition to a knowledge society, interdisciplinary thought is a must. History of science is one such subject.

Why History of Science

The moot point is not, however, the definition of, but what science and technology have done for the society or world civilization? Of course they have created scientists

- A name coined by Whewell in 1840 in his book 'Philosophy of the Inductive Sciences'. Much later than Priests or Lawyers, scientists in the Mid-twentieth Century started being absorbed in Institutions
- Scientific laboratories or Universities. To this day, these institutions do not play leading role in governance in most societies. The question or problem needs to be addressed.

Science, to quote J.D. Bernal is a 'cumulative tradition of knowledge'. Scientists stand on earlier scientists shoulders. But this is not simple addition or a linear growth. This duality comes out only in history of science.

Science to technology to production has changed societal structures. But the off shoot of production has been a degradation of the environment. That too has been understood only in the 21st Century!

Methods of Science draw us to the philosophy of science. This will be taken up later.

Also, the interaction of science with culture and society is very crucial for the understanding of growth of science as well as society.

Broadly it can be taken as follows:

1. History of science enables us to understand the stupendous intellectual & innovative efforts scientists and technologists made through the centuries. It expresses the victory of collaboration and the collective spirit of men or groups of scientists cutting across borders

2. Scientific truths, being independent of space and time, are more universal. The culture of science is a global culture – a global intellectual treasure. The search for scientific truth is different than that of spiritual leaders. It takes time to establish a scientific truth.

3. A study of history of science as a discipline is needed to know about ideas, practices, innovations, events, individuals, groups and institutions that shaped science to trace the trajectory of this social and intellectual activity over time.

4. Why modern science did not grow in India? The history clearly shows that Greek Science owes its development to Egyptian and Babylonian Science. Indian science developed to a very high level between 400 and -900 A.D. This in turn helped Islamic Science which in turn influenced European Renaissance. The world was not Eurocentric or US Centric as it is now. What happened to Indian Culture – which gave birth to scientific disciplines of Ayurveda, industries like metallurgy & ceramics, and made rapid strides? Answer needs to be found to this question.

5. History of Science builds a bridge between science and the humanities. The 'two cultures' dilemma may be solved with the study of such a subject.

There are many other needs for which the references can be consulted.

Philosophy of Science

Philosophy of science is concerned with the assumptions, foundations, methods and implications of science. It deals with very serious questions about the use and merit of science and tries to explore whether scientific results are actually a study of truth. Very often scientists and engineers question the necessity of handling these questions. Here we may quote physicist Richard Feynman ***"Philosophy of science is about as useful to scientists as ornithology is to birds"***. This is possibly an extreme view, and we may consider the view of Losee, which says: "***The distinction which has been indicated between science and philosophy of science is not a sharp one. This is based on a difference of intent rather than a difference of subject matter"***.

What is the subject matter of Philosophy of Science?

1. Study of the difference between scientific knowledge and other types of knowledge. To distinguish science from non-science is one of the central themes of philosophy of Science.

2. Procedures or methods followed by the scientists to investigate nature.

3. Determination of correctness of scientific explanations.

4. Logical and rational basis of accepting the scientific laws and principles as truths. What we know as true today may not remain true at a future point of time.

5. Questions of ethics in practicing science. Questions are raised whether genetic engineering is good for mankind, how far it should go and where to stop. This is where theology is penetrating science questioning their basic tenets.

Study of Philosophy of Science helps us to explain how techniques of experimentation, observation and theory construction have enabled scientists to uncover the secrets of nature. It gives us an insight into how science should proceed, what methods of science should be used, what are the limitations of these methods and how much confidence is to be placed on the results obtained by following these methods.

Most importantly, it helps better to understand science and to show how by following the methods of science, the human mind opens up to innovations.

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We may briefly mention some of the methods of science:

(i) Deductive logic or reasoning: This is a process of reaching a valid conclusion following deductively from a given set of premises. A valid conclusion may be false if the premises are not true. Deductive reasoning is one of the old methods practiced by ancient Greek Philosophers like Aristotle.

(ii) Inductive method: This is a method of reaching a general principle or law from a number of specific observations. It states that if a situation holds in all observations, then the situation holds in all cases. A correct inductive argument may have true premises but a false conclusion.

(iii) Axiomatic system: It consists of a set of axioms from which by using some or all axioms together, a proposition or theorem can be derived logically. Euclid's Geometry is a classical example.

(iv) Positivism: This school of philosophy holds that the only authentic knowledge (or reality) is that which can be observed, detected and positively verified.

(v) Scientific realism and instrumentalism: Scientific realism claims that science aims to find out truth and scientific theories to be regarded as true or like true. The antirealist's or instrumentalist's view is that science does not aim at truth, and scientific theories should be regarded as useful to describe nature.

(vi) Scientific explanation: Scientific theories are expected to offer explanation of events that have already occurred, in addition to providing prediction of future events. Philosophers investigate whether a theory has successfully explained a phenomenon, as well as what gives a scientific theory explanatory power- the unification model and casual model proposed by Kitcher & Salman.

The list is long and need not be covered comprehensively within the short course of this deliberation. However, Karl Popper's "falsificationist" philosophy is worth mentioning. It begins with the universally accepted point that any amount of evidence can not prove a scientific hypothesis, because there are always untested predictions. Popper states that we should favour those hypotheses, which are falsifiable, yet unfalsified.

It is necessary to note some of the scientific thoughts in classical Indian philosophies in this context.

In Caraka Samhita, written somewhere about A.D. 300, origin of the deductive and inductive methods as well as experimental methods can be traced. Caraka also introduced concepts of heredity which are similar to our modem ideas on the subject.

Vaisesika Sutra, supposed to have been written by Kanada, is a philosophy of rigorous materialism. It believes in atomic structure of material and advocates a mechanistic theory of causation.

The Nyaya philosophers had criticized the self-validity of knowledge and established the theory of ascertainment of truth by verification. The major value of Nyaya philosophy consists in its contribution to method and precise terminology to be used in philosophical discourse, which was subsequently adopted by all schools of Indian philosophy.

Carvaka philosophy also known as Lokayata philosophy was a materialistic philosophy in contrast to other spiritual philosophies. Their views about origin of the world is that in the beginning being (life) came out of non-being, that matter is the ultimate reality. Lokayatikas deny past and future birth, all knowledge being posterior to and derived from experience. There is no second world, death is the end of all.

Orthodox Indian Philosophy Schools like Samkhya, Yoga, Vaisesika, Nyaya, Purva Mimamsa and Vedanta can be traced from Vedic and Upanisadic writings. Fundamental distinction of these spiritual schools are great though all believes in existence of Soul and its possible liberation, doctrine of Karma and Rebirth and acceptance of ultimate validity of Vedas, However dissenting views have also been expressed by the so-called many unorthodox Indian philosophies of which major are Buddhism, Jainism and the Carvaka or Lokayata.

Among Indian philosophers and scientists, Sri Akshay Kumar Dutt (1820-1886) was one of the first to oppose the metaphysical basis of Hindu philosophical texts and in his book 'Bharatbarsher Upasak Sampraday' (1870) he dealt with in depth, how hindu philosophy, mostly was neither empirical nor positivist. He consistently expressed that modern science was shaped in west and went into the reasons for it. Sir J.C. Bose (1858-1937), was one of the greatest scientists born in India. His work spanned from electromagnetic waves to nature of plant's life. However, even being an experimental scientist, his philosophical views were

metaphysical and 'Vedantic'. On the other hand Acharya Prafulla Chandra Ray (1861-1944), a great teacher, experimentalist and entrepreneur, wrote in his book 'History of Hindu Chemistry' (1904, p.195).

"The arts (technical) being thus relegated to the low castes and the professions made hereditary …….. the intellectual portion of the community being thus withdrawn from active participation in the arts (technical), the how and why of phenomena – the coordination and effect – were lost sight of – the spirit of enquiry gradually died out among a nation naturally prone to speculation and metaphysical subtleties and India for once bade adieu to experimental and inductive sciences ….. and (India's) her very name was all but expunged from the map of the scientific world." P.C. Ray mainly puts the onus on Sankaracharya's 'mayabad'.

As for Ramendra Sundar Trivedi (1864-1938), who was more a science populariser, than scientist – he wrote extensively on science and philosophy, and that too in very simple vernacular. He wrote extensively of philosophy in his book Jijnasa (1904) – where he writes in the essay 'Panchabhut' – "there is no need to combine philosophical analysis to scientific analysis. It is impossible." In the same book he discussed Buddhist philosophy which denied existence of Atma (Soul) in a separate essay. He was way ahead of his time.

An exhaustive study of Hindu Philosophy of Science was done by Prof. Brajendra Nath Seal (1864-1938) in his book "The positive sciences of Ancient Hindus' published in 1915. In p.39 (Sahitya Samsad Reprint, 2001), he writes "….. Vedanta and Purba-mimamsa has made some contribution (regarding basic tenets of chemistry, physics etc.); however overall it is negative." To understand Indian Philosophy of Science, this book is a 'must read'.

The writings of Debiprasad Chattopadhyay (1918-1993) must also be mentioned in this connection. He, a philosopher, and follower of Marxism, elaborated Indian philosophy's scientific basis and materialistic tradition in many of his books, particularly, 'Lokayata Darshan' (1956) and 'Science & Society in Ancient India' (1977).

Philosophy of Science has been given most importance in Marxist writings particularly in 'Diabetics of Nature' by Engels. According to him "dialectical thought is only the reflection of the motion through opposites which asserts itself everywhere in nature, and which by the continual conflict of the opposites and their final passage in one another, or into higher forms, determines the life of nature." Dialectics is central to Marxist philosophy of science.

A study of philosophy of science should include all these aspects.

Technical Questions

It was German engineers who, between 1775 and 1840's used the term 'technik' elaborating a discourse relating this term to philosophy, economics and culture. "Technik" meant the totality of tools, machines, systems and processes used in the practical arts (as technology was called in its early state) and engineering. Thus technology and engineering were differentiated long back. Now we use the terms interchangeably.

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Lewis Mumford's landmark work "Technics & Civilisation" in 1934 talked about three different social systems developing, arising out of different technologies. He introduced the concept of technology complexes: the water-wood complex, the coal-iron complex and the electron-alloy complex. When we talk about knowledge society giving over-emphasis to Information and Communication technologies or Nanotechnology – where we talk about atomic nature, are we following the laws of obeying nature?

The questions central to Philosophy of Technology have been raised by David Nye [9] very comprehensively. Some of these questions help us to the study of History and Philosophy of Technology:

(i) Is technology deterministic or is it shaped by culture?

(ii) The predictability of technology.

(iii) Does using modern technologies break down or increase cultural differences?

(iv) The relationship between technology and nature.

(v) Does new technology destroy jobs or create new opportunities?

(vi) Should market decide the choice of new technologies?

(vii) Are advanced technologies leading to a more secure life?

(viii) Increasing technology use and its impact on human mental abilities.

Technology depends upon the technology to grow – it is self replicating. These questions bring scientists, technologies and the humanities people closer to understand what is good for civilization.

Needed – A Course on History and Philosophy of Science and Technology

Sri Samarendranath Sen prepared a B.Sc. level syllabus on History of Science in 1960s in India. No University here wanted to run such a course. However, Asiatic Society did run a short term course for some time.

Abroad, we have many Universities, which run courses in History and Philosophy of Science and Technology.

It is imperative now that we start such a course in one of our Universities. Research in this area may lead to solving the problems of sustainability and the newer problems facing modern society.

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