of scientific research in India, came up with a good suggestion: 'levy an R&D cess on industry and let the funds thus collected be managed by an independent body outside the government'. If this were to happen, paucity of funds for R&D would become a thing of the past. India could then be investing far more than 2% of GDP, suggested by Rama Rao, on R&D, as against 0.8% invested now. It also makes sense that the funds be administered by a non-governmental agency. Subramaniam suggested the formation of a national level corporation and several regional corporations for R&D, in which research laboratories, universities and industry could be partners. Such partnerships would ensure greater synergy and focus the country's R&D to problems of immediate relevance. One other suggestion was to establish a few commissions such as the Atomic Energy and Space Commissions, both of which have delivered the goods to a certain extent. But Raja Ramanna warned that some commissions, such as the Electronics Commission, had failed badly.

That most of the people who attended the meet stayed for all the sessions shows how much regard they have for Subramaniam. He has played an important role in shaping scientific research in India. During his tenure as Minister for Agriculture we had the Green Revolution and during his tenure as Minister for Science and Technology the NCST came into being, which was later transformed into a full-fledged Department of Science and Technology. He had also contributed to the growth of DRDO when he was holding the Defence portfolio and was responsible for the introduction of remote sensing in India. Now at 90, he is keen to see that in the knowledge millennium science and technology should serve India well and should address and solve many of the problems that continue to plague the country.

What is the probability of the recommendations of the conference being translated into policy and action? This was essentially a meeting of scientists and science policy makers within the scientific community, with active participation of the secretaries of the Department of Scientific & Industrial Research and Department of Biotechnology, the Director General of the Indian Council of Medical Research, the Chairman of the Space Commission, and the Chairman of the Atomic Energy Regulatory Board, apart from some very distinguished scientists. The secretary of the DST was to have attended but could not make it. But decisions on some of the recommendations have to be taken by the Government and the Parliament. In matters such as these, one's ability to strike a favourable deal with the individuals and institutions that can translate recommendations into policy and results is as important as having the ability to come up with the right recommendations in the first place. Luckily for us, science has not been unduly affected by party politics. Let us hope whichever party forms the government after the forthcoming election will pay heed to the recommendations of the summit.

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# Science Summit* – Agenda for action

*The agenda for action which constitutes the declaration released at the end of the recently concluded Science Summit in Bangalore is reproduced below.*

*– Editors*

The Science Summit discussed a variety of crucial issues affecting science and technology (S&T) and national development. The challenges of the future are indeed formidable, demanding focused effort to meet them. We need to sharply tune our programmes in S&T to satisfy the minimum basic needs of the common man and promote sustainable development. We also need to concentrate on efforts in a few priority areas related to S&T, innovation and industrial competitiveness, where India can create a global niche. India has to become a world leader at least in a few areas of basic sciences as well as technology. In addition, we have to satisfy the crucial infrastructural needs in areas such as energy, transportation and education. Out of such pragmatic efforts would emerge an India, which is economically sound and where social justice prevails. Much of the accomplishments would become possible only if the administration and management of science and of the country are thoroughly revamped. Some of the priority recommendations of the Summit are highlighted in this agenda for action.

*Organized by the Bharatiya Vidya Bhavan at the Indian Institute of Science, Bangalore, during 7–8 August 1999, under the chairmanship of C. Subramaniam.

## Basic needs and sustainable development

A strategy for sustainable development will have to be worked out by having an integrated approach to planning, financing and management. Out of this should emerge programmes which provide not only the basic needs such as food, safe drinking water, shelter and so on, but also employment or livelihood opportunities particularly in the rural sector. All the programmes related to basic needs must clearly establish indicators of environmental, social and economic sustainability. It is necessary to form consortia of institutions in each eco-

region of the country, making use of ecoregional maps. Such consortia could include all universities, technical institutions, civil society organizations and extension and credit agencies which could provide a single window technical support system. Of the various important tasks, high priority should be assigned for providing drinking water and for attaining higher productivity per unit of land and water through eco-technologies developed by blending modern technologies, and traditional know-how. The productivity of dry-land farming of crops such as millets and pulses needs to be improved. Opportunities are available to achieve a doubling of production of pulses using technologies on the shelf.

Non-farm livelihood security has to be improved through the adoption of alternative technology-based mass consumption, such as eco-friendly building materials and construction, food processing, renewable energy, water, sanitation, etc. In order to provide the much needed focus and adequate thrust for sustainable development, a **Sustainable Technology Board** should be constituted jointly by all concerned scientific agencies. Such a Board can help to achieve synergy and convergence among all on-going programmes relating to environmental, social and economic development.

## Infrastructure requirements including education

In order to ensure that the haphazard development of infrastructure is remedied, attention has to be paid to important aspects such as reliability, professional management of infrastructure areas, promotion of environmentally sound practices, re-training of workers and managers and so on. It is necessary to work out completely new strategies for infrastructure in areas such as transportation, including air transportation, pollution-free vehicles and mass transport systems, including proper use of waterways and of the coastline.

Education must be treated as an important infrastructural element, because without a sound base in education at all levels, other sectors cannot grow in the country. It is high time that at least a few of our institutions are comparable to the best elsewhere in the world. There are many important aspects of the education sector that need immediate attention. Some of these are:

- Maintain the growth rate of literacy at about 10% per year till 2005.
- Make the school environment conducive to reduce drop-out rate and at the same time promote vocational channel training schemes after the school level.
- Proper utilization of distant education has to be made to take care of the vast demand on the educational system.
- It is high time that a flexible system of education including the semester system and continuous evaluation of students are introduced nationally at least at the level of higher education.
- Allocate 6% of GNP for education as recommended by the various national education policies announced earlier.
- There should be no dichotomy between higher education and primary education and both require equal support. The higher education (university) system has to be liberated from the archaic administrative system and governing structures.
- The infrastructure of universities for science and engineering education and research has to be improved with a sense of urgency. This would require around Rs 200 crores per annum for the next 20 years.
- The programmes and plans of the various national academic authorities such as *UGC, AICTE, NCTE,* IMC, etc. should be coordinated by a **National Board of Higher Education**.

## Critical technologies

Critical technologies that will give the country a niche and competitive edge need to be identified and fully supported. Of these, the areas of information technology and biotechnology are vital.

In information technology, we have to make full use of the new opportunities provided by combining it with the drastic reformulation and reorientation of the structures and functions of our institutions and organizations, at the same time avoiding various pitfalls which are readily recognized. The areas for immediate attention in information technology are: a vast enhancement of the information infrastructure (e.g. networking); development of high-end software capabilities; much greater emphasis on hardware development; development of cheap no-frills computers, and incorporation of local language and content in computers and internet applications, to enable all sections of society (including rural areas) to obtain the benefits of this technology. Information technology should be widely used in administration to promote transparency and efficiency of governance.

In biotechnology, there is need for greater coordination of programmes and for exploring ways of connecting the research-end to the product-end by establishing a suitable mechanism such as an **autonomous corporation**. Public concerns relating to the environmental, nutritional and social hazards associated with genetically modified organisms (GMOs) should be addressed through multi-stake holders, policy guidance and monitoring bodies capable of undertaking dispassionate benefit–risk analysis.

## Technological innovation and industrial competitiveness

Innovation and creation of wealth through innovation have to get greater recognition as important tools of development. We need to network all our knowledge pool and all our resources to facilitate invention and innovation and build formidable intellectual assets, which will give India a dominant global position. In the world of knowledge-based competition, intellectual property rights will emerge as a key strategic tool. Industrial investment on R&D will have to be increased, both quantitatively (it is around 0.7% of sales turnover today) and qualitatively (by investing not in mundane products but in emerging cutting edge technologies). However, preparedness in issues linked to intellectual property (IP) is rather poor. A stronger physical and intellectual infrastructure on IP, rigorous enforcement structure, greater public awareness (including academia and business), and new reward systems need to be set up to reap the benefits from the emerging IP paradigms. Patents will be strategic tools in the industry's competitiveness and higher levels of investments in generalizing and utilizing patent portfolios will need a thrust.

Networking of knowledge and infrastructure facilities to promote a synergistic and cooperative effort betwee

industry, educational institutions and research laboratories should assume a priority. Through proper planning and judicious support, it should be possible for India to become an R&D capital of the world by promoting not only national R&D effort but also providing opportunities for international investment for R&D to be carried out in India.

We need a dual approach, in promoting individual innovators as well as large consortia. Thus, special measures should be taken to promote 'technopreneurship' among the individual innovators. Supporting innovations by risk financing through venture capital funding can create 'Indian Silicon Valleys'. On the other hand, in the consortia approach, R&D corporations should be set up both at national and at state/regional levels, where research institutions and universities will be major share-holders and about 25% of the shares would be reserved for industries. The R&D corporations could undertake consultancy and sponsored research backed by the entire S&T community and institutions.

Equally important is a national system of innovation, of which S&T is only one component. Innovation in India's social and economic institutions, and in the system of their governance is as crucial as innovation in the products and production processes of economy. A National Innovation Policy, which invites a creative participation of every individual in nation building has to be launched. Just as we had launched a freedom movement, let us launch a second freedom movement or an innovation movement to build the new India of our dreams.

## Funding of science

Every effort should be made to increase the funding for science to about 2% of GNP in the next 4–5 years, the present funding having declined from the level of over 1% (1989) to 0.83% (1998). Investment in basic science needs to be stepped up urgently. The present level of funding of basic scientific research is around Rs 100–150 crores, which should be doubled in the next two years.

The existing mechanism of funding such as SERC of DST seems to be somewhat outdated, not only in the modalities and procedures adopted, but also in the context of the dramatic exploration of new areas of fundamental research. In order to make sure that the research funding is administered properly by paying attention to priority areas and also provide the necessary support to the entire scientific community by adopting innovative policies and programmes, a **National Science and Engineering Research Board** (NSERB), should be established, along the lines of the National Science Foundation of USA/ China. Various Government Departments and agencies as well as the industry could contribute funds to NSERB. One of the responsibilities of NSERB would be to continuously monitor the emerging frontiers of science and engineering, to bring out an annual report on national S&T indicators and to benchmark Indian S&T in the framework of global S&T.

## Attracting talent

Science and engineering is attracting little talent nowadays for research and higher studies. It is a matter of grave concern that many of the science departments at the undergraduate level are being closed down for lack of interest shown by the younger generation in science. This may lead to a crisis situation, since our very best young minds need to take up science and engineering as a career. It may not be enough if we just provide opportunities for young people to visit laboratories or to receive some training. An attractive career development programme for scientists and engineers needs to be designed and implemented. We should explore all means to attract the best students for science and engineering. It is well known that wherever suitable facilities, an intellectually stimulating environment and adequate amenities (such as an apartment) are provided, young people have always been prepared to work in India with great dedication and success. We need to recognize that it is not the physical income alone but it is the psychic income that is important for these young people.

## Management of science

Management and administrative practices employed today in our institutions are not conducive to promoting science. The bureaucratic hurdles are retarding progress in most institutions and so are political interferences. Empowering the scientific institutions by making them truly autonomous and recreating that institutional culture and ethos, where individual scientists can experience the joy and beauty of science, think in an uninhibited fashion and have opportunities to perform are essential. Systems that are responsive and caring, especially to the needs of young scientists, need to be built by overhauling the entire machinery of administration and procedures.

General administration in the government needs a major change. Generalists can no longer govern all branches of the government. This is specially so in the science department, which has to cope with exponentially expanding knowledge and respond to it. Tools of information technology have to be increasingly employed in administration to minimize drudgery and bureaucracy and increase transparency and efficiency.

## Science advisory mechanism for the Government

Ever since India got freedom, there has been a national science advisory mechanism to the Government and the Prime Minister. It is important to see that such a mechanism exists, at all times, in order to help take balanced decisions with respect to various crucial aspects of S&T as well as in areas where S&T inputs are necessary for the government to take appropriate decisions. A **Science Advisory Committee to the Cabinet** (SACC) should be established by every government in power, together with a **Cabinet Committee on S&T**. The recommendations of SACC should go directly to the Cabinet Committee on S&T for consideration and decision.

Such an advisory mechanism will enable the government to come out with a bold and visionary policy and programmes in S&T.