

**CRISIS IN INDIAN SCIENCE
AND
POSSIBLE WAYS OUT**

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In January 1987 a lecture-discussion series was arranged at the Indian Institute of World Culture on 'Alternative Science'. For some time now many scientists have become concerned with the basic problems faced by developing countries like India and whether the present science and technology can provide suitable answers.

This paper delivered by Professor M. D. Srinivas who teaches at the University of Madras in the Department of Theoretical Physics deals with the basic concern of science in India. Professor Srinivas is also involved in a movement — Patriotic and People-Oriented Science and Technology — which issues a Bulletin, arranges seminars and takes a fresh look at the problem.

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Indian Science and Technology has perhaps been sufficiently indicted from the same platform and perhaps from more august platforms in this city during the course of the Indian Science Congress, which was held recently. This has brought to light various aspects of the present crisis in our science and technology. I view this crisis as a reflection of the crisis in Indian society, a view many may share; but, unlike many others I do not think that the latter crisis can be resolved by "Science and Technology" (i.e., modern western science and technology). While I view the crisis to be very serious, I also feel that we are now perhaps in a position to come to grips with it. Perhaps we have now reached a stage where we feel free from our earlier "historical compulsions", and are in a position to take stock and initiate different kinds of efforts, not all of which may yield fruits; but if we go about it seriously, soon we may find major insights as regards ways of resolving our present crisis.

What is this crisis in Indian science and technology? According to me the main problem with our science and technology is that, like our polity, economy etc, our science and technology has not become functional even after 40 years since independence. There seems to be no significant link between our concepts, theories, methodologies etc and our efforts and with what is being sought to be achieved. It is no wonder then that our science and technology has not contributed in any significant way to the betterment of the lives of our ordinary people; on the contrary their initiatives are repeatedly curbed and their resources depleted more and more often as a consequence of our efforts to promote science and technology for development. From thinking beings most of our people seems to be getting reduced to mere mechanical contraptions. Even for the relatively affluent there seems to be very little satisfaction from the workings of our science and technology. Our urban conglomerates are becoming more and more inconvenient. Our health and educational systems are in near total disarray; and so on. Except in some very isolated pockets or for a truly miniscule minority there is little evidence of the power or grandeur that modern science and technology is supposed to provide. Our image of ourselves is quite low. Even relevant and sometimes spectacular individual achievements here and there, do not seem to take us far as a people.

I would first like to emphasize that this kind of stagnancy that we see all around us today is not something endemic to the Indian society. While in its long history this civilization has had its ups and downs like most others, most of its institutions were functional and even flourishing and creative barely two centuries ago. While many times in the past we did borrow ideas and techniques from various sources, never did we feel underdeveloped or backward or so totally lacking in knowledge and methodology that we felt compelled to constantly seek advice and even wisdom from others, however powerful or successful the others might have been.

It is perhaps important for us today, to comprehend how our society was functioning a couple of centuries ago. All available records and impressions of Europeans and others show that in 17-18 centuries, and in earlier periods, our science and technologies were not only functional here but were valued all over the world. Results of Indian Astronomy were analysed by major European astronomers like Euler, Laplace and others. Even around 1820s the astronomical predictions made in South India regarding eclipses etc. were found to be often more accurate than the results from the best European methods then available. It was also found that Indian astronomy was based on sophisticated mathematical methods* involving a whole lot of higher algebra, trigonometry, theory of infinite series etc. In the same way, in another field of science, the knowledge gathered by our botanists was very highly

fancied. The South Indian botanist's knowledge of about 750 plants species was recorded for the European scientific community by the Dutch Governor of Cochin in 17th century in his 12 volumes treatise *Hortus Malabaricus*, and this happened to be a major source used by Linnaeus, the father of modern European Botany. Incidentally it may be mentioned that recently the Chairman of the Central Council of Indigenous Medicine mentioned that they have now recorded over 2500 species of herbs in India of which more than half have been discussed and analysed in great detail in our own older texts of medicine and Botany.

Coming to technologies, we need only mention a few here. For instance it has been estimated that in late 17th century there were about 10,000 furnaces in this country each capable of producing about 20 tonnes of wrought iron and steel annually. In 1850 such a furnace which could be set up in any village, was said to cost about 6 shillings. More importantly, the steel produced in India, known as *Wootz*, was valued very highly in early 19th century for its very special qualities. It appears that the Indian technologists had evolved a process of producing high quality steel without there being a need for attaining very high temperatures or using large quantity of fuels as seemed to be the case with the then contemporary European processes. Incidentally it may be mentioned that the recent energy crisis has once again focussed the attention of Western Countries today on the sophisticated process of iron and steel making evolved in India over 2000 years ago and still practiced in certain tribal and other so called backward areas.

Coming to agriculture, the high productivity of traditional Indian agriculture, needs to be highlighted. Around 1804, it was found in and around Allahabad that the average yield of an acre of land was about 56 bushels of wheat per harvest while it was only about 20 Bushels in England at the same time; added to this was the fact that there were usually two crops in Indian agriculture per year. The European observers were struck by the Indian implements such as the drill plough or the techniques, such as the rotation of crops etc, many of which Europe seems to have developed only in the 19th century as a part of its 'agricultural revolution'. They were equally impressed by the sophisticated irrigation system in operation here. There were about 38,000 tanks in the old Mysore State comprising only an area of about 29,500 square miles. There were at least 50,000 tanks in the old Madras Presidency. Thus a fair estimate of the number of tanks in South India in 1800 would be about a lakh or more.

While the Europeans in 17-18th centuries seem to have admired the quality of the products of Indian technologies, or the results achieved in Indian sciences of Astronomy, Botany etc., they were often skeptical (especially so after the British conquest of India starting from mid 18th century onwards) of the theoretical basis and sophistication of our science. It is indeed true that much of the sophistication of Indian theories, concepts and methodologies did escape the European scholars of 17-19th centuries. But it does not mean that our sciences lacked such a basis. It is well known today that there exist more than 1000 treatises on logic in India, more than half of which have been written during 16-18 centuries. The same can be said about the science of language, which like logic was considered to be a foundational discipline for all Indian sciences. The methodologies of Indian science have invoked considerable attention of present day scholars who are looking at alternatives to Western methodologies.

The functionality of Indian sciences and technologies over two centuries ago is only a reflection of the fact that this society was indeed functional then. Historians have now shown how there was operative here a large educational system which catered to the society's needs. In the 1820s, in Madras Presidency alone, there were about 11,500 schools and 1100 colleges. Over 1/3 of the children of school going age were educated, the medium being the regional

language. More significant was the fact that boys from all the communities seem to have participated in this educational system. For instance, in Tamil speaking areas about 80 % of all the students belong to the non-dwija categories; the pattern was similar in other areas also. Even more than the education system, what in perhaps of great significance for us today the very sophisticated political economy that was evolved in India possibly over a very long period of time. At the time of British conquest, it is clear from many records; that in most of the areas about 30 % of the gross produce was directly allocated at local levels for maintenance of village and inter-village infrastructure. There appears to be an outlay of about 5 % on irrigation, substantial amounts on village temples, artisans, washermen, barbers, village doctors, water pandals, flower gardens and so on. The number of village servants in many villages was over 50. It is indeed the breakdown of this sophisticated political economy and the reduction of most of our villages to a state of utter poverty which resulted in a large scale destruction of the base of our indigenous science and technology. Superimposed on this was the new idea that was foisted on us by the British educational system that the misery and decadence that was all apparent in 19th century was endemic to Indian civilisation, baiting if at all some unknown golden age in the remote past.

When we talk of science and technology in the context of our country today, we normally refer only to the modern Western science and technology which has been in operation here for about 'a century and a half. The involvement of Indians with this science and technology with a view to learn and innovate begins in the last quarter of the 19th century. Here it may be instructive to note that around that time (in 1875) the introduction of modern Western science as a subject of study was advocated by the Governor of Bengal in a letter to the Viceroy stating that this could be one way of showing the Indian his rightful place: "We shall do more and more to direct their thoughts towards practical science

Where they must inevitably feel their utter inferiority to us". In fact what becomes dear by even a cursory study of the Government policies of the last 150 years is that every modern Western institution, idea or technique that was introduced here was always so tailored to be in opposition to the indigenous — often with undisguised racial overtones. ~

Around the time of our attaining independence, there was indeed a major debate as to the path that independent India should follow. The view of Mahatma Gandhi, who is perhaps the most well-known critic of modern Western civilization, was that we should not plan for India's future on the basis of Western models — be it in organizing our polity or our economy or education or science and technology. However, most of our leaders then, were not in any sense of the term confident or prepared to work out appropriate models for independent India, based on our own historical experience, and face the difficulties or hassles involved in this process. Thus independent India has not in any major way sought to work out its own solutions, based on its own theories, concepts and methodologies. It is this refusal to try and stand on our own which has to a large extent caused the present day crisis in our society.

I do not mean to imply that there have been no achievements of Independent India. My claim is that we perhaps do not have a correct appraisal of what our actual achievements are. For instance, there was a steady growth in our agricultural sector in the period 1949-64. The aggregate production increased at a steady rate of over 3 % per annum (larger than the rate of our population growth); even the yield per hectare showed increase at a steady rate of 1.6% per annum. There was a steady growth recorded in all important food crops which are essential in the Indian diet, such as rice, pulses etc. Our cattle wealth increased. Thus independence did bring some respite to our impoverished farmer. But this process was greatly

disturbed by the so called modernization of Indian agriculture which was taken up on a large scale about 25 years ago. It could perhaps come as a surprise to many of you if I tell you that the rate of growth of our agriculture production has gone down significantly in spite of (or because of) the so called *Green Revolution* in the period of 1966-1980. The aggregate production increased only by 2.5% per year and yield only by 1.4% per cent per year. Further in the post Green Revolution period not only was there a deceleration in the rate of growth, but also a great distortion in the balance that was earlier maintained in the production of various food crops. The pulse-production stagnated and later started actually to decline. There was no significant increase in rice production at all, and no wonder that in- a recent conference the Green Revolution was dubbed as a 'wheat and potato revolution'. We are often led to believe that the green revolution has made our economy self-reliant. We are told of the food imports that became necessary to keep our population fed prior to 1965. While these food imports have declined in the latter period our foreign dependence, has, instead of being reduced, increased tremendously. We are now importing large amounts of fertilizers, pesticides, farming equipment and much more the know-how of high yielding varieties. I could go on to establish how costly this whole exercise (which is termed modernisation of agriculture) has been to our peasantry and to our nation as such. But that is besides my main point, which is that this 'modernisation' in agriculture or in any other sector has not increased the efficiency of our resource utilisation compared to processes that were already in existence prior to modernisation.

Now-a-days there are indeed several critiques of modern science and technology in India as in the West itself. The large scale ecological destruction due to modernisation is now becoming well-documented and talked about as it has started assuming alarming proportions. More significantly it is now becoming clear as to how adoption of modern technology in the way we have gone about it in the last 40 years has deprived most of our people of their resources and knowledge. My discussion above of Green Revolution is only an example of this feature which can be substantiated in many a sector of our economy. But what seems to me to be even more serious is the fact that even- after 40 years of independence we have totally failed to come to grips with modern science and technology. We have so far failed to produce a truly innovative science and technology community, a community which is in a position to stand on its own and on equal footing with those elsewhere, even if it fails to tackle or provide solutions to all of our problems. In fact, despite brilliant individual achievements, the Indian endeavour in science and technology seems largely marginal to the world or international science and technology enterprise,

Now, even if the majority of our scientists are mediocre, as has recently been claimed, what appears to be the case is that even our best scientists and technologists seem quite overwhelmed, and are more or less resigned to their own rather marginal status in the international science and technology enterprise. Talking of mediocrity, it should be first emphasized that the majority in any community would be in some sense only mediocre. But what they do and achieve seems to contribute, in most of the societies, in some significant way to the advancement of the goals of that society. When we are referring to the mediocrity of the majority of our scientists we are perhaps only referring to the problem that in our society their endeavours and efforts do not seem to add upto anything meaningful. But then who is to blame?

In any case, it is to the failure of the best of our scientists, and technologists that I would like to call your attention. We seem to produce a large number (perhaps over 2000) of scientific journals. It is common knowledge that most of these are not valued very highly outside this country. We often wonder why advanced countries often attempt translating a

whole lot of Japanese and Chinese journals. But I would urge you to start reflecting on why our own best scientists do not contribute their major technical articles to such Indian journals, where they happen to adorn the editorial boards. If Indians journals are indeed so bad that one cannot better them or their reputation, then could we not stop publishing them altogether?

As another instance of the persistent failure of even the best of our leaders, administrators, scientists and technologists and other professionals I should mention our continued and abject dependence on foreign-aid and (what is even more deplorable) on foreign-advice. It is perhaps time that we realise that the foreign aid our Government receives is less than 10% of its overall outlay, and much of this 'aid' itself is earmarked for purchase of foreign equipment and know-how. This meagre 'aid' has however assumed the crucial role of as arbiter in deciding how the greater part of even the other 90 % of resources raised from within this country are to be expended. The debilitating effects of our dependence on foreign- advice is even more serious. Mind you, while saying this I am all for our experts scouting around the world for all kinds of information, know-how, knowledge etc. In fact I would call upon them to do so not merely from the modern West (and even here, our information base seems to be mostly confined to the current workings of the Anglo-Saxon world) but from a whole lot of others (many of those with whom we have a long history of close interaction) who seem to be doing many things on their own, apart from succeeding many a time in harnessing modern science and technology to suit their own purposes. Our peculiar problem in recent times appears to be that we have forgotten that every civilization has to make its own mistakes and learn. Indeed while it is amply evident that we have made many a mistake, very little of it has been on our own initiative or under our own responsibility based on our own thinking and considered judgement, so that we seem to be at a loss and are so far unable to learn much from -all our mistakes or even achievements.

I have more or less exhausted all my time in trying to explain what I consider to be the crisis in our science and technology in recent times. As my title for this talk indicates, I am expected to spell out possible ways out of this. Surely you do not expect me to have a single solution or formula by which we could get out of the present stagnation that we see all around. Well, the main hope I see is based on the age old Indian wisdom that such situations do indeed arise in the life of any civilization. It is part of our age old wisdom that even extremely well-planned and strong systems are bound to decay or become weak; in the same way, any theory, any methodology or any solution that is worked out is a product, of its *Kala*, *Desa* and *Avastha* and is bound with changes in them to become ineffective or even irrelevant. So we need not bemoan the current crisis in our civilization as anything *specially* caused by our own weaknesses (of which there must be plenty). I think it is time that we ponder over how different societies and we ourselves have gotten over various crises in history. I should specially emphasize this because of the tendency amongst many of us to get totally caught up with the so called uniqueness of the problems or the achievements of 20th century,

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For instance we should perhaps pay serious attention to comprehending not only the current sciences, technologies and other institutions of the West but also the way these sciences and technologies may take shape in the near and far future. For this we need to be quite conversant with the way West has arrived at the current technologies and theories of science, a process which also involved understanding and assimilation of ideas, techniques, methodologies etc., from various areas and civilizations in the last 7-8 centuries. As is well-known, from about 12th — 13th century onwards, Europe set about acquiring detailed knowledge of mathematics, astronomy, medicine and various technologies from the Arabs and from other parts of the world ; all this was used as inputs leading to the formulation of the

so-called modern theories of science starting from the 16th century onwards. In the same way the European interest in technologies of Asian areas is very serious till the mid- 19th century (and even later) by which time Europe managed to develop technologies of its own in most areas. What is of interest to us today is not that Europe borrowed many theories and techniques from various areas, but that it could refashion them to suit its own purposes, so that often over a period of even a generation or two the origin of these ideas and techniques were forgotten ; in fact these ideas and techniques themselves changed their morphology significantly over time so as to get integrated with the European world view and become operative in whatever European society was set on doing. In the same way, the much publicized current Western interest in alternative theories and models (of which especially India and other Asian regions are looked upon as major repositories) is only in continuation with the European efforts of the earlier period. They only serve to provide inputs (or sometimes, corrections) to resolve that current of future crises anticipated by modern Western civilization.

What has been stated above may not constitute a correct or even reasonable understanding of how the West has arrived at its modern theories and methodologies, sciences and technologies etc. But what I want to emphasize is the fact that today there is as much need for us to comprehend all this as for acquiring competence in working with the modern science and technology by learning the current theories in science or the current technologies of the West. We seem to have done fairly well in acquiring the latter' competence in the last few decades. But we seem to have totally failed to initiate any steps to achieve our own comprehension of modern science and technology and its relation! to larger goals and seekings of the modern Western civilization. Since such an exercise has not been undertaken in this country in any major way, it is no wonder that we derive little benefit from all our endeavours at modernisation, however intense these efforts may otherwise be.

As I have emphasized, the current situation, or that of the last 30 to 40 years, can best be described as a period of stagnation, if not of decay in the Indian's innovative capacity. We have now to undertake a major exercise to seek and restore sources of our own creativity and especially learn from the manner in which Indian society dealt with similar crises in earlier periods. Here there is a problem. Any attempt to seriously comprehend our own genius — our philosophy, our social and political theories and models (based on which many of our people continue to function even today), our scientific and technological heritage (much of which is alive albeit with major shortcomings) —is often construed as some sort of a romantic attempt at "going back". Some even argue that this would constitute or at least strengthen 'obscurantism', 'fundamentalism' etc. All this only reveals our own state of confusion which has prevented us from making serious efforts to comprehend our past and its relevance for our present and future. If we do not undertake such an exercise what is indeed the alternative before us? Do we wish to continue to be saddled with 19th century European theories of ourselves and of Europe (as is evident from the contents of most of our text books and other general literature), or even with the current Western conceptions about India or the West ? Or do we seriously believe (here I must say 'romantically") that modern science and technology or modernization or Westernization being in any case inevitable for all societies, things will get sorted out automatically for us in due course of time ?

One other serious problem in any attempt to comprehend our heritage and our genius has been our own ambivalence towards it. While most of us do value our heritage greatly in the abstract, we are not sure how to go about actually understanding it or putting it to use for our present needs. It in fact appears to me as if most of us feel our heritage to be so delicate that it is alright (or even necessary) for us to keep it only in cold storage or under protection

and not let it get exposed to the demands of the present or to the rigorous tests imposed by modernity ! As a typical instance, let me draw your attention to the call by the President of the recently concluded Science Congress that a major effort should be made to make use of the expertise and services of the nearly 4 lakh practitioners of indigenous medical systems in our national healthcare programmes. But how does it happen that perhaps not even one representative, of this huge task force of medical scientists could find a place in such a massive Science Congress and this focus is not even taken note of while such suggestions are made? If this is our understanding of science and its relation to our heritage, how could we ever make either of them work for our future?

I could perhaps spend a lot more time in bringing out similar incidents of how we the elite, the intellectuals, the professionals etc, of this country have shirked the major task of seeking our own solutions, based on application of our own genius, our innovative capacities and abdicated the overall responsibility clearly resting on us. Still it is indeed gratifying that 40 years of independence has generated in us a lot of competence and even some confidence. Surely we can now address ourselves to the basic issue which is one of working out suitable models, be it of polity, economy or science and technology, which will suit us today, suit the ethos of our people and their needs. In this task the modern Western (or for that matter, the current Japanese, Chinese or other) models can only give us some clues and may help us sort out particular problems. It is our confidence in ourselves, our people and dependence on our own indigenous theories (be they of so called 'Ancient' 'Medieval', 'British¹ or "'Independent" India) which could help us work out appropriate models. If we are ready to face this challenge, we will "surely find some way out for our current non-functional, stagnant situation. This will be just a first step in ameliorating the problems we have created for the ordinary people of India.

