Science & Technology

Networking for Excellence

Prof V S Ramamurthy,
Secretary, Department of Science and Technology
Government of India

At the individual level, Scientists and Technologists of Indian Origin (STIOs) have been usefully interacting with their counterparts in India over the last several decades. What is now required is to build upon it and move ahead taking note of changes and new developments. Indian science has now matured with strengths in basic sciences to technology development and commercialization.

India is increasingly participating in international S&T programmes for example in Rice Genome Sequencing and in programmes at CERN, Brookhaven National Laboratory and Fermi National Laboratory.

Technology incubators in the emerging areas of biotechnology, pharmaceuticals, advanced materials, high performance computing, etc. are examples of new opportunities for the development of cutting-edge technologies.

In this changed scenario, it is necessary that while younger scientists are continuously exposed to front-line international science, the more experienced scientists participate in large international S&T programmes.

Individual initiatives of STIOs in the past have proved very useful and should and will continue. The request to STIOs is to give special attention to the following:

· Act as a bridge between Indian S&T and large international S&T programmes, identify such programmes and inform possibilities and opportunities.

· India has set up internationally competitive research facilities such as Giant Metre Radio Telescope (GMRT), Himalayan Chandra Telescope at Hanley, National Facility for Structural Biology, Pharmacological Testing Facility, etc. and additional ones like the 2 GeV Synchrotron Radiation source INDUS-2, Superconducting Tokomak at the Institute of Plasma Research are being set up. Larger inputs from STIOs in these facilities and their programmes and participation of younger scientists from abroad will be very useful.

· Indian competence in technology transfer and commercialization is still rather weak. India can gainfully learn from the experience of STIOs to understand what needs to be undone from the existing practices and what is to be done in taking R&D to market place, utilization of venture financing and for technology entrepreneurship.

Dr Bhaktab Rath,
Head, Materials Science & Component Technology Directorate,
Associate Director of Research, Naval Research Laboratory
(NRL), Washington, DC

India and US have long shared the common commitment to the advancements in Science and Technology, perhaps best reflected in Prime Minister Nehru's statement, "The world would ultimately be saved, if it is to be saved, by method and approach of science." Evidence is that some 10,000 scholars from India in a period of twenty years prior to 1981 received their doctorate degrees in physical sciences from the US, the largest number from any single foreign country.

NRL itself has been involved in over 70 projects with India under the Indo-US Science and Technology Initiative supported by the US State Department's PL-480 funds. This collaboration between the leading institutions in India and the United States has produced to date: (1) over 700 archival research papers published in international technical journals, (2) in excess of 55 Ph.D. theses in India, (3) four technical books and five book-chapters, and (4) over 20 topical workshops and conferences proceedings on emerging areas in science and engineering. Over 200 Indian scientists visited US research institutions. Recognition to collaborative research has come through national and international awards to scientists in India.

A wealth of resource and potentials to develop Science and Technology collaborations with STIOs in the United States and other countries exists. These can be easily tapped to enhance India's S&T excellence and to provide the much-needed infrastructure to transfer technologies from the laboratory to production.

Past experience shows that people are the main resource. Indians show an eagerness to create new knowledge and a quest for basic knowledge in sciences is truly a global endeavour. We should aspire for richness of ideas. There is no better opportunity than to harness the willingness of STIOs to join forces with scientists and engineers of India to promote excellence.

In addition to supporting collaborative research in Physical Sciences, deep commitment is to two areas: 1) India's energy independence through research to understand the nature of its vast deposits of methane hydrates along the continental margins, and 2) to effectively predict monsoons and climates including the genesis and track of super-cyclones, in order to utilize this knowledge for better water management. Research in these areas now, not tomorrow, is vital to the health and well-being of the nation.

In conclusion, it is high time for us to join hands in earnest for the betterment of the people through Science and Technology unencumbered by national politics and bureaucracies.

Dr Bikash Sinha,
Director, Saha Institute of Nuclear Physics, Calcutta

Over the last decade or so, India has made substantial progress in advanced science and technology. Indeed, in certain sectors of advanced technologies, India is arguably one of the best in the world.

Participating meaningfully in the most advanced international facilities/laboratories has now been part of India's S&T agenda for quite a few years. As an example, India's participation in the programme of one of the largest laboratories in the world called CERN at Geneva. We collaborate with CERN, not only in building state-of-the-art equipments for the largest accelerator in the world to be built (Large Hadron Collider), but also in experiments with collaborators from all over the world.

In the process, India has become a world-class player in areas such as cryogenics, superconducting magnets, high-speed efficient communication network, electronic chips and so on. Thus, collaboration with CERN has also resulted in unprecedented technological of fallout such as MANAS chip designed and manufactured in India by the Saha Institute of Nuclear Physicis.

In brief, CERN collaboration is an example of megascience project par excellence. Similar but small-scale collaborations with Japan, Germany, UK, USA and other countries have given us rich dividends, both in terms of advanced technology and frontiers of fundamental science.

However, the participation has been by and large one way. Our scientists and technologists go "there" – with (of course) our equipments built in our country. In order for the collaboration to turn truly global, time has come to attract our global partners to equivalent facilities, being built or to be built in India. The Giant Metre Wave Telescope, the Synchrotron Radiation Facility, and the Superconducting Cyclotron Facility, being built at Calcutta are some examples.

Both way traffic is necessary to make a lasting impact of India's S&T on the global scene and to increase the standard and efficiency of India's S&T enterprise. Then, our Indian colleagues settled abroad will have an even more meaningful participation.

Gurude S Khush, University of California, (Department of Horticulture), Davis, California

Dr Khush presented India's participation in International Rice Genome Sequencing Project as a "Success Story and Workable Model".

Amongst the cultivated plants, rice was selected for genome sequencing, as it is the most important food crop and a model for research on other important food crops such as maize, wheat and sorghum.

The International Rice Genome Sequencing Project (IRGSP) was launched in 1999 under the leadership of Dr Takuji Sasaki of Japan. Nine countries joined IRGSP and assumed responsibility for sequencing one or part of a chromosome. At the suggestion of Dr Khush, India joined IRGSP and two teams in India (under the leadership of Dr Aklesh Tyagi and Dr N K Singh undertook the responsibility of sequencing long arm of chromosome 11. DBT under the leadership of Dr Manju Sharma provided the financial resources. Several scientists were trained in Japan as well as in USA. India not only met its target by the end of 2002 but also additionally sequenced 14 MB of chromosome 11 and submitted the data to the IRGSP. Congratulatory messages were received from the Prime Ministers of Japan and India and the President of USA at a ceremony to announce the completion of the project where Indian scientists were also invited.

Research to determine the function of identified genes is a future programme of setting up a "functional genomic network" and India should participate in the new programme.

Dr Chidambram

Co-President observed that the presentation of Dr Khush provides an excellent example of initiative by STIO enabling India's participation in Mega International S&T Programme and would be worthwhile for a wider STIO community to adopt this approach in other areas.

Prof E C G Sudershan, Co-President, Department of Physics, University of Texas, Austin, USA

Science and technology development has been integral components of national planning. Many leading high visibility institutions pursue both. Earlier, it took many years between publicly available science and its consequent technology to develop. This time the gap has been shortened to a year or even months due to improved communication and sophistication of the technologists. Often, science is pursued for its own sake, and yet the application and technology eventually emerges out of it.

The right strategy is to provide wide opportunities to both science and technology and establish an environment and culture of hard work and perseverance that compared to the US institutions are weak in some Indian institutions. Universities were the right place to provide such opportunities, as it is there that the new ideas flourish and with a continuous flow of people the universities become sources of discoveries and inventions. Finally, in generating new ideas, to be following a parade is enjoyable, but it would be better if one can be in the lead.

Strong emphasis on the basic scientific research in the universities is not only important for its own sake, but also as the foundation for the post-modern technology. It is in this that the STIOs can play an important role.

Theme II

Enlarging Technological & Business Opportunities in Partnership with STIOs Abroad

Co-Chair: Dr R A Mashelkar and Dr Praveen Chaudhari

Dr R A Mashelkar,
Director General, Council of Scientific and Industrial Research and Secretary, Department of Scientific and Industrial Research

India has to move ahead with confidence in its knowledge resources and S&T capabilities tolerating the obvious deficiencies in infrastructure and constraints imposed by the economy that is still to develop at levels available in several advanced countries.

India needs faster movement on the route from "Saraswati to Lakshmi" I, route from knowledge to wealth. In this, India expects to gain from the rich experience of STIOs. With their remarkable record of successes in creating wealth from knowledge, STIOs can be effective mentors to our younger generation.

Another area of STIOs participation is in the utilization of the competitive advantage offered by India's S&T. India offers the best intellect per dollar cost. For example, India designs satellites at one-fifth of the international costs. That is why some 60 foreign companies have set up their R&D bases in India. The potential is enormous; India is now set to become a global R&D platform.

India is an attractive R&D platform from demographic considerations also. The high percentage of younger people in its population is an excellent pool of skill-based competence.

India has a strong and extensive public-funded R&D system, one of the largest in any country. This gives India an added competitive advantage.

STIOs can play an important role in bringing R&D from their countries to India on the basis of these advantages.

In brief, India has always been and continues to be a land of ideas with competitive advantages in S&T. STIOs are to participate in transforming India from a land of ideas into a land of opportunities.

Dr Praveen Chaudhari,
IBM Research Division, Thomas J Watson Research Centre, New York, Vice-President of Research

Scientific activities can be divided into two broad categories: understanding of nature and the application of this understanding to help mankind. The former is easy to

implement and the latter extremely hard for its success depends not just on science or scientists but also on the receptiveness of the surrounding environment.

Looking at the Indian research enterprise from an international perspective, as an outside view, it is seen that:

· India spends only about 0.6 to 0.8 per cent of GDP on R&D, compared to 2 to 2.5 per cent spent by US and Japan. As there is a positive correlation between the Purchasing Power Parity and R&D, India should target an expenditure of around 2 percent of GDP on R&D.

· The composition of R&D funds shows that whereas the ratio of Industry to Government R&D funds is about 2.5 in the US and 4 in Japan, in India it is as low as 0.5 indicating a weak industry investment in R&D.

· The major portion of R&D expenditure in India is accounted for by the National Laboratories at number one, followed by Industrial Laboratories and the Universities.

· In terms of research publications per million population, for India the figure is less than 10 compared to, say, Switzerland's 200.

· Although quality of research publication is hard to judge, still if one looks at the citations received by Indian research papers, less than 1 per cent of research papers from India receive citations compared to, say, 8 per cent for UK and 46 per cent for the US.

Therefore, the overview that emerges is that Indian S&T has individual islands of excellence, but the average is poor. This raises certain questions such as:

· Should R&D be increased?
· Should it be increased at the universities?
· Should Indian industry be encouraged to do more R&D?
· Should foreign R&D organizations be encouraged to come to India? If yes, how? Does the software example in India teach any lessons?

There are no ready answers to these questions. More deliberation is required, but it appears that islands of excellence or one of a kind may not be adequate to make India a developed nation.

Mr N Vaghul,
Chairman, ICICI Bank Limited, Mumbai

Lead Speaker

India will play an important part in the knowledge revolution is clear. What role will India play is to be decided.

In this context, the field of biopharmaceutical is definitely full of opportunities. The global pharmaceutical industry is undergoing a period of transition and is in dire need of a transformation of its R&D strategy. 53 per cent of top 100 pharmaceutical products are going to be out of the patent regime, low-cost imitations will be a threat and yet cost of new drug development is high, returns are low and the shelf life is reducing.

There is, thus, a significant unmet need for greater efficiencies from a cost, speed and productivity perspective. India, with its large scientific community backed by Government support and push to biotechnology, offers good R&D opportunities. The Indian pharmaceutical industry is also undergoing a period of transformation driven by changes in the intellectual property regime. Just as the Y2K issue was a catalyst for the

information technology industry, these two factors could be the catalyst for making India a strong participant in the global biopharmaceutical industry.

While the economic advantage of outsourcing services (particularly where IT and life sciences intersect) will continue to be an attractive opportunity for India in the near term, making investments in value-added services and technology will lead to creation of sustainable businesses.

Admittedly, the overall economic environment and infrastructure have to improve, as also the mindset of existing venture capital institutions that look for immediate returns has to change. India is still moving ahead. ICICI has created a Knowledge Park in 200 acres of land given by the Andhra Pradesh Government. 16 institutions have already come up, and an Institute of Biotechnology appropriate for the needs of biopharmaceutical industry has been set up.

The challenges ahead are to fill in the deficiencies in science management and entrepreneurship. This can be achieved by creating an entrepreneurial and research-based culture in India through partnership with some successful STIOs with long experience in technology and business that are ready to act as mentors.

Mr Narpat Bhandari, Founder, ASPEN Semiconductor Inc, & Private Venture Capitalist, USA, Trustee, University of California at Santa Cruz

It is imperative for India to join the race in the nanotechnology area, the future of which is here and now.

Molecular nanotechnology – or "nanotech"- is the technology of manipulating materials at the molecular level or the "nanoscale" and a nanoscale science, engineering, and technology that is a confluence of physics and chemistry, biotech and environmental sciences, of atoms and molecules as also of entrepreneurs and techno-commercial experts. It is creating the groundwork for a paradigm shift in the manner of their application and manipulation for the humankind's greater good, whether in healthcare, environment & ecology conservation or for optimizing energy efficiency.

As the impact of nanotechnology is going to be pervasive across the globe, across all industries, India cannot remain untouched by its growing tide.

The US has launched major programmes. The National Nanotechnology Initiative funds of over $1 billion will be spent in nanotechnology research and development in 2003.

Given its immense potential, nanotechnology has been identified as one of the new millennium initiatives to be followed by the Government of India.

Innovative partnerships between India and the US initiatives is critical to fund scientists and engineers across disciplines to integrate research and education, accelerate applications, and fully explore the implications of nanotechnology.

Creation of a "Nano-Harbour" on the lines of Silicon Valley, the driving force behind which were primarily the vast number of Indian technocrats and engineers is needed as a network of excellence that presages the coming revolution.

Panel discussion

Action Plan for Networking of STIOs Abroad for India's S&T Excellence

Dr Thomas Abraham,
Vice-President of Research, Business Communications Co, Norwalk, USA

NRI/PIO movement in America has been active since the early 1970s through the setting up many Indian organizations. In 1989, at the First Global Convention of People of Indian Origin convened by Dr Abraham, Global Organization of People of Indian Origin (GOPIO) was formed. GOPIO coordinated a programme with TIFAC (under the Ministry of Science and Technology) in 1993 in which a delegation of experts was brought in from the US to speak on the state of some of the cutting-edge technologies.

Experience and expertise of taking technology to a marketplace available with business communication and other STIOs can be effectively provided to India by working together. Organizations like GOPIO can also help in identifying STIOs in the cutting- edge R&D areas to facilitate interaction with Indian R&D.

At an individual level, efforts such as providing books and journals to Indian universities are also useful.

Mr Sam Kannappan,
Consulting Engineer, Houston

Ways to contribute to India

Based on the experience of industrial consultancy technical audit in the areas of engineering procedures, safety, manufacturing and design would like to play an advisory role in a feasibility study on in India and in terms of technology transfer, would like to work towards, in general, setting up manufacturing plants with advanced technology available in the USA and in the Linking of River Waters Project in particular.

The National Water Policy issued by the Ministry of Water Resources, Government of India, in April 2002, called for private-sector participants and a Task Force on Linking of Rivers has been set up to bring about a consensus among the states.

STIOs propose to work towards the goal of linking the rivers by 2012. They would provide a small percentage of equity towards the linking-the-rivers project. Assistance will be offered by STIOs in the feasibility study, project management, project funding, procuring heavy earth moving equipment, new technology in rock tunnelling and other areas, as required. They will also provide assistance in the preparation of studies for consideration by the World Bank, United Nations Development programme and US AID. Many serious challenges will emerge in such a mega size project and these can be tackled jointly.

Dr Srini Kavari,
Director - Research, INSERM, Paris

Starting in 1985, interactions have existed through a number of Indo-French symposium and workshops on Immunology jointly organized in India, lectures delivered at various research institutions and universities in India under the TOKTEN programme and training provided to postdoctoral fellows from India at INSERM. These experiences provide a solid foundation for future initiatives.

Immuno-therapy and the need for the next generation of immuno-globulins is a good example of an important area for future action plan on India's excellence in S&T in partnership with STIOs.

STIOs in France need to take much more active interest in Indo-French bilateral programmes like those of the Indo-French Centre. For fuller realization of partnerships,

STIOs should act as a bride between India and France to seek and use opportunities of collaboration.

Prof J Shukla,
President, Institute of Global environment and Society (IGES), USA & Professor, George Mason University (GMU), USA

Action plan for joint STIOs and India may be based on the past successful experience. This includes travels to India as a scientific leader to establish the scientific infrastructure of monsoon forecast supercomputer centre (NCMRWF) and collaborations on weather and climate research with Indian scientists and a participation in a number of international workshops and conferences in India.

In addition, the setting up of a college (Gandhi Degree College) in the village Mirdha in the Ballia district of India, for the education of rural students, especially women, has also been an enriching experience.

A Centre of Excellence in India for Climate Modelling due to human activities could be set up as a collaborative project with STIOs. The centre with a critical mass of young scientists will provide training in mathematical modelling of atmosphere, ocean and land systems. The centre will also maintain a state-of-the-art computing facility, which can make ensemble of climate model integrations to define the level of uncertainty in predications required by policy-makers, decision-makers and the stakeholders.

Mr Krishan Singh,
Instituto de Geofisica, UNAM, Mexico

Future initiatives can be built on the past professional interaction with India that began in 1995 as a member of the International Advisory Committee (IAC) on seismic instrumentation in India, with funding from the World Bank, followed by work with Indian colleagues on the estimation seismic hazard in Delhi, visit to Bhuj in 2001 at the invitation of the Government of India as a member of the Foreign Advisory Team (FAT).

Regions in north and northeast India are exposed to seismic hazard. The advances made in seismic observations in India in the last five years are impressive. Much progress has been made in understanding the geodynamics and seismotectonics of the region.

However, realistic seismic hazard estimation and its mitigation appear to lag behind. It will require large-scale studies on the propagation and attenuation of seismic waves, local site effects, and seismic micro-zonation to adequately quantify the seismic hazard. A close collaboration between seismologists and seismic engineers will be essential.

STIOs have the expertise in this field and a desire to help in tackling this formidable but the challenging task. Specifically, the areas in which STIOs could make useful contribution to seismology in India include training of Indian scientists in acquisition, processing, and analysis of broadband and strong-motion data, help in the setting up of the Earthquake Risk Evaluation Centre (EREC) and advise in problems, projects, and curricula related to seismology and seismic hazard.

Prof M A Vijaylaxmi,
Director, Molecular Interactions & Separation Technology Lab, Lim TechS, Universite de Technologie de Compiegne (UTC), Compiegne, France

Active involvement with Indian science has been through, for example, membership of Ministry of Science and Technology, Government of India's Standing Advisory Council -

Overseas, chaired by the Secretary, Department of Biotechnology, MoUs of UTC with IIT, Delhi, Anna University, and Vellore Institute of Technology (VIT), as consultant and adviser to the Council Scientific and Industrial Research and some French and Indian Industries.

STIOs can usefully interact in the following manner:

· Advising, networking and also partnership tie-ups with French industrial partners, particularly, SMEs. For example, in cost-effective and non-denaturing recovery of poly/mono clonal antibodies from different sources - animal sera, hybridoma cell cultures, ascite fluids; specific recovery of IgG3 from different sources; preparation of "standardized" protein for diagnostic kit in collaboration with a French-based company.

· Organizing symposia and workshops in different Indian scientific centres with participation of 20 to 40 European and or American experts in the respective fields invited using funds available from outside India. This could open up the contacts and increase the potential for collaborations.

· Facilitating India's participation in mega European projects.

In terms of future vision, rather than large size national institutional structures, the regional structures and the S&T expertise within those structures could also be targeted for collaboration. This will be in conformity with the new decentralization policy in France and also the Government's efforts to strengthen and boost the regional structures. For example, the Mayor of Toulon has awarded a Biotech-Mega Centre dedicated to human health and would like Indian industry and laboratories to go there as partners.

Dr Subodh K Bhargava,
Former Group Chairman & CEO, Eicher

Several new opportunities have emerged in India for STIOs.

· Cost-effective and competent human resource and large-market advantages have already made India an attractive location for value addition through manufacturing. R&D has emerged as the next sphere for locating value-addition activities. IT has already demonstrated this, and similar opportunities in other frontier areas of technology are open to STIOs.

· The Indian industry is rapidly changing its mindset in the face of international competition. The Indian industry is now keen to work with laboratories and individual experts and thus welcomes R&D people from abroad as partners.

· Technology incubators in biotechnology, IT, new materials, etc. have already been established in India and more are to come. This is another new opportunity the STIOs can make use of.

Dr Manju Sharma,
Secretary, Department of Biotechnology, Government of India

Biotechnology is a major power especially for developing countries as a source of livelihood, health and food. STIOs' contribution to biotechnology is to be viewed as their concern and contribution to the well-being of one billion people in India.

Extensive programmes in biotechnology are already afoot in India from human resource development, frontline research, to applications in health, agriculture and to encourage entrepreneurship and provide gainful occupations to marginal populations with emphasis on women empowerment. Some areas in which STIOs can contribute significantly are:

· In filling up critical gaps in expertise in R&D and entrepreneurship.

· In conducting clinical trials, standardization, validation, packaging and commercialization of biotechnology research results in India. Biotechnology Consortium of India Limited (BCIL) has been specifically set up for this purpose. STIOs, for example Dr Anand Chakravarty, have already joined hands in this area.

· Biotechnology incubators have already been set up in India. STIOs can come to these incubators as also cooperate in establishing new incubators.

· Biotechnology, though critical for the nation's development, requires heavy investments. India welcomes foreign investments in this area. A Fast Track Committee for Foreign Investments in Biotechnology has been set up for this purpose.

Dr Kota Harinarayana, Vice-Chancellor, University of Hyderabad

The University of Hyderabad, a premier institution of postgraduate teaching and research in the country, enjoys the status of "University with Potential for Excellence" given to it by the University Grants Commission. With its research output rated in the "High Output-High Impact" category, the University has embarked on a number of initiatives in interdisciplinary areas such as establishment of Modelling, Simulation & Design Centre, Nano Science & Technology, Bioinformatics, etc. and has also formulated new courses in these areas to train students.

The University would like the support of STIOs in their initiatives in:

· Strengthening the infrastructure in the new areas of research.
· Participation in running the new courses.
· Establishing collaboration with premier universities and research labs.

Of special interest to STIOs would be the Univesity's unique programme called "Study India Programme". Run in collaboration with University of Pittsburgh, Missouri Southern State College and University of California, the programme enables students from abroad to study at the University of Hyderabad over a period varying from two weeks to a semester and get familiarized with Indian art, humanities, social issues, etc.

Prof Ravi Kulkarni, Director, Harish Chandra Research Institute of Mathematics & Mathematical Physics, Allahabad

The model of "Science Conference Centres" such as in France, Germany, etc. is an effective mechanism for cross-fertilization of ideas. Researchers from different countries come for short - and long-term stay, conduct joint research, and hold conferences, seminars and workshop. New ideas get generated, and for young scientists joining these activities, this becomes an exciting learning place.

Few such centres in India set up with participation of STIOs would go a long way in boosting the science scenario in the country. STIOs are known for their capacity and commitment to raising resources for the cause of academic pursuits. For example, resources of the order of $2.5 million were raised by STIOs for establishing a Chair of Indian Studies at Columbia Universities. It is, therefore, not unrealistic to expect similar initiatives from STIOs for the establishment of Science Conference Centres in India.

Prof R Natrajan,
Chairman, All India Council for Technical Education, New Delhi

The alumni of several Indian technical institutions have been "paying back" to their Alma - Mater in both monetary as well as non-monetary forms. They are extremely valuable stakeholders in providing feedback to the Indian system, particularly since they observed both Indian and international systems, and have also achieved success in the face of international competition.

Learning from the past experiences, it is clear that the alumni-institute relationship requires careful nurturing and mentoring. It is important for the institutions in India to keep in continuous touch with their alumni. Achievements should be shared so that each party feels proud of the relationship and thereby enhances its own status. There are naturally mutual expectations from the relationship. Clear articulation of mutual expectations and needs is important with a commitment to fast feedback and quick responses. Reunions on golden, silver or even pearl anniversaries, e-groups, involvement of current faculty and students in alumni-institute activities, identification of champions and nodal persons to provide leadership are some of the mechanisms that got a long way in establishing purposeful and sustainable relationship.

Amongst several possibilities and opportunities that such relationships open up, one can mention the involvement of STIOs in the following activities:

- Visiting Professors to Indian universities for teaching, R&D, consultancy assistance, joint guidance or sandwich Ph.D. programmes have been successful with Germany, US etc.

- Consultancy on R&D projects.

- Joint international Conferences, Workshops, Symposia, Meetings, etc. on mutually beneficial and interesting areas.

- Internship for meritorious Indian students in international industry, and in a reciprocal fashion, similar opportunities for international students in Indian industry.

- Since a lot of Indian companies do offshore work, it would be useful to establish linkages with "STIOs" abroad.

Recognizing that STIOs work in different type of organizations, government, universities, R&D labs or in business/industry, separate opportunities and strategies have to be worked out for facilitating interaction with each of these groups.

Prof Samir Brahmachari,
Director, Institute of Genomics and Integrative Biology, New Delhi

Recognizing that Indian S&T scene has now matured and that India has laboratories and capabilities in several areas that compare with the best anywhere in the world, STIOs interaction has to be on an equal partnership basis. Both should be able to see mutually beneficial financial and commercial returns from the interaction. Participation of STIOs in creating R&D facilities as a "business model" would be useful.

In the area of human resource development, substantial investments in India and indeed in most countries are made not from the point of view of financial or commercial returns to individuals or to groups, but as a social welfare or public good measure. Therefore, it is not unreasonable to also expect substantial contributions from STIOs to the cause of human resource development in India in the spirit of philanthropy.