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January, 9th. 1967

Dear Siddhartha,

I was glad to get your letter and the interesting enclosures. As you probably suspect, I have considerable sympathy for the views you have expressed in your letter to the New Scientist in response to my article.

The problem of how to integrate science and technology into the fabric of a transitional society, appears to be one for which neither scientist emeriti not social scientists studying science have any answers. I have felt ~~th~~ for quite some time, that what you call, "demonstrating this relevance to others" is something for which the onus lies on the scientists of India. It is the scientist, by which I mean not only the academically trained specialist but all those who appreciate the "communality of science", who has to "convince his ~~pe~~ sponsors". Two corollaries follow from this: firstly, Indian scientists must be in India to even attempt this task of "educating our rulers", and by rulers I mean not only the political, administrative or industrial rulers, but also the scientific rulers--the "old guard". Secondly Indian scientists ~~wh~~ must think clearly and in strictly practical terms, of what contributions science, engineering and technology can make to social and intellectual modernisation as well as to the crucial need of economic growth. As one becomes more and more familiar with the literature, one begins to feel that leading economists (who are the only people who have looked at the question of how to use science and its derivatives productively) both within the country and outside, just do not see the micro picture of what each scientific and engineering discipline can contribute to growth. They see the problem almost entirely at the macro level, of a new "input" into the economy. It is scientists alone who can make concrete proposals for what can be done now, in machine tools, fertilizers, metallurgy mining, power etc. It is for these reasons that I was highly struck by some of the questions that students at Imperial seem to be asking themselves, as evidenced by para 3 in your memo, "A Thought". But to my mind the real answer is, so to speak, not ~~analyse with~~ to decide on the basis of analysis, but to decide "with one's feet"---to go back.

There are two questions that I would like to pose to all those who are worried about this problem:

1. "Are the Norms of International Science Applicable in the Current Indian Context?"

'International Science' is the product of the "research revolution" that has taken place in the more advanced countries in the last 25 years. ~~Yet~~ It is thus a very recent phenomenon. Yet we often forget, that those societies have been unconsciously building up the infrastructure necessary for achieving "outputs" from such a revolution for over 300 years!! Indian society today is a pre-research culture, whose problems are centrally concerned with how to exploit the nation's natural resources most effectively, and at the same time increase the productivity of its super-

abundant human resources, both in agriculture and in industry. These are the challenges we face, challenges very different from those for ~~which~~ the solution of which the "research revolution" came about. So we cannot just couple the "Research Engine" straight into our society. We will have to adapt it drastically and simultaneously prod society to change.

Our pressing task is ~~to~~<sup>to</sup> secure minimum living standards for our people. To do this requires two kinds of research. The first, I shall call "adaptive research" and the second "conventional research". The latter is identical with the research of more advanced societies, and should serve the limited role of providing a channel of communication with science in other countries. The ~~latter~~, which should be the bulk of our effort both in universities and government labs, has been talked about from time to time, but is something that Indian scientists do not know how to do. Who will teach us, since we do not know? Not the more advanced countries, for they can only teach us conventional research. We will have to utilise our own resources, the resources of Indians both at home and abroad, to devise the techniques and methodology of this new research. Most importantly we will have to modify our higher educational system to provide the orientation, stimulus and the environment necessary for such research. We must devise a standard of rewards and recognition that is not chained to the research paper, but values the location, identification and where necessary adaptive development of a process, idea or solution from the published literature, which awards Ph.D.s for the tackling of industrial problems in design and development, of cost-effectiveness analysis of processes or programs being worked out. We must thus innovate in the very idioms of scientific investigation and technological and engineering application.

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But then who is "we"? While the national political, industrial and scientific leadership must of course play a major role, it is scientists, from B.Sc. and Dip. Tech onwards who must form the spear-head. However, involvement in such "larger" problems will reduce the time one can devote to instruction or research and will also expose one to the threats and pressures of the powers-that-be. What I think will deter Indian scientists even more is the fear, that they will "fall-behind" their colleagues abroad in the "research-race". But then one must decide ~~is~~ a basic question of values—do you see your contribution to science as being more important than that to your country? It is a basic emotional question, that some may call patriotism, but scientists in China, Israel, the UAR and Yugoslavia have faced and answered it, so why not we? I refer you in this connection to an article in the November issue of Scientific American, called "Technology in China", which shows how the Chinese are not afraid to try new ways of using science rather than being used by what I call "international science".

2. "How much Science for India?"

The problem is simple. We are just producing far more engineers and scientists than our economy can absorb—25 % of all engineers and 30% of all scientists trained since 1950 are today unemployed and of the 300,000 scientific and technical personnel in our National Register around one third are involved in jobs in which they have no use for their professional education. This is human waste on a colossal ~~scale~~ scale. What is more the financial resources allocated for science are very low, so low in fact, that the rapid growth in manpower has resulted in the outlay per scientist employed ~~to~~ <sup>to</sup> have actually gone down by 20% since 1960. We are very simply trying to build up a

scientific enterprise appropriate in terms of numbers of trained manpower for a technologically and industrially much more advanced society, but which is at the same time allocated financial resources for R & D and education (of scientists and engineers) which is among the lowest in the world. What a paradox!!

I am sorry if I have written a tome, but I feel these are points that enlightened scientists, who "worry" should think about. Please keep me informed about the activities of the Indian society of Imperial College on this problem as I am very interested in your sort of effort. I should also like to see your letter in the Hindu. I shall send you copies of some of my ~~own~~ papers and articles on "science studies" in the near future.

I am glad to learn that we have so many common friends! As you probably know, Saraswathi (Cookie) is working in the Jewish Hospital in New York for this year and the next. Lata and Peter came round to see us a few months ago. I have been meaning to write to Rangu for some time, but have somehow not been able to get down to it.

With all good wishes,

Yours sincerely,

Ashok Parthasarathi