

CORRESPONDENCE

The character of science in India: Then and now

During the past two decades, Indian scientists have often discussed the question of excellence in science in India, and the present status of Indian science *vis-à-vis* that in the West. These discussions have also centred on the question 'Why does Indian science lack lustre?'. As I write this brief, I hasten to add that my idea here is not to add one more piece to the existing library of editorials on the topic. In my own assessment, the actual situation is very different from what it has been made out to be. I firmly believe that the calibre of scientists in India and also the extent of their involvement in diverse branches of science is exemplary. In fact, it would be difficult to name a field of research, however esoteric or intellectually demanding, in which we do not have several scientists currently engaged at the highest intellectual level. Excellence is there, no doubt. However, we must do better because we must lead often, and not trail, in excellence.

An analysis

In order to make any meaningful specific self-assessment, we have to define our questions clearly. One may ask: Do we have a good stock of educated scientists? How creative are we? What have we contributed by way of development of the fields in which we have substantial interest? Is the Indian institution of science attractive enough, intellectually and economically, to draw in the brightest of young talent? And many other questions.

It is not a matter of debate that we have a large stock of extremely talented and dedicated scientists. This is indeed an unquestionable truth, but, regretfully, we must recognize that in most areas we are not leading the frontiers of science; we are being led as partners in science

by the West. In scientific literature, Indian scientists figure prominently in all disciplines, but will they figure prominently in future textbooks? We are indeed doing good intellectual science but we are not pulling the leash. I would like to address myself specifically to this principal question: With all the talent as our proud asset, why do we miss out on making a mark in science? This question would certainly involve a consideration of several factors. Are we short of funds? Do we have an inadequate infrastructure to be viable? Are we too far behind to catch up with the West? I believe a partial answer to the problem discussed can be found in the analysis presented here. Much more needs to be said and discussed, but I do believe that the central problems are covered here.

The late forties and fifties marked a global explosion of scientific research. India joined this revolution soon after gaining independence. The Nehru-Bhatnagar-Bhabha partnership led to an explosive growth in science and technology. Even with several quick changes in leadership, the government continued its encouragement of science. We now look back to see what we have achieved in the last 50 years!

In this assessment most of us do get disheartened! The main reason is that our expectations were high. In the pre-independence era, even without much investment in science, we had made very important contributions in science. One expected that with creative scientists like Bose, Raman and Bhabha as our pre-independence track record, India would be in a much stronger position in the second half of the twentieth century. But this did not happen, since we have so little to brag about today that can be compared to our earlier performance. What went wrong?

I believe that nothing has yet really gone wrong! We are currently passing through a transition period which has, however, unduly stretched out. Some of the developments in the process of growth of science in India occurred too quickly, providing a shock to the earlier system of education and research in India. Several consequences affected deeply the mental make-up and conscience of Indian scientists. Two special affectations must be mentioned here. Both of these concern the personal ego and psychology of scientists. As science in India became important, scientists also became more important. The Indian Academies gave wider recognition, inducting many more scientists during 1950–1980 in the fellowship of the Academies than in the previous years. And the government inducted several senior and famous scientists in leading positions at the Centre. Several of them either moved to Delhi from their ivory castles or made frequent visits to Delhi to confer at very high levels. Science then assumed a strange halo of power and influence, with the result that young scientists dreamt of quick recognition by Academies, and then accession to power. This led to a blasphemy – due to the ensuing dichotomy between carrying out honest, creative academic work on the one hand and having administrative influence/power on the other.

There was yet another dominating cause of breakdown in the process of creative and scholastic research work in India. During 1950–1970 it was quite easy for bright Indian scientists to get invited abroad as post-doctorates and visiting scientists. A large number of Indian scientists then spent periods of the order of two to five years, with repeat visits subsequently for shorter periods during the seventies to the present. The Indian scholar was based in India but had his

heart set abroad, where he found it easier to work and also less expensive. And at home, he did not work on a collaborative spirit, instead, he concentrated on working with his colleagues abroad.

The above affectations are not unexpected, especially during the period of rapid growth. We can blame ourselves for slipping, and we can ask why we cannot provide Indian scientists with better working facilities. These discussions will not take us anywhere; rather, we must realize that we have passed through extreme weather, a period of transition, and it is now time to settle down—to take stock of what we have, and then to proceed from there on.

Another issue, probably the most serious problem we have ever faced, concerns our universities. The number of universities explosively increased from 20 in 1947 to 200 at present. Yet, even though we have young budding universities, it is generally accepted that the standards in universities have declined precipitously. This seems to be true even for those established just a decade ago. The central problems and a number of solutions have been discussed often (see, for example, letters by P. R. Pisharoty, S. Krishnaswamy, A. R. Prasanna, Hari Narain, Rajaram Nityananda, M. Vidyasagar, K. Srinivasa Rao, N. S. Narasimhan, K. Subba Rao and K. R. Subrahmanya in *Current Science*, 1994, 67, which focus on questions relating to setting up a national science university in India as a solution to the problem).

Problems come and go; as old ones disappear, new ones appear on the scene. We are now facing another acute problem—how to keep our retiring scientists principally engaged. Scientists who were in their thirties during the 1960s are now trying to find ways and means to keep doing research in the only profession they learnt in their ivory tower! Fortunately, several of the academies and the scientific organizations have a number of fellowships and professorships to offer. Those who are more visible or more effective preferentially get these positions, probably. Others try to get some temporary docking opportunities within institutions in India or abroad. Nevertheless, the central problem remains unsolved. A good fraction of the retired scientists (past 60 years of age) who have been quite active during 1960–1990 cannot be expected to lay down their arms suddenly. *I do believe*

that even with the retired scientists put together in a suitable manner, we can generate original science at a very high level.

I may also mention in passing another matter of quite common occurrence and concern. Most senior or established scientists travel quite extensively within their country to committee meetings, or for conducting examinations of graduating students. And of course, when they are in their home base, they spend a considerable part of their time in similar committee meetings. The continuity equation here is satisfied since scientists from other organizations in India participate in many of these committees. Such commitments are generally very thankless/unproductive ventures but do serve the single purpose of pumping one's ego, making one feel self-important. It must be recognized that it would not take much persuasion of one's will-power to reduce such commitments by a very large factor, but we all do find it easier to accept such commitments rather than sit down and do a day's hard work!

In the light of the foregoing, we clearly have two choices:

- (a) Keep writing articles on how poor our science is.
- (b) Get on individually and collectively with the task of determining what one's real problems are, and what may be the solutions. Very positive attitudes are necessary!

The solution!

In this analysis, clearly some of the questions are:

- (a) How can we use our scientific manpower effectively to rapidly revamp our educational system?
- (b) How can we learn how to organize our scientific careers: (i) maximizing the time spent in hard-core science and (ii) conscientiously choosing the scientific disciplines that would maximize the effectiveness of our capabilities and available facilities.

Here I would give a much higher priority to maximizing the time available for scientific work, because unless one has some time at hand to spend in intellectual exercises, to mentally go through the scientific process, how can one achieve anything? Honestly, ask yourself when you last sat even for 3–4 hours at

a stretch thinking about good scientific questions. It would be just and prudent for a scientist to compare the performance of a scientist with an Olympian since every scientist is individually (or in a group) competing with the best brains in the world. The intellectual product of a scientist is a global product. If we accept this, let us ask ourselves when we last studied as we did in our college days: Do we train ourselves and contemplate the problems at hand in a serious manner, even 3–4 hours a day, seven days a week, or else become helpless because we are too busy with other commitments. We now tend to work alone, without collaboration with senior scientists in India, and even within one's organization. This is an aspect that also needs immediate attention.

It would take us a few decades to adjust to a proper work ethic that meshes in with the country we live in, and its environment. Our thinking has been perturbed by distant forces, and we are not living our lives the way we should! I feel confident, however, that we will rectify this situation soon. We are in transition already and will soon be in a more favourable situation when we do what we think is correct, when we come to realize that the decision must be made to do fundamental science.

My analysis of the present health of Indian science clearly suggests that we can indeed make the excursion to a much higher level of science. And I am not holding back on the solution to this exercise. My conviction is that the solution is entirely in the hands of scientists. The way we are presently conducting ourselves and doing science, it is even a surprise that we are able to trail close to the fast-moving frontier of scientific thought. The reason why we can even reproduce new, emerging science in our country is that there is a tendency in the West to overpublish, and quickly. A good scientist told me not long ago, on returning from a scientific meeting: 'I now know what to do. There are so many things to be done, which will keep us busy for a long time. I am glad I went to the meeting'. We, of course, attend scientific meetings to exchange ideas, but new concepts in science emerge only from one's systematic, original and hard work. As is well known, the scientific mosaic is never the result of just adding ideas from different scientists; the practising scientist

has to cast a network of postulates/hypotheses, first test their validity by thought process and then intellectually conduct the tests. This process is never easy if done properly; it is as tiring as the most strenuous physical exercise. But we generally do not have the time (or the will) to engage in this exercise. How can we expect a different outcome than what we have after nearly half a century of independence!

In my highly personal analysis, we are currently in distress because we do not have the time to work, or even to think. We do not burn the midnight oil because we are able to make 'a good success' of what our profession demands. Burning the midnight oil is, of course, not a road to success, but it is a necessary condition in creative work. If the reader would allow me to talk glibly, I would say that the healthy set of scientists comprising those who are in excellent health and routinely blessed with seven-plus hours of good sleep would rarely contain a creative scientist. This set would contain excellent technicians, the backbone of scientific enterprise. The creative scientists would be found amongst the sick set, containing those who do not get good (proper) sleep and suffer from many ailments that may even include mild depression. The extremely glib statement is being made primarily to convey a message so hard to communicate to our band of scientists, namely that if we have to do original scientific work, we have to work hard on the task. We would have to keep away from distractions, tasks requiring attending meetings, traveling, etc.

In many organizations in India, research in basic science is conducted as a routine affair. Nevertheless, these institutions have an excellent publication record. The appraisal system in India and elsewhere tends to encourage quantity rather than quality, and if one can generate enough mass, one is considered successful. But research in basic science requires excitement in daily work. Just as in a chemistry laboratory, the test tubes have to froth—gases, bubbles and colour, so should the minds of scientists be continuously in fervour, even if for the wrong reason. Again, this is only a necessary condition for creative science. But in the absence of a froth, we cannot expect any discoveries.

If we succeed in doing the above, we then certainly have the infrastructure to do excellent science. As a second step, it would be required that we choose a problem we can solve with the means we have at our disposal. It would be even better if we had some advantage over others, i.e. the natural setting was just the correct one for tackling the problem. A rather straightforward example would be the study of particular geological, hydrological or oceanographic problems unique to the Indian peninsula. In India it is possible to conduct high-altitude balloon flights and recover scientific payloads from low latitudes. This makes it feasible to study both cosmic ray fluxes and the nature of nuclear interactions at high energies, free of interference from low-energy cosmic ray primaries. The late Dr H. J. Bhabha chose studies of cosmic radiation as a higher-priority subject because of this reason. Indeed, the work of Indian physicists in the field of cosmic ray figures in a very important manner in textbooks on the subject.

It is, in fact, not necessary to have a geographical advantage to study a subject and make an important contribution to it. It is necessary only to do it *correctly*, with the guidelines discussed earlier in this brief. The field of radioastronomy is an example of this case. The Ooty Telescope and now the Giant Meterwave Radio Telescope (GMRT) are world-class laboratories.

The fields of theoretical physics and pure mathematics are certainly areas where we are at par in terms of facilities for work with the West. These have always been the potential areas of research for Indian scientists. We can improve in these areas by very large factors if proper incentives are given to the participating scientists.

However, we must recognize at this point that even in theoretical fields, we have a considerable handicap compared to the West. Their higher standards of living allow them to (i) easily purchase books and science magazines and (ii) work in the laboratory for long hours and at odd hours because of greater conveniences in running their household and going to and from the laboratory. So, we must recognize that we have to work harder than those in the West and also

make greater personal sacrifices to do science on a dedicated basis.

I must apologize here for the fact that several of the remedial measures I have talked about sound like motherhood statements. In reality, since we have everything we need to conduct high-level research but have neglected our basic role as scientists, of scholarly pursuits, these motherhood statements do become necessary. I have to emphasize here that we have to work hard and intellectually (as is expected of us); we just have to get to it. There is a true story worth recalling here. A hard-working mother had three well-endowed sons each of whom did everything they liked and enjoyed the pleasures of vagabonding. They always left the house in a complete mess for the mother to clean up. Then one day the mother went on a strike and halted all her daily chores. The sons retaliated by not responding for four days. But then they realized that they had been wrong, and corrected themselves quickly to make ultimately a happy family. What punishment do we need, and how long will we remain in our transition phase before we do realize what our normal duties are!

So, assuming that we overcome the problems of our recent past, and when all of us, especially the more senior scientists, do engage ourselves in serious scientific pursuits, burning the midnight oil as a routine, so forth and so on, we would then have countless exciting possibilities. Before concluding, I must emphasize that we must succeed soon in overcoming the problems of recent decades, because we are now in a transition, and since we have the potential (both the manpower and capabilities), and since we have demonstrated repeatedly our deep involvement and creative intellectual work. On the latter, I would just like to refer to another article in *Current Science*, 1994, 67 (referred to earlier), 'The first sixty years', by S. Ramaseshan. It is an exciting story of the evolution and science of the Physics Department at the Indian Institute of Science during its first 60 years of existence.

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