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Fashioning the Future—Some Complex Issues in Science, Philosophy and Culture

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SCIENCE has for long been the best friend of humanity. It's achievements are truly enormous—putting a man on the moon and breaking the genetic code are two of the more dramatic feats of science.

It is to be expected that modern science and the technology based on it, by virtue of its versatility and vitality, will raise some major questions for humanity. What is strange, however, is that many of these questions cannot be answered by science itself.

In this paper, we shall pick up three clusters of such questions all of which have some ethical import: (*a*) two examples of decision-making in science and technology; (*b*) the problem of the kind of society in which science develops; and (*c*) science as a problematic human instrument for fashioning the future. There seems to be no fully scientific method by which we can arrive at a satisfactory answer to many of these questions. My Marxist friends may perhaps want to argue that science itself is capable of dealing with all of these problems: I would be interested in such arguments in the cases that are set forth as examples.

Decision-making in Science and Technology

Peaceful Uses of Nuclear Energy

Let us take two examples to illustrate this cluster of problems: the peaceful use of nuclear energy, and genetic engineering, or the manipulation of living organisms. Both, as we shall soon see, are really live issues for us in India, though the general public is only just beginning to awaken to the importance of these questions.

India has embarked on a determined programme for the peaceful uses of nuclear energy. There are two aspects to this. First, that of peaceful nuclear explosions, which we shall not discuss here. What we did in Pokhran on 18 May 1974, was simply to dig an L-shaped tunnel, and to put a 12-kiloton plutonium device into an underground chamber at a depth of 107 metres. The device went critical according to plan and exploded, raising a dome of earth 170 metres in diameter and 34 metres in height; the dome slapped down in less than 3 seconds producing a crater 10 metres deep and less than 100 metres in diameter. The experiment cost Rs 32 lakhs. This technology can be used in the future for building harbours, digging deep canals or underground water reservoirs; to seal off burning natural gas, etc. There are connected problems which we will not go into here.

What we need to discuss are problems raised by our nuclear power projects in Tarapur, Rana Pratap Garh, Kalpakkam and Narora. Only in Tarapur do we use enriched uranium as fuel and therefore have to depend on the Americans with all the attendant problems that Carter and Morarji once discussed in that famous private conversation some years ago—problems which have not yet been settled. In the Rajasthan, Madras and U.P. projects we use natural Uranium[1], enriched[2] by 'moderators', or materials with light nuclei (like ordinary water, or heavy water in which the hydrogen is deuterium; i.e., hydrogen with one proton and one neutron in its nucleus, rather than the single neutron nucleus of ordinary hydrogen) which can absorb fast neutrons emitted by radioactive materials and slow them down to thermal energy which is what is needed in reactors.

Now what is the problem? To put it briefly: the whole fuel cycle is full of problems, mainly radiation hazards. The mining of uranium ore, production of the yellow cake, disposal of the tailings left after production of the yellow cake (usually about 100 times as voluminous as the cake itself), the liquid waste from the caking process—all these are full of radioactive hazards. Many of the buildings in Colorado are still dangerous, because their basements are filled with trailings-sand. Just the ordinary functioning of a nuclear reactor leads to a lot of radioactivity escaping into the biosphere. Chief among these, argon-41, fortunately has a half-life of only some two hours. Impurities in the cladding, around the fuel rod, may also lead to radiation leaks. Iodine-131, often leaked by reactors and released in large quantities by the fall-out from atmospheric test explosions, is exceedingly dangerous. Its half-life is eight days; enough to be absorbed by the grass and so into cows and through cows' milk into humans. And hence the risk of blood cancer in both children and adults. Dr. E. Sternglass, Professor of Radiation Physics at the University of Pittsburgh, read a paper in 1969 at a symposium sponsored by the US Atomic Energy Commission, which stated that some 400,000 infants less than a year old, had probably died as a result of nuclear fall-out between 1950 and 1965.[3]

The used fuel-rods are the most dangerous; they have to be disposed of or re-processed. At the British Windscale nuclear reactor, about 600 cubic metres of highly radioactive waste had been stored by the end of 1974. In the USA, the Hanford Reservation in Washington State had 250,000 cubic metres of high-level radioactive waste stored in ordinary steel tanks. More than a dozen leaks have already occurred. A leak in the large tank (No. 106:T) released approximately 435,000 litres of highly radioactive liquid into the earth before the Atomic Energy Commission (AEC) and its subcontractors decided to empty the tank into other tanks. This liquid contained 40,000 curies of Caesium-137, 14,000 curies of Strontium-90, as well as some plutonium. Most of this would have already reached ground-water levels and contaminated the water people use.

Even without leaks developing, some of these tanks, which are made of concrete with an inner lining of steel or glass, can last only a few dozen years. Strontium-90 has a half-life of 28 years.[4] This means that Strontium remains dangerously radioactive for at least 300 years. Plutonium has a half-life of 24,400 years.

New techniques of leak-proof storing have been devised in the last few years. But waste management continues to be a problem, though experts, including our own in India, are loathe to admit this. Whatever the experts may say, people know enough about the accidents that took place on 3-Mile Island in Pennsylvania (two in 1979 and one in 1980), not to fully trust the experts.

If a future has to be fashioned for mankind, one which is not hellish, we will have to do something about nuclear testing, nuclear arms manufacture and its use, and even about the use of nuclear power for peaceful purposes. To my knowledge, no scientific demonstration has proved that the increase in the incidence of cancer in our time is not caused, at least in part, by nuclear fallout and leaks. For the educated layman such an investigation seems necessary, though it is difficult to devise conclusive tests.

In India we have marched boldly forward in the construction of nuclear reactors, leaving it largely to the experts to worry about the ensuing hazards. There has been no public debate; nor a significant nuclear protest movement. The people are largely uninformed about the hazards of reactor accidents and of fuel waste-disposal. We know little about the huge Windscale accident in the UK where one plant burned down, another had to be closed, and both entombed. What do we know about the military nuclear power plant accident in Idaho in 1961, when the whole plant exploded releasing lethal levels of radioactivity, killing instantly several Americans? Or about the accident at the Enrico Fermi Plant in Detroit in 1963 which led to its shut down?

Why did Switzerland shut down its Lucens reactor in 1969, when operations were at full steam for only a few months? The answer is: because of a major accident in the cooling system.

What happened at the West German power station of Wuergassen on

12 April 1972? Again, a valve failure in the cooling system caused an accident which led to its closure.

Someone should collect the nuclear folklore of the last two decades, in order that we may better understand why there is a virtual nuclear power moratorium in the USA and Sweden, and also in order to see how we, in India, are fashionig our own future.

Someone should also tell us more about Plutonium (P^{239}), the new-made element, which so far as we know does not exist in nature. It was first created by Glenn Seaborg and his colleagues around 1940 at the University of California. Today P^{239} is everywere, used or produced in reactors and nuclear weapons. The Rocky Flats fire in Colorado (1969) caused by the self-ignition of two tons plutonium in Building 776-777 has made people very wary. The immediate loss was estimated at $ 65 million. Plutonium had been released into the surrounding air, earth and water. One microgram of plutonium entering the human lung can cause lung cancer. Two tons of plutonium is enough to kill two billion of the world's four billon people, or half the world's population.

This raises three basic questions:

1. Do we have the right to play with such highly toxic materials which may endanger the health of people all over world now and for many generations to come?
2. Are we taking the option for using nuclear energy after due consideration of all the factors involved?
3. Do we leave such matters to the experts, or should the public be directly and actively involved in informed decision-making?

Can Science answer these questions?

Genetic Mutation

The second example that I would like to offer in the problem of decision making in science concerns genetic engineering. Ever since 1953 when James Watson and Francis Crick gave us the structural analysis of the compounds which form DNA (the master molecule in most genes), and Nobel Laureate Har Gobind Khorana created a biologically active synthetic gene, humanity has been confronted with enormous power-the power to alter the basic structure of all living beings.

It is this capacity for gene mutation which gave us the green revolution with its high-yield variety of seeds. It is this technology which led to the interesting case of Anand Chakraborty developing an oil-eating bacterium for the General Electric Company in the US. A patent was then applied for in 1972; but this has been contested in the US courts for the last eight years. It was only on 16 June 1980, that the US Supreme Court ruled by a majority of five against four, that man-made organisms like bacteria can be patented.

In principle, it is possible to produce in the laboratory a bacterium against which humanity has no resistance. You can then patent it under some pretext, you can store it and later use it for blackmail, sabotage and so on.

In the USA plant seeds can also be patented. Seed companies have been creating new high-yield or disease-resisting seed varieties by genetic mutation. In Britiain, for example, if a seed company has a plot of high-yield tomatoes, then, people living in the neighbourhood are forbidden by law to grow any other variety of tomato in their backyards—ostensibly to protect the seed company's tomatoes from miscegenation. The fine for growing an outlawed variety of tomatoes can be as high as £ 400!

Biologist Garrison Wilkes in an article published in the *Bulletin of Atomic Scientists* (1977) expressed the fear that traditional varieties of vegetable and foodgrains may disappear through lack of use. Dr. Erna Bennett of the FAO in Rome also estimates that by 1991 "fully three-quarters of all the vegetable varieties now grown in Europe will be extinct due to the attempt to enforce patenting laws." More recently, *The Washington Post* wrote an editorial on the 'Seeds of Trouble' which said that farmers around the world are planting fewer and fewer varieties of crop. This decrease in genetic diversity may make crops more vulnerable to pests as well as to climatic changes and we may, as a result, face catastrophic famines in the future.

What is more worrying is that the big transnationals are buying up the seed companies. Soon, companies such as Union Carbide, Shell, Pfizer, Ciba-Geigy, Purex, Upjohn, Sandoz, etc., may have a virtual monopoly on plant seeds.

These are all problems which scientists cannot solve by themselves. We cannot fashion the future unless ordinary people like us can begin to inform ourselves and insist that decisions taken nationally, as well as internationally, are conducive to human justice and human free dom.

Science and Society

A UNESCO study estimated that, in 1974, global expenditure on Research and Development amounted to $ 101,785 million of, which only 2.6 per cent was spent in the developing countries, while 97.4 per cent was spent in the developed countries—North America 35.3 per cent; Europe (excluding the USSR) 30.7 per cent; and the USSR 21.4 per cent. By contrast, South America spent only 0.8 per cent and Africa 0.5 per cent. Of the 2,978,204 scientists and engineers engaged in research, 93.9 per cent were in the developed countries with the USSR leading with 39.3 per cent, Western Europe 23.8 per cent and North America 19.1 per cent. All of Asia, including Japan and China, accounts for only 14.6 per cent of the total.

Science develops in this loaded international science-technology order: those who have, can have more and more. Those who do not, will have less and less. The UN Conference on Science and Technology for Development, held in Vienna in the summer of 1979, failed to propose any real solutions. It could only call for the establishment of a \$ 250 million R & D assistance fund for developing countries, to set right a gap of \$ 96,500 million per year.

To put it another way: in a society where injustice dominates, science and technology instead of becoming instruments for the eradication of injustice have become efficient tools for further exploitation and a more deep-seated injustice. This is true both internationally and intra-nationally. Science and technology are not automatically and inherently good. If society is badly structured then science can become an enemy of the poor, the powerless and the exploited.

The manipulation of economic theory is another way in which science is used to perpetuate a situation of exploitation-domination. The best recent example is Milton Friedman's book *Free to Choose*. Friedman sees inflation as the central problem of the economy and blames the government for printing too many currency notes. It is a simple theory: when there is more money printed than the value of goods produced, then the currency loses its value, or, prices increase in terms of the value of the currency.

But why does the government print more money? According to Friedman, it does so for three reasons: rapid growth in government spending; government's policy of full employment; and the attempt by the Federal Reserve System to control credit supply by regulating interest rates rather than by curtailing the supply of currency. His solu-ion is equally simple. I quote: "Just as an excessive increase in the uantity of money is the one and only important cause of inflation, so a eduction in the rate of monetary growth is the one and only cure for nflation." Of course, Friedman also admits that cutting down currency upply, and therefore a trimming of all deficit budgets and excessive overnment spending, will reduce the rate of growth and increase nemployment.

Economic theory, masquerading as science, has a great capacity for oodwinking not only poor consumers like ourselves, but also the lanners of our economy. Our prevailing liberal-scientific economic eories, whether neo-classical or neo-Keynesian, contain ideological sumptions that distort the truth. To cite some points, as a non-econo-ist, I would mention the following:

1. The growth-assumption or the non-growth assumption, i.e., either 'more is better' or 'enough is best' (as in Steady State Economics).
2. The 'invisible hand' theory which makes the assumption—though mitigated by Keynesian recognition of governmental monetary and fiscal action as a necessary regulating factor—that justice need

not be built into economic theory.

3. The 'value-free assumption' that economics can be developed as a science quite independent of politics which is the science of power distribution e.g. the assumption that the important factors are inputs-outputs or prices and wages, or inflation and employment or such value-free measurable entities.
4. The assumption that justice will automatically follow the increase of total production, without worrying too much about the distributional and organizational factors at the production stage.
5. The failure to recognize the fact that organized social labour is itself an epistemological category, powerfully influencing our perception of what is wrong and what needs to be done.

The net result is that we propagate pernicious economic ignorance even among our intellectuals who are trained in economics. Economics as a science then stands in the way of economic planners proposing what is really necessary for a radical alteration of the social and political organization of human activity in order to reduce injustice and promote human welfare.

Economic science becomes, thus, an ideological tool of the exploiting classes; the rest of society is unable to trust its experts.

Science and Culture

The third cluster of issues has to do with the role modern science plays in our approach to reality and in our creation of culture. Modern science has replaced medieval religion not only in Europe, but also to a significant extent in India. Among the educated urban elite of our country, science, or the opinion of reputed scientists, has the power to influence both intellectual and spiritual authority. Especially after the launching of Rohini, the prestige of science has also sky-rocketed, if you will pardon the pun. In very complex issues like nuclear power, or the Silent Valley Project in Kerala, educated people are only too prone to 'leave it to the experts'.

The myth that scientific knowledge is 'proved' and 'objective' has been exploded in the West. Scientific positivism may still be the structure upon which the thinking of many scientists and non-scientists rests. But as an intellectual position it has now been acknowledged by the best minds in the West, to be invalid.

The present 'legitimation crisis', as Peter Weingart put it, in which science finds itself, is largely confined to the non-Marxist West. Marxist philosophy, never having accepted empiricism as an exclusive methodological principle or non-subjective objectivity as the standard for truth, is not affected by the current failure of nerve on the part of Western science.

In the English speaking West, the breakdown of positivism in all its forms has generated widespread despondency about the attainability of truth and has induced a general lack of confidence in the power of science to be the final arbiter of truth. There is a gnawing despair at the heart of Western civilization, felt only by sensitive people, about the future of a civilization based on the proven, mistaken assumption that science and technology could deal with all possible issues of knowledge and actual operation. Until recently, what was scientifically demonstrated was alone regarded as 'truth'. But today two propositions, expressed by philosophers, seers, poets and literary figures and very seldom by scientists themselves, lie buried in the Western subconscious. These are:

1. Science cannot lead us to the ultimate truth for which we thirst and which alone can give us certainty, stability and security.
2. There seems to be no alternative to our kind of science, for arriving at the meaningful and valid truth, *in our operations on the objective material world.*

This pervasive doubt about the ultimate validity of science is not shared by the Marxist world of scientific and philosophical thought. If there is a largely credible variety of Scientism going, then, one finds it only in the Marxist world. It is credible because it is not, as in Western positivism, obsessed with the ridiculous idea of an objectivity free from any trace of subjectivity. The Marxist philosophy of science has from the start, or at least beginning with Lenin, recognized the element of subjectivity in all knowledge. Marxism only refuted the Hegelian idealist principle, in turn based on Plato, that Consciousness or Ideas alone were real; Engels, for instance, rejected all notions of mentalism or solipsism. The Marxists insisted that the external world 'out there' is not a creation of man's mind: it is 'there'—'objectively'.

The fundamental question in Marxism concerns the relation between the reality of sensations, concepts and ideas which we experience, and the reality that supposedly exists 'out there'. In other words, it concerns the relationship between the subjective experience of reality and the objectively existing reality. In the post-positivistic Western world, the definition of truth provided by Alfred Tarski is regarded as sufficient: given a meta-language or a meta-mathematical set of symbols in which 'propositions' and 'facts' can be denoted by commensurate signs, Truth exists where p=f. In non-technical language this is called the correspondence theory of Truth, one which the Marxists reject. In place of 'correspondence', Marxist epistemology and the Marxist philosophy of science substitute the concept of 'reflection' in order to explain the relation between the content of knowledge and objective reality. 'Knowledge reflects the objects; this means that the subject creates forms of thought that are ultimately determined by the nature, properties and laws of the given object, that is to say the content of knowledge is objective.'[5] Marxism thus defends scientific knowledge as objective because it is a reflection in man's subjective consciousness of an objective material reality.

This position gives rise to two difficulties: first, it is not scientifically demonstrable; second, it is inconsistent with certain other affirmations of Marxist philosophy.

The problem of undemonstrability arises primarily from the present limits of our knowledge. That range, in terms of magnitude, is of objects of the size of 10^{-14} to 10^{28} cm. That means: one by one million four hundred thousand of one by the billion of a centimeter is our lower limit, while our upper limit is 10^{28} cm or about 13,000 million light years. This is indeed a prodigious range, but it is not infinite.

According to Marxism, material reality is not only self-existent and eternal but also infinite. (Incidentally, religious people say something similar about God.) If reality is infinite and if we know that only a finite part of it (10^{-14} to 10^{28} cm) is now reflected in our consciousness, then, how can we, based on our limited knowledge of this finite range, pronounce judgement on the nature of the whole of reality? In order that it may become intellectually more rigorous, Marxism will have to deal with this question in the future. But for our present perceptions about the ways in which we can fashion the future, this question is important, and cannot wait for a final resolution.

The problem of inconsistency in Marxist thought arises because of the insistence on the one hand, that material reality is infinite and that it is a single-law governed system, and on the other, that in this system where all parts interact with each other the speed of such interactions cannot exceed 'C', the speed of light. The fact (if it is one) that, within our range of knowledge, 'C' is *not* exceeded would not by itself be adequate for postulating 'C' as a strict upper limit for the whole of reality. Quite apart from the theory of tachyons (particles that move faster than light), in an infinite system, if its parts are fully to interact, the speed of reaction will also have to be infinite. How otherwise can two infinitely distant parts act and react with each other at a finite speed?

We already find new laws emerging as we go down the range of our knowledge to the sub-atomic level. To isolate 'quarks',* we may have to go down to the scale of 10^{-33}. At present it is beyond our capacity to break-up the sub-atomic particles into such micro-micro-objects. But how can we make laws about the limits of speed in the universe, or about the laws of interaction, which would be valid for the whole range?

If he is honest, the religious person cannot claim to have answers to all these questions. Nor does he want to use the gaps in our knowledge

*'quarks' are hypothetical sub-particles of which all sub-atomic particles could be composed.

in order to legitimize religious belief and practice. What he objects to is the habit of making absolute *scientific* judgments based on very partial knowledge. The honest, religious person does not claim that his understanding of reality is *scientific* in the sense that it is established by the canons of established scientific method. What he would insist upon as his fundamental human right is, simply, that he should not be bull-dozed by any dogmatism that masquerades as scientific certainty.

This insistence by the informed religious person has great relevance to the issue of fashioning a future—a relevance that can only be alluded to here. The concept of a 'secular state', imported from the West, is a historically conditioned one; it arose in the context of a revolt against the religious authority of the medieval Roman Catholic Church which in its time dominated all civil and cultural institutions in Europe. The early positivistic as well as the more recent post-positivistic, or critical-rational approaches to secular reality in Western liberalism, as well as the overly dogmatic ontology of social being in Marxism, are creations of that cultural milieu. While these are useful for us up to a point, they cannot be decisive either for the fashioning of our national future in India or for the kind of contribution India could make to the fashioning of the future of humanity.

The least one can do is to promote conversations at a sufficiently deep, scientific and competent level among proponents of (1) the secular Western liberal view (2) the marxist view and (3) the informed, honest religious view, in order to see how all three proponents, from their different perspectives, can jointly contribute to the fashioning of a future in the process of which they might, perhaps, be refashioned themselves. □

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[1] U^{235} with 92 protons and 143 neutrons in its nucleus, forms about 0.7 per cent in natural Uranium i.e., only 7 out of 1000 nuclei in natural Uranium are fissile.

[2] Enrichment of natural Uranium means increasing the proportion of fissile U^{235} in it—a very expensive process. Uranium enriched to 90 per cent U^{236} is best for bombs. But for nuclear power plants, a much lower degree of enrichment is sufficient. The French have a better technique for commercial fuel enrichment (as distinct from the bomb technology of the USA). There is also the Centrifuge enrichment technique developed by Britain, Germany and the Netherlands together. Even more exciting is the laser enrichment technique now in its final stages of research.

[3] Walter C. Patterson, *Nuclear Power*, Penguin, 1976.

[4] Half-life is the time for radioactive material to lose half of its radioactivity. If a ton of fuel waste has 100,000 curies of Strontium radioactivity, it will be reduced to 50,000 in 28 years, 25,000 in another 28 years, 12,500 in another 28 years, and so on.

[5] USSR Academy of Sciences, *The Fundamentals of Marxist-Leninist Philosophy*, (Moscow: Progress Publishers, 1974), p. 204.