

Note presented by K.R. Sreenivasan (krs@ictp.it) for the Italy-India Forum in Roma in Sala Delle Colonne on 6 Dec 2006.

Distinguished Colleagues:

1. My perspective

I am not sure I am the right person to discuss the “Indian Model of Scientific Research and Innovation” because I have been away from India for more than 30 years. The saving grace is perhaps that I visit the country nearly every year, and am connected to the Indian scientific community quite closely---both at the working level and at higher circles. Perhaps this slight distance may give me better objectivity.

Another saving grace may be that the Abdus Salam International Centre for Theoretical Physics in Trieste, here in Italy, which I have the honor to direct for the last four years or so, has a close connection with India as part of its focus on science in developing countries. ICTP is dedicated to the advancement of advanced scientific research and the building of scientific capacity in developing countries. One aspect of the international commitments that Italy honors---the aspect to which Mr. Pacifico made reference earlier---is that our Centre is largely supported by the Government of Italy. Over its history, it has hosted a large number of scientists from all parts of the world in a variety of scientific programs. This graph gives an indication of the distribution of visitors from various geographic

regions. In particular, we get a good number of scientists from India (about 250 each year spending about 400 person months at ICTP), as shown in the next graph, I have had occasion to talk to many of them and get a sense of things are from their points of view. Perhaps this opportunity gives me some perspective, as well.

For these two reasons, I have agreed to speak here. I shall say also something about Italy and India together but you should not expect a thorough analysis. Yet, I hope that these comments will be useful for understanding one important aspect of India, especially because science and innovation are often thought to be drivers of Indian economic engine.

2. India's accomplishments in research and higher education

On the positive side, there are some great institutions such as the Tata Institute for Fundamental Research, the Indian Institute of Science, the Indian Institutes of Technology, the Jawaharlal Nehru Centre for Advanced Scientific Research, the National Institute for Advanced Study, the nine or so Central Universities, and a handful of smaller and specialized institutions such as the Raman Research Institute, the Harish-chandra Institute, National Centre for Biological Sciences, and so forth. In some rough sense, the faculty members of these institutions are comparable in quality to those in the best institutions in the world. Their alumni are highly successful both within the country and without; a number of companies in Silicon Valley in California owe their wealth to them. The terrific Indian students and

professors that one hears about in the US (for example) come primarily from these institutions.

Most of these institutions are supported adequately by the Central Government, and their mode of operation is entirely merit-based and generally free of interference from politicians. The students often receive first-rate education. At least until recently, the operation of these institutions was not subject to extraneous considerations such as regional politics, religious or economic or social status of students and faculty, and so forth. These institutions are centers of excellent research, with no mission other than to excel. In fact, research is a priority for them and the teaching load for the faculty is rather light. They are, however, small in size and strength. One can say that these institutions have amply demonstrated that first-rate things are possible in the country.

Even in these institutions, one should not think that everything there is great. For instance, the salaries are low in comparison with those in developed nations, the faculty has limited opportunities to travel abroad, getting first-rate equipment takes time, and there are occasionally some embargo effects as happened soon after the atomic explosions a few years ago, and so forth. On the whole, however, the faculty has the time and wherewithal to engage in intellectual pursuits, and to pay attention to students.

By the way, the Department of Science and Technology was set up by the Government to promote new areas of science and technology.

It plays a vital role by organizing, coordinating, supporting, promoting and overseeing scientific research activities in the country.

Continuing on the positive side, there is another mechanism by which scientific research is supported in the country. It occurs through the umbrella of a few scientific institutions set up purely for research, with little or no educational functions (at least until recently). They are all funded by the Central Government. Examples of such institutions are the Atomic Energy Commission (a huge establishment responsible, among other things, for the nuclear energy programs), the Space Commission (which is responsible for all space-related programs such as launching of educational and communication satellites), the newly established Earth Commission (which will concentrate on all earth-related activities), and so forth.

Then there are many labs, on the order of 20, that come under the Council of Scientific and Industrial Research, whose labs are engaged in specialized research on aspects such as aeronautics, electronics, chemical physics, agriculture, and so forth. Until recently, the connection between these research labs and the local industry was minimal, and, indeed, there used to be quite a bit of mistrust between the two; the labs were usually loathe to commercializing any of their research. Now things have changed and all the labs are all very busy with making money out of their knowledge, and quite successful at it.

These commissions and research labs are, in principle, mission oriented though they support a broad range of activities: there is a general atmosphere in those places that a good person ought to be supported independent of his contributions to the principal mission. Let me clarify that “mission oriented” does not mean that these places are engaged in military research and applications---in fact, they have traditionally shunned a strong link with defense. There are separate defense labs for that purpose. The defense establishments award research grants to the top research institutions as well as other universities (described below), especially on aspects that have some fundamental component, and the system is much like that in the US in this regard.

3. The languishing university system

On the negative side, there are some 300 or so universities that are supported by the local or state governments. To a first approximation, most of these universities work in abysmal conditions. Some of them have had reputed history but have fallen on hard times; many were created in the last fifty years by upgrading smaller colleges without, however, providing adequate support. The admissions are open to anyone with a diploma and merit is not the major consideration. The local politicians often interfere with decisions of vice-chancellors of these universities (who are sometimes political appointees), and the merit of the students and faculty members is often not a prime consideration. The funding is poor and facilities are barely maintained.

Yet, many students from these places make it in the world, it is because even such a poor system has not managed to vanquish the students' drive, and the desire of their parents, to succeed in education as a means of social upward mobility. I think that this speaks volumes for the general optimism of the people. The downside is that quite a few university students receive poor education, often with no interest in intellectual endeavors, but, by political influence or otherwise, end up in positions of power in the public sector. Research culture in these universities is a hit-and-miss affair, and those few faculty members who are engaged in it do not perform competitive research most often. Their teaching loads are rather heavy and there are few incentives for stretching themselves.

Thus, the educational system in India is a combination of unequal opportunities and unbalanced record of accomplishments, and is a mix of plenty and poverty. This dichotomy should be kept in mind in understanding Indian research, education and innovation. My description is somewhat sweeping and the exceptions are easily found, but the rough picture is essentially as I have stated.

4. Elitist science in democracy

I submit to you that this dichotomy is the result of a conscious but unstated choice. I believe that there was a realization that elitism in science and democracy in practice have to be balanced somehow, and the balance was achieved essentially by singling out some

institutions for elitist treatment while others entirely served the egalitarian ethos.

The situation is worth contrasting with that in the US (which I know well), and in Italy (which I know less well). In a totalitarian system, such as the former USSR, or even present day China, the interests of a few can be pursued without a heavy price to pay. In democratic societies, there is always a tension between the elitist pursuits of the few and the broad interests of the many. The solution that India found to resolve this issue with respect to science is not that different from what one has in the US. There are the elitist private universities, in one of which I served as professor for some 22 years, which take the best students possible and recruit the best faculty available. They have no special obligation to admit students from a particular State or minority groups (although they strive to be responsive to such issues).

On the other hand, the State Universities do have an obligation to admit students from the State that funds it and, in general, cannot opt for a “merit-only” philosophy. The difference between India and the US is that the overall level of the faculty in the US is quite high, even in most State Schools, and there is reasonable support for research in nearly all of them. The country is rather rich overall, which enables it to compete with the best talent from anywhere. I know instances where Indians have opted to remain in a US university of lower quality than join an Indian institution of higher overall reputation. The power of the Dollar against the Rupee cannot be ignored.

5. The Italian scene

I might now say a few words about the Italian scene without going into too many details. There isn't enough time even if I knew what to say more precisely. My perception is that the sense of egalitarianism in Italy has been dispersed uniformly through all its universities.

There have not been great distinctions about the support that different universities receive from the government. It is true that some great Italian scientists work successfully and well within Italian universities, and attempts are often made to build elitist groups around them, but it is difficult to sustain them if the environment of the university as a whole is against any elitist tendencies. On the whole, if the American system is to be regarded as a good model, the Indian system comes closer to it than the Italian system, though, of course, the Indian system is a lot poorer overall.

Let me continue for a bit more. The main research institutions in Italy are the Consiglio Nazionale delle Ricerche (CNR), Istituto nazionale di ricerca metrologica (INRIM), Istituto Nazionale di Alta Matematica (INDAM), Istituto Nazionale di Astrofisica (INAF), Istituto Nazionale di Fisica Nucleare (INFN), Istituto Nazionale per la Fisica della Materia (INFN), Istituto Nazionale di Geofisica e Vulcanologia (INGV), Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), and others. They are very similar to the umbrella organizations that I have mentioned in India, and some of them have great traditions.

The handicap of the Italian institutions is that the effort to keep them democratic has given way to overabundant bureaucracy and an institutionalized lack of transparency: for instance, heads of research organizations tend to be nominated by the government rather than selected by the scientific community. I see many commonalities between how bureaucracies in Indian and Italian universities are sometimes used in similar fashions to prevent good things from happening. In Italy, the love for intellectuals individually lives side by side with weariness towards institutionalized elitism.

The tide may, however, be turning and new money is going into the creation of an MIT-like elite university called the Italian Institute of Technology. But I see it as a bad sign that its birth is being led by the accountant general with the help of a consultancy company. Yet, in spite of all its problems, I am certain that the country enjoys a greater level of intellectual accomplishment than is true for India on the average. It is also clear that Italy takes care of its citizens than India does, where most things are made possible only through personal enterprise.

6. Future prospects and innovation

Returning to India, there are some important implications of the dichotomous solution evolved in India, the one to which I referred a few paragraphs earlier. Many students trained in the country's elite institutions are well enough regarded outside India that they go off to build their research careers in the US as well as other countries. One

good thing is that many expatriate Indians keep some connection with their country even after they leave it for good; this connection is a delicate matter in academics but is straightforward in business. The typical “brain drain” in India was not of great consequence for many years partly because there were not enough local opportunities for everyone, and the industry and private enterprise was not in great shape. In some sense, it was clear that the country was producing a larger number of educated people than it could absorb. This is not to say that the country did not suffer from the exodus of its bright people, but the situation must be considered in the context of what the former Prime Minister, Rajiv Gandhi, said: “better brain drain than brain dead”.

Now, however, the situation is different. Opportunities in private enterprise are exploding, and people are looking for qualified people. The worry is that those industries do not actually have a broad base of well qualified people from which to draw. As I already said, if one excludes the top institutions, the education received by students is very uneven, and it is mostly from this uneven pool that the local enterprises can draw their lot. Thus, there is a growing realization in India that unless the university system is overhauled, it will soon run out of well-trained people who would regard quality as the essence of their work. This is a frightening prospect for a country of a billion people!

These days, people talk about the knowledge triangle consisting of education, research, and innovation. Most of what I have said so far

concerns education and research. The Indian innovation in certain sectors such as ITC, biotechnology and pharmaceuticals are now quite well known. The Indian scientists adopted themselves to the needs of the hour pretty well in these areas, and I believe that, as the shackles of the government become loose, there will be more innovation in other areas. An outstanding example of a thriving company of the type of Infosys, whose chief executive officer I recently met in Bangalore. As I was taken around in a tour of the campus, it felt as if it could well be somewhere in San Diego: the weather was similar, the grounds were kept similarly neatly, the buildings were modern, the intensity of the people who work there was similar, and their enthusiasm no less. This is the good part. The bad part is the poor infrastructure as soon as one steps outside the campus. The traffic is congested, and the pollution and noise levels high. Unless something is done quickly, this lack of infrastructure could throttle the enhanced level of creativity and innovation in Indian enterprises. Nevertheless, what goes in favor is the spirit of the people and a can-do attitude; but it cannot supplant a great deal of investment, both domestic and foreign, that will be needed to make the large changes needed.

But the worry about the lack of well-qualified pool of people from which to draw is an aspect that concerns all prime movers of innovation in India. To produce a pool of students who are capable of creative work in both public and private sectors of the country, they have come to recognize that it is important for the quality of university teaching to improve. Since it is difficult to make every university in

India a research university (and this may even be counter-productive), it is better to think of other ways by which those university teachers who desire to be engaged in research are provided research opportunities for some time of the year, each year. Thus, proposals have been made to set up remedial centers in research-oriented institutions. These centers would have a small but strong research base but draw upon permanent researchers of great distinction in the country to be an organized resource for all university teachers to improve their research standing, thus eventually imparting a sense of quality to students, and creating more people interested in science and intellectual inquiries.

7. Cooperation between Italy and India

Historically, India and Italy are very much alike. Layers of history lie buried beneath each other in each country, yet there is continuity with the remote past---like no other countries and civilizations in the world. Both peoples are highly intelligent and flexible. They love friends and family and respect for tradition. Both countries thrive on many small-scale industries. Until recently, the sense of a local community has been stronger than the sense of a nation----obviously because, even though each country has a lasting cultural commonality, its political unity in the modern sense is relatively new. By nature, I believe that it is very easy for the two countries to understand each other. Indeed, the Indian visitors to ICTP feel quite comfortable in Italy. They are the largest in number from any country, after the Italians. At the scientific level, there are many cooperative efforts, especially on a one-on-one

basis. Since the visit of President Ciampi to India nearly two years ago, several agreements have been signed. One example is the research work on e-grids, in which Italy excels and India has some needed expertise as well. Our own center is involved in it.

Nevertheless, the connection between the two countries has not been as strong as it could be. It is true that Italy and India have had many ties in the remote past, and Ambassador Dogra and others have made references to it. However, starting early 1900's, for instance, when Italy has looked to the East, the emphasis has been toward China and Japan. Italy's trade with India is no more than that with Croatia. Indian intent towards Italy has also been lukewarm, as shown by the slim business connections to-date---mostly because India's political and geographic survival depended on connections with big countries such as USSR in the past and the US now. But I emphasize that the similarities between the two people is so strong that it makes perfect sense to take advantage of it.

But this time, there may be better will for cooperation. In the Italian Financial Newspaper *Il Sole venti quattro ORE*, Mr. Manmohan Singh, the Prime Minister of India, after his meeting the Prime Minister of Italy, Mr. Romano Prodi, is quoted to have said: "This time, it will be different". The title of the article published on Tuesday, November 28, is "Delhi chiama Roma: pronti a cominciare una nuova era." I hope so. The Indian minister of Industry, Mr. Kamal Nath, already visited Italy, along with a number of Indian commercial enterprises. In February of the next year, a representation of the Italian Government and

confindustria, which is a confederation of Italian enterprises, will travel to India. I am very pleased that Prime Minister Prodi will visit India next February.

8. Indian problems

Indian problems have generally been well understood. The main one is its large population, whose large segments are still poor. The shackles of the government have held back the innovative spirit of its people for long. Several governments since India became independent have not encouraged foreign investment. Noting that the East India Company came as obsequious traders but conquered the subcontinent, this may well have been a reasonable reaction. In any case, even during its most difficult days, the country laid foundations for developing education and scholarship, and this speaks volumes for the foresight of its leaders. This has served the country well in its present heady days of expansion.

It is, however, unclear if this ethos is diminishing with time and if the preoccupation with business and money (about which I am quite positive) is not eroding long-term investment on things that don't pay off quickly. If my worry has any basis, it is a matter for some concern. Another concern is that the pace of development may well be eroding its sustainability. I believe that the large rate of growth is making the megacities of India less inhabitable, the pollution levels are constantly on the rise, biodiversity is diminishing, the infrastructure is still weak, the disparity between its rich and its poor is definitely not shrinking,

and the energy crisis is almost on the horizon, and basic necessities such as drinking water are still not available to many. I have a constant worry that the economic development is occurring at the expense of the sustainability. India has shown enormous resilience in the face of all its difficulties and fostered a thriving society in democratic traditions, and the same innovative spirit will have to come to the fore to solve its many problems.

Whether India will turn out to be a great country with great lessons to offer the world will depend on how it balances its present growth with opportunities for posterity. I am myself rather optimistic, but am often tempered by the awareness of the numerous issues just raised.

9. Conclusion

I am an Indian by birth and by the many years of living there as a young person; I was educated there and owe the country a lot. I then moved to the US where I spent some 25 years before I came to Italy where I have lived for the last four years. The perspective I have is one of this collage of experiences, but seems to me to be unbiased. I myself love Italy, its people and its culture, as I have always loved Indians and the country's great culture. It will please me very much if the two countries can come together more. It is natural culturally, scientifically, and, even more, temperamentally. I hope it will happen for the benefit of both countries.