CURRENT SCIENCE

Volume 63 Numbers 9&10 10&25 November 1992

Saving Indian science*

[*Guest editorial*]

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In spite of the modest support for science and technology, the Indian scientific community has hitherto performed well. The apparent decline in support in recent months has raised questions about the future of science in India and has left scientists with a certain feeling of hopelessness. A period of benign indifference will cause serious damage to the fragile science base in the country.

THERE is an implicit faith in the modern world that science and technology are intimately related to productivity, economic development and international competitiveness. Although such a premise is widely accepted, some doubt has been expressed in recent months whether in fact science and technology are so essential for economic growth and industrial development in every situation. One occasionally hears policy makers and administrators asking whether we are not wasting money on fundamental scientific research. Such questions threaten the very presence of a science-base in this country where, with great difficulty, a reasonable scientific infrastructure has been built up over the last four decades.

It is recognized that science and technology are not one and the same. Science is international while technology could have a national frame of reference. They are however interdependent. Advances in science help to develop new technologies while at the same time the need for new technologies and products provide the drive for new scientific discoveries. In converting a scientific discovery to a technological product, there is an entire innovation chain. Proper institutional linkages and promotive mechanisms are important factors in taking a laboratory discovery to a sellable product. An examination of the status of science and technology in the advanced countries shows that it is not always possible for every country to be equally good in both science and technology. Britain, for example, was a cradle of creative scientific ideas, but did not become a modern technological giant. Japan has been extraordinarily successful both in technology development and industrial productivity and has the most leading position in the world today. It has a good science base as well, but we cannot say that accomplishments of Japan in technology are directly linked to the scientific discoveries made there. In the long term, however, there seems little doubt that competitiveness in technology would require a high level of scientific capability. It seems unwise to borrow someone else's science to develop technology, but even to do so, one requires sound infrastructure and high competence.

The Indian scenario provides great challenges to science and technology. There appears to be no other equivalent situation in the world wherein a poor democratic country with a very large population has attempted to make use of modern science and technology not only to solve the pressing problems of society, but also to be counted as a modern nation in a highly competitive world. There are many things to be done. The efforts required range from one end of the spectrum to the other and demand mission-oriented R&D as well as fundamental research in priority areas. To this end, it is necessary to fully exploit the nationalism as well as the innovative capabilities of our scientists and engineers.

The language of science and technology is needed today for survival. It has become a cultural need. Even the poorest of the poor and the smallest of the small countries need this language if only to decide on the options for development and policy for import. Developing countries

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*A variant of this article has appeared in *The Hindu*, 7 October 1992.

without a good science base or with high illiteracy would have to provide the kind of education to the masses that would enable the country to fully derive the benefits of modern science and technology. Science education has a crucial role in development not merely in producing skilled manpower, but also in inculcating scientific temper in the entire population, especially amongst women who hold the key to progress.

Why is science essential?

Because we need the language of science for survival, science has to be protected for its own sake. The funds spent for blue-sky research may vary from country to country just as the percentage of the GNP spent on science and technology. Yet, it seems that unless creative scientific activity is promoted, it would be difficult for us to cope with advanced technologies and new developments in industry, in the long run. How much a country spends on fundamental research and on other aspects of science and technology related to development would depend on the size of the country, the objectives and goals set out by the country as well as the development strategy. Economic and industrial growth sans science and technology cannot be the route for India. It is unlikely that a model based on some of the small, prosperous Asian countries would be relevant to a country like India. Once agriculture productivity is ensured, it is only through industrial productivity directed towards export (besides the large domestic market) that resources can be mobilized. In this regard, foreign investment alone would not suffice. National commitment and doggedness in becoming competitive are more important. Competitiveness as well as improvement in the overall quality of work will come about only when there is a sound domestic policy based on internal strengths, of which science and technology constitute an important component. Some policy makers expect new or improved technologies to come out of our institutions, but they seem to have little use for science. It seems to me that such demands are not only unfair, but also unimaginative.

True international competitiveness seems to be possible only when there is intellectual competitiveness. It is therefore not surprising that Japan, which has performed so well in technology and industry, is now seriously concerned about its scientific research capabilities. Japanese science and learning have long been driven by the requirements of the government or industry which were devoted mainly to surpass the West. Japan now seems to be more concerned about comprehensive measures to promote science and learning with a perspective to the 21st century. There seems to be the realization that advances in technology and national prosperity will go hand-in-hand with its intellectual and scientific competitiveness. Futuristic science is an essential ingredient of futuristic technology.

Investment in science and technology

It is instructive to compare the investments made by us with that in some of the advanced countries. The US invests up to $150 billion on R&D per year while Japan invests $ 100 billion per year. In India we spend much less than a billion dollars per year towards all our efforts in science and technology. India was investing just over 1% of the GNP in science and technology compared to 5 or 6 per cent by some of the advanced countries. Unfortunately, in the last year or so, the percentage of GNP spent on S&T has come down to something less than 0.9. In Japan and the US, a high percentage of the expenditure on science and technology comes from private industry. Japan has however become conscious of the great importance of government intervention not only to direct the course of science and technology in relation to economic and industrial growth but also to make sure of its competitiveness in science. The Japanese government has therefore doubled its budget for scientific research this year. In the US where private industry has had a major share of S&T expenditure, it appears that the absence of sufficient government intervention and support for science and technology is responsible for it becoming somewhat less competitive (in technology) in the last few years. Basic science in the US continues to thrive, but it would seem necessary for the government to invest sufficiently towards infrastructure facilities and so on to ensure that the future of science, technology and industry is secure.

For open-ended research in educational and research institutions, the total budget available in India is in the region of one billion rupees (say 30 million dollars) per year. The proportion of the national R&D budget spent in educational institutions in India is probably less than 5%, compared to 15–30% in some of the advanced countries. A high proportion of the budgets of educational and research institutions goes to salaries and other infrastructure expenses. It may be of some purpose to compare the budget of a leading scientific institution in India with a comparable one elsewhere. The annual expenditure budget of the Indian Institute of Science, Bangalore, with about 1500 research workers would be around $ 10 million (including research project funding). The budget of the Institute of Physical and Chemical Research in Japan is $150 million. Although such comparisons may not be strictly valid, they do tell us something.

Considering the very small expenditure on science and technology in India, it is my view that Indian scientists have done reasonably well. Many of my friends abroad

wonder how we work with so little and against so many odds. The same may be said about the higher education sector where investments have been terribly sub-critical.

A fear has been expressed in the advanced countries such as the US about market forces alone determining investment in R&D. If immediate profit dictates investment in science, it is likely that technological growth and industrial development would be hampered. For example, if market forces alone determine the R&D investment in advanced materials and biotechnology, it is quite possible that we may miss a major innovation that may revolutionize not only science, technology and industry but our lifestyle itself. It seems imperative that investments in R&D are such that the long-term gains of the industry (and the country at large) are kept in mind rather than immediate profits alone.

In India, almost all the funds for science and technology come from the Government. The share of industry is negligible. Neither does the Indian industry make real demands on the R&D institutions. It is necessary for the industry in India to increasingly contribute towards science and technology in the country, but we cannot afford a situation wherein we are caught unawares with no one really interested in science and technology itself. Due to fiscal difficulties, the Government may be facing some limitations now, but it has to ensure that science and technology do not go down for lack of sufficient interest. It is essential for the government to continue to provide the support for S&T and higher education till a proper sharing mechanism between industry and government develops. In our preoccupation with short-term economic measures, we should not lose sight of our long-term needs and strategies. The Government could consider levying a cess or initiate such other measures as would ensure that the industry, as the main beneficiary contributes appropriately to science and technology and higher education. I expect that before long, the demand for science and technology will increase sufficiently in order for the industry, particularly in the private sector, to support science as well as higher education.

One of the significant features of today's world is the globalization of R&D. For example, Japan invests considerably in R&D in the US; so does UK. We in India will have to examine how such a globalization affects our own efforts and also how to become part of the globalization. One possibility is that India with its high technical manpower can attract R&D investment from abroad due to obvious advantages in carrying out work here.

Widening gap between India and advanced countries

I am seriously worried by the widening gap between us and the advanced countries. It is becoming increasingly difficult for Indian scientists to carry out even basic experimental research of a calibre comparable to that in advanced countries and publish it in good journals. The number of good papers from India in any given area published in high-impact journals is rather small. When it comes to technological development, the competition is much more severe.

The infrastructure and other facilities of most educational institutions and even national laboratories are so below par that it is becoming nearly impossible for scientists to take up challenging experimental R&D problems. The situation is particularly bad in our institutions of higher learning. Some funds are always available to the national laboratories, but even the minimal funds required for existence are denied to most of the educational institutions. We are short of equipment for research and the number of journals in the libraries is fast decreasing. There is not a single institution of higher education in India where the facilities are comparable to those available in equivalent institutions in the advanced countries. The situation has become worse in the last few months. Unless immediate remedial measures are taken, we will not be able to demand even the present level of performance from educational institutions.

Another problem we face is the sub-critical funding of R&D areas of high impact. For example, if we have to carry out competitive R&D directed towards lowering the cost of photovoltaic power (using amorphous silicon solar cells), we have to compete with Japan. Japan is making massive investment in this area with a view to bring down the cost to one-tenth the present cost before 2000 AD. If a technology developed in India has to compete with that developed elsewhere, we face an uphill task. The essential result would be that there will be a monopoly of advanced countries in advanced science and technology. This is certainly unfair and unjust. We have to find an adequate role in science and technology for ourselves and accrue the benefits of the results of R&D related to the future of mankind.

Need for an orchestrated plan

A large developing country such as India faces problems in deciding exactly what to do in science and technology. Clearly, several types of efforts are required. Policy makers and planners have to spell out the national objectives and goals in no uncertain terms and chalk out a well-orchestrated programme of action. They have to raise the necessary resources with the help of the industry. The following would be an important set of items on the agenda for action.

* We have to invest adequately in science education to

ensure that the necessary scientific temper is inculcated in the common man.

* There should be sufficient investment in S&T-related sectors which are directly related to the pressing problems of mankind such as agriculture, food, health, etc.
* We need to invest heavily in certain specific areas where we have certain unique advantages due to the available natural resources, or other special features. Solar energy beneficiation would be one such area.
* S&T related to crucial sectors such as communication, energy, biotechnology, advanced materials and informatics has to be supported since these areas will determine the course of the next century.
* R&D required for technology development, upgradation or modification in export-oriented industry has to be supported.
* We have to ensure that science and technology find an adequate role in upgrading our performance in socioeconomic sectors such as coal, building construction, railways, etc.
* Basic scientific research in chosen areas has to be adequately supported.
* Funding of higher educational institutions should be sufficient to improve their crumbling infrastructure in order for them to be able to carry out high quality R&D.

All this can be done only with the willing cooperation of our scientists and engineers. We have only a small number of highly talented people and it is necessary that they are fully supported and encouraged. Good scientists are a rare, delicate species and they need to be frequently assured that the country needs them. This seemingly simple effort is occasionally found wanting on the part of policy makers and politicians. A positive attitude towards science and scientists by politicians and administrators will yield results far in excess of expectations based on investments and will motivate scientists to work beyond the call of duty.

Epilogue

The apparent decline in support for science and technology in the country has created an atmosphere of depression in the scientific community. Many scientists wonder whether economic liberalization necessarily implies less dependence on science and technology (a feeling that may have the origin in what is happening in Russia and Hungary where science and technology had a big role till recently). The scientific community, by and large, is worried about the future of science in the country. A period of benign indifference will cause irreparable damage to the fragile structure of Indian science and technology.

Fortunately in this country, the Prime Minister has been always responsible for the science and technology portfolio. Suitable mechanisms have been employed to obtain the advice of the scientific community on relevant issues. The direct interest of the Prime Minister in science has helped to promote a close relationship between the Government and the scientific community in the past. This tradition must be maintained. It is important that scientists feel that they have the support of the highest office in the country. The involvement of the Prime Minister has yielded real dividends and has enabled scientists and engineers to perform, in spite of the many shortcomings. It is necessary to take care that scientists are not always questioned about matters, but are gently handled so that their optimism and dedication can be counted on. The scientific community should not be at a psychological disadvantage or feel ignored. A period of benign indifference would destroy what little has been gained in science in the last four decades.

Scientists should not forget that they are answerable to society in some way. Scientific institutions would have to shed their excess weight and become pragmatic and action-oriented. While investment in science and technology should be made enthusiastically by the government and the industry, scientists have to properly articulate the need for such support. They have to adequately justify the need by producing high-quality results which give benefits in the long-term as well as in the short-term, with a proper balance. Scientists probably would require the help of economists, socilogists and others in articulating their needs as well as their usefulness.

Politicians, planners and administrators need to constantly contemplate on the long-term needs of the country in order to determine what science has to be done today to answer the needs of tomorrow. They have to treat the scientific and technical manpower as an important asset to the country and strive to help science to become an essential ingredient of our societal make-up.

Post-script. I have written this article in great anguish. I am terribly concerned by, what appears to be, a decrease in the national commitment to science. I am equally concerned that science is not being fully utilized. I have been carrying out research work in this country for over 33 years. I have noticed in recent months, a feeling of hopelessness amongst many of the good scientists. It hurts me to think that there may be a view in some quarters that science is not essential. If science is irrelevant, I feel like a reject. Without science, I do not know how to live. I may be a romantic fool with regard to science, but the excitement and rewards of science cannot be matched by anything else. I hope and pray that no power will succeed in undermining science or take away the dream of scientists.