Lecture 29
Organization of Scientific Research in Postcolonial India

The institutionalization and professionalization of scientific research, resulting in the growth of the scientific community in India, has traversed a tumultuous turmoil since the colonial period. The struggle over the colonial science policies and economic exploitation in the areas of industry, mining, forests, etc. and decline in production in artisan-based industry like handloom, and later, after Independence, the efforts to build scientific infrastructure to develop and industrialize India present us with a continuing theme of challenges confronting the scientists in building institutions to pursue science in India.

One of the most important scientific research institutions that were set up during the colonial regime was the Asiatic Society of Bengal in 1784. The Asiatic Society, modeled after the Royal Society of London, was established to carry out historical, anthropological and sociological research on Indian history, culture and ancient texts. The researchers were mostly British administrators, who carried out research, and the Asiatic Society provided a forum for scholars to exchange their ideas and research findings. The amateurs with their Eurocentric perspectives studied the Indian society to guide their administrative practices and legal system that saw the emergence of the Geological Survey of India, the Botanical Survey of India and the Meteorological Survey of India during the colonial period. Scientific research began in universities during the mid-nineteenth century with the establishment of University of Calcutta, University of Bombay and University of Madras in 1857. The nineteenth century also witnessed the establishment of scientific institutions by Muslim intelligentsia. The Delhi College, the Aligarh Scientific Society and the Bihar Scientific Society were established by the Muslim intelligentsia. Intelligentsia drawn from different religious groups realized the significance of modern science for material and cultural transformation of India, and attempted to democratize science in their own way by establishing scientific institutions and using the local or vernacular language as the medium of democratization (Mallick 2006). The leadership of these institutions conceptualized science in a variety of dimensions, viz., science as a systematized body of knowledge, science as a method of knowing and ultimately, science as a tool to shape the future goal of India. Consequently, scientific research was organized by establishing full-fledged academic departments and laboratories in the early decades after India’s independence.

Establishment and Expansion of Scientific Institutions in Post-Independence India

By the time India achieved independence in 1947, the scientific disciplines like physics, chemistry, mathematics, geology and the biological sciences were well established in the universities. There were a few leading scientists in these disciplines who were already recognized in the international sphere. The tensions in the organization of science in India were related to the building of S&T infrastructure in the context of development and further expansion of S&T institutions, which received little attention of the colonial regime. India was rather fortunate in having the leadership of Madan Mohan Malaviya, Jawaharlal Nehru, Subhas Chandra Bose and many others who showed keen interest in the development and use of S&T for India's problems of development since the pre-independence days. The support and involvement of this political leadership of the Indian National Congress (INC) for the national science phase forged close links between science and politics in the inter-war period.

Immediately after Independence, Nehru at the Indian Science Congress in 1948 called upon scientists by observing that, 'in India there is a growing realization of this fact that the politician and the scientist should work in close co-operation'. India's science policy after 1947 as reflected by the non-formal personal relations that Nehru had with Homi Jehangir Bhabha in the Atomic Energy Establishment (AEE), Shanti Swaroop Bhatnagar and later Hussain Zaheer in the Council of Scientific and Industrial Research (CSIR), Jnan Chandra Ghosh and P.C. Mahalanobis in the Planning Commission and D.S. Kothari in the defense related area. The science-politics "nexus" under the leadership of Nehru contributed to the growth of S&T infrastructure and in assigning an important role to S&T in the political agenda. Though Nehru was instrumental in laying the foundations for planned economic development through the Five-Year Plans, India's first ever Five-Year S&T Plan (1974-1979) came into being only in 1973. Though Nehru consulted and interacted with a wide section of the Indian scientific elites, the enduring relationship these elite scientists had with Nehru was of special significance for the growth of science in certain specific directions. In fact, there existed an Advisory Committee for Coordinating Scientific Work (ACCSW), which was set up in 1948. Nehru was the Chairman and Bhatnagar was the Secretary. The ACCSW operated till 1956 when it was replaced by the Scientific Advisory Committee to the Cabinet (SACC). This Committee was also chaired by Nehru and other members included Bhabha, Kothari and others who were already close to the "power corridors".

Science Policies and Changing Culture of R&D in India

The Scientific Policy Resolution (SPR), 1958 was a culmination of the debates on the need for achieving such rapid socio-economic development. The SPR of 1958 of the Government of India illuminated clearly and concisely the relationship of science to national goals. To achieve the national goals, India had to leap-frog from a state of economic backwardness and social disabilities – attempting to achieve in a few decades a change, which has historically taken centuries in other lands, which involved innovation at all levels. There was a need for a constant interplay between the basic sciences, technology and industrial practice, if economic progress was to result from the activity undertaken.

The SPR, 1958 emphasized that the key to national prosperity lay in the effective combination of three factors, viz., technology, raw materials and capital, of which the first is perhaps the most important, since the creation and adoption of new scientific techniques can, in fact, make up for a deficiency in natural resources, and reduce the demands on capital. But, technology can only grow out of the study of science and its applications. The main objectives enshrined in the SPR, 1958 were (a) to foster, promote, and sustain, by all appropriate means, the cultivation of science, and scientific research in all its aspects – pure, applied, and educational; (b) to ensure an adequate supply, within the country, of research scientists of the highest quality, and to recognize their work as an important component of the strength of the nation; (c) to encourage, and initiate, with all possible speed, programmes for the training of scientific and technical personnel, on a scale adequate to fulfil the country's needs in science and education, agriculture and industry, and defense; (d) to ensure that the creative talent of men and women is encouraged and finds full scope in scientific activity; (e) to encourage individual initiative for the acquisition and dissemination of knowledge, and for the discovery of new knowledge, in an atmosphere of academic freedom; (f) to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge.

In a nutshell, even before India attained Independence in 1947, the political leadership in India not only realized the significance of basic and applied research as critical resources in achieving rapid economic and socio-cultural transformation but also consciously built universities and research institutes for pursuing scientific research. The political leadership in India, which was engaged in the freedom struggle during the first half of the 20th century, articulated the contours of the modern nation-state in India, and the role of modern science and technology in the process of nation building. Especially during the interwar period, the political leadership in India not only saw the need to achieve freedom from colonial rule but also recognized the need for building a blueprint for a prospective independent India. An examination of the debates on the interaction between science, technology and society during the interwar period provides insights into the process of policy-making in the post-colonial era. After achieving Independence, the Government of India, under the leadership of Jawaharlal Nehru, adopted a Socialist model of society in 1952, and the

Industrial Policy Resolution of 1956 placed public sector industrial undertakings in commanding heights in several key sectors such as iron and steel, railways, ship building, and telecommunications. Further, the government created and/or expanded some mission-mode public R&D institutions in the areas of: space, nuclear, defense; and made allocations of substantial funding to the mission-mode R&D institutions. In addition, SPR, 1958 ignored these aspects pertaining to technology, which led to the Technology Policy Statement (TPS) formulated in 1983. The basic objectives of TPS centered round the development of indigenous technology and efficient absorption and adaptation of imported technology appropriate to national priorities and resources. Expansion of the existing universities and establishment of new universities led to a steady growth of human resources in science and technology since Independence. Initially, to offset the inadequacies in technology development within India, the Government of India encouraged imports of technology and later import-substitution as important strategies for technological development.

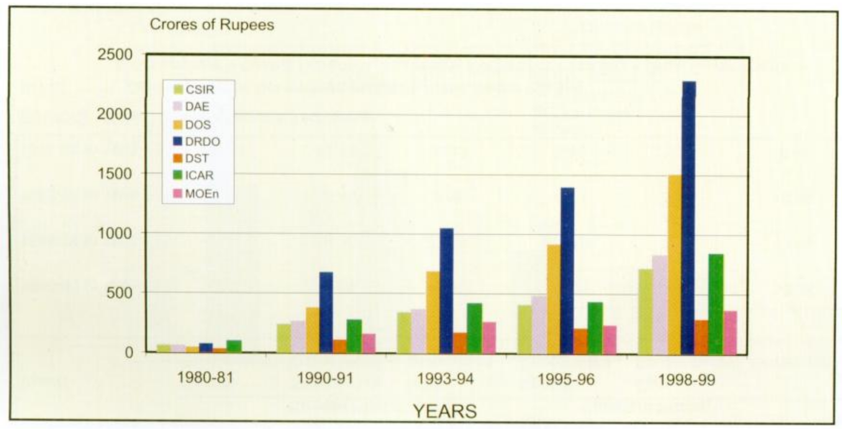
In the 1980s, under the policy of export-led growth, technology imports were further liberalized. The manufacturing industry did not have either compulsion or incentive to approach the R&D institutions like the universities and mission-oriented R&D institutions like the laboratories of CSIR for consultation and collaborative research. These policies have inhibited collaborative interaction between the industry and academia for a very long time.

The changing context of production of knowledge characterized by the advancements in knowledge in the areas such as molecular biology and biotechnology and information technology and the new institutional context of the IPRs of the WTO, policies of liberalization adopted by the Government of India in the early 1990s, have created new conditions for industry, R&D institutions and the government to come together and create productive alliances to be competitive in the globalizing world. In this context, the practice of science and its products are increasingly getting intertwined with social, economic, political, cultural, legal, ethical, institutional and ideological issues. In other words, the contexts of production of scientific knowledge, mandates, culture, meanings, values, attitudes and interests of scientific organizations seem to be changing. The context lies in the fact that “knowledge” must be transformed into technology and utilized as a vehicle for social and economic development. Scientific knowledge, which was hitherto a public resource, has become an intellectual property (Haribabu 1999). The new context influences the value system, attitudes and social action of the scientists. Thus, the crisis of science in India has both external and internal dimensions with a complex interrelation (Jairath 1984). Recently, the Government of India has come out with the Science and Technology Policy in the year 2003. The main aim of the S&T Policy of 2003 was to encourage research and innovation in areas of relevance for the economy and society, particularly by promoting close and productive interaction between private and public institutions in science and technology. The S&T Policy of 2003 intended to integrate scientific knowledge with insights from other disciplines, and to ensure the fullest involvement of scientists and technologists in national governance so that the spirit and methods of scientific inquiry permeate deeply into all areas of public policy making.

Earlier, the State was almost the sole sponsor of the scientific research in the country. The agencies of the State involved in providing research grants restricted their clientele to the scientists located in public R&D institutions. Recently, the public funding bodies have begun to support the research efforts in private sector too. Innovative mechanisms like incubators, biotech parks are supported by the State funding agencies to encourage the industry-academia-public R&D networking. In 2003, the Department of Science and Technology (DST) and the University of Hyderabad organized a brainstorming session with the heads of all the public and private sector pharmaceutical R&D institutions. The DST officials informed the gathering that the Government of India would be allocating funds amounting to Rs. 159 crore annually towards promotion of collaboration between public and private R&D establishments and the aim of the workshop was to elicit the requirements of the pharmaceutical industry in the changing context of knowledge production. The biotechnology industry seemed to be interested in having a central facility for pilot scale production which could be shared by several units. Prior to 1990s, the industry in India did not seem to be interested in collaborating with the universities to find solutions to their problems, as the industry was able to import technology from other countries. The adaptation of imported technology to achieve the goals of import substitution also led to the enhancement of indigenous technological capabilities. The industrial R&D except in a few cases largely remained a tax saving device. In the changing context, the industry has to change its mind-set and start interacting with the academia to survive. The university system continues to remain in isolation. This isolation also meant that the universities pursued their teaching and research that was not oriented towards addressing the real world R&D problems of the Indian industry. Within the academic culture in the university system, there has been a greater emphasis on publications, as the publications counted for career advancement within the university system. In addition, the government has not been able to provide a sustained support to the universities. In the early 1990s, there was a policy move towards declaring higher education a non-merit good and hence did not have to be supported by the State. As a result, there was a paucity of funds for innovative research. Further, one notices in the university system a tension between a culture of creativity and a culture of conformity. It does not imply that there should be no norms to guide the organization of research; these rules have to be more enabling rather than constraining the endeavours of the university scientists. This is reflected in the way the research funds are managed. Though the universities claim that they are autonomous, the university bureaucracy tends to conform to the norms intended to be followed by a typical government department that is involved in the implementation of policies rather than in creative endeavours. In other words, emphasis on basic research, declining support for research that resulted in poor infrastructure and the rigid bureaucratic environment of the universities have become barriers for any creative linkages with the industry.

As a result of quantitative growth of universities since Independence, today India has three hundred and fifteen universities engaged in teaching and research. However, the universities are differentiated in terms of universities funded by (a) the central government via the University Grants Commission (UGC); (b) the state governments and (c) the Ministry of Human Resource Development of the Government of India like the Indian Institutes of Technology (IITs). The differentiation also reflects a kind of stratification in terms of prestige and reputation. The university system in India is responsible for teaching at undergraduate, post-graduate courses and research. It is because of the contributions of the university system that today India has one of the largest stocks of human resources in several branches of learning including science and technology. And, today CSIR has 45 national laboratories/institutions and 13 science departments across the country like the Indian Institute of Science (IISc), Bangalore. Most of the universities remained isolated from the industry. Only a few universities, institutions of technology and national R&D laboratories of CSIR have been able to forge links with the industry over the last sixty years. Figure I and Table I provide the rapid expansion of the science base through various agencies – public and private.

Figure No. 1
Central Government Research and Development Expenditure by Selected Scientific Agencies



Source: Data Book (2004), New Delhi: Department of Science and Technology, Government of India

Table No. 1
National Expenditure on Research and Development and Related Science and Technology Activities (1998-1999)

(Crores of Rupees)

	Expenditure on		
Sector	**R&D**	**Related S&T**	**S&T**
Central Government	8055.02 (62.5)	680.15 (74.1)	8735.17 (63.2)
State Governments	1026.54 (8)	237.42 (25.9)	1263.96 (9.2)
Public Sector Industry	651.01 (5)	--	651.01 (4.7)
Private Sector Industry	2790.41 (21.6)	--	2790.41 (20.2)
Higher Education	378.56 (2.9)	--	378.56 (2.7)
Total	12901.54 (100)	917.57 (100)	13819.11 (100)

Source: Data Book (March 2004), New Delhi: Department of Science and Technology.
Note: S&T Expenditure = R&D Expenditure + Related S&T Expenditure

Table No. 2
National Expenditure on Research and Development (R&D) at Current Prices for Selected Countries

(Millions of US Dollars)

Country	**Current Prices**						
Australia	1795.2 (1981)	1918.6 (1985)	2176.5 (1986)	2483.1 (1987)	3271.2 (1988)	3972 (1990)	4750.2 (1992)	5351.7 (1994)
Canada	4783.9 (1985)	8244.2 (1990)	8000 (1991)	8510 (1992)	8795.8 (1994)	9005.8 (1995)	9211.1 (1996)	10136.6 (1999)
Japan	27126 (1981)	30233.6 (1983)	37269.6 (1985)	68007.7 (1987)	82930.7 (1988)	102231 (1991)	109248.8 (1998)	Not estimated henceforth
Germany	16970 (1981)	16652.2 (1983)	16820.3 (1985)	31853.6 (1987)	33974 (1989)	46413.2 (1993)	Not estimated henceforth	Not estimated henceforth
France	11494.4 (1981)	11788.2 (1985)	16352.9 (1986)	20190.3 (1987)	21929 (1988)	28907 (1991)	31621.6 (1994)	Not estimated henceforth
UK	11890 (1981)	9974.2 (1983)	10165.8 (1985)	12870.8 (1986)	18873.5 (1989)	20998 (1991)	20733.1 (1993)	25711.9 (1998)
US	63810 (1980)	116796 (1985)	139255 (1988)	164493 (1992)	169100 (1994)	193206 (1996)	205742 (1997)	244143 (1999)
India	1596.7 (1984)	1979.1 (1986)	2405.2 (1988)	2270.4 (1990)	1930.8 (1992)	2172.4 (1994)	2349.3 (1996)	3066.7* (1998)
Israel	680.5 (1981)	800.7 (1982)	1005.4 (1983)	772.8 (1985)	1017.1 (1989)	1152.5 (1990)	1489.7 (1992)	1940.2 (1995)
Pakistan	250 (1982)	230.7 (1983)	273 (1984)	263.7 (1985)	315.3 (1986)	320.8 (1987)	Not estimated henceforth	Not estimated henceforth

Republic of Korea	348.6 (1980)	1327.7 (1983)	1327.7 (1985)	4195.7 (1989)	4733.1 (1990)	5670.5 (1991)	6391 (1992)	9826.1 (1994)
Brazil	1150 (1978)	1459.1 (1982)	1168 (1983)	802.3 (1984)	869.4 (1985)	Not estimated henceforth	Not estimated henceforth	Not estimated henceforth
Nigeria	183 (1983)	129.9 (1984)	92.8 (1985)	45.8 (1986)	21.5 (1987)	Not estimated henceforth	Not estimated henceforth	Not estimated henceforth
Philippines	82.9 (1980)	46.3 (1983)	36.7 (1984)	75.4 (1989)	68.1 (1990)	71.6 (1991)	115.3 (1992)	Not estimated henceforth

Source: 1. Statistical Yearbook, UNESCO (2002).
2. Data Book (March 2004), New Delhi: Department of Science and Technology, Government of India
3. World Science Report 1998, UNESCO.
4. Science and Engineering Indicators, National Science Foundation.

Note: 1. Figures in brackets indicate year.

2. * The data relate to the financial year 1998-99. Source for exchange rate is Economic Survey, 2000-01.

3. Canada – data do not include humanities and social sciences; from 1975, these are only excluded from the productive sector (integrated R&D).

4. Japan – not including data humanities and social sciences in the productive sector (integrated R&D).

5. Germany – data prior to 1991 refer to FRG. For 1985 and 1987, total expenditure includes respectively 470, 615, 330 and 664 million DM for which a distribution between current and capital expenditure is not available.

Not including humanities and social sciences in the productive sector.

6. UK – for 1981, 1985 and 1989, data do not include funds for R&D performed abroad.

Not including data for humanities and social sciences, except for 1989.

7. US – not including data for law, humanities and education. Total expenditure does not include capital expenditure in the productive sector. In 1980, capital expenditure for R&D in private non-profit organizations is excluded.

8. Republic of Korea – not including Military and Defense R&D. Data for 1980 exclude law, humanities and education; from 1981, not including humanities and social sciences.

9. Brazil – not including private productive enterprises.

10. Nigeria – data relate only to 23 out of 26 national research institutes under the Federal Ministry of Science and Technology

11. Pakistan – humanities and social sciences in the higher education and general service sectors and not included. Not including Military and Defense R&D.

12. Israel – not including data for humanities and law financed by the universities current budgets.

13. Philippines – not including private non-profit organizations in 1980.

14. Available data for various years for different countries are reported.
15. Conversion of national currency into US $ is based on Statistical Yearbooks (1998), UNESCO.

Table 2 depicts the national expenditure on Research and Development (R&D) at current prices for selected countries – both developed and developing. The Council of Scientific and Industrial Research (CSIR), established in 1942, had no independent laboratories worth mentioning till Independence, but by the 1950s, a network of fifteen national laboratories in the physical, chemical, engineering and biological sciences was created chiefly due to the efforts of Bhatnagar and the support he received from Nehru. This development is known as the "Nehru-Bhatnagar effect". By 1997, there were about thirty-five national laboratories under the umbrella of CSIR involved in various S&T areas. From a small number of 100 R&D personnel in 1947, the CSIR had grown to 2,000 in the 1960s and to 6,000 in the 1980s.

Institutions and Universities engaged in Scientific Research in India

Several universities were established in the post-Independence period to train young people in various branches of knowledge including natural sciences, social sciences and humanities. Beginning in the 1960s, professional courses that drew inputs from social sciences such as the management education, mass communications and social work were initiated. On the one hand, Table 3 indicates that there has been a substantial growth in the number of universities that initiated scientific research in India. On the other, Table 4 gives us the classification of universities – central and deemed on the basis of region.

Table No. 3
Growth of Institutions engaged in Scientific Research in India

Period	Number	Percentage
19th century	9	2.8
1900-1947	22	6.9
After 1947 till date	225	71.42
Data on year of establishment could not be ascertained	59	18.73
Total	**315**	**100.0**

Source: Directory to R&D in Sociology and Social Anthropology (2005)

Table No. 4
Classification of Universities on the basis of Region

Region	Number of Central Universities	Number of Deemed Universities	Total Number of Central and Deemed Universities
North	7	27	34
East	1	5	6
West	1	14	15
South	3	20	23
North-East	6	1	7
Total	**18**	**67**	**85**

Source: Directory to R&D in Sociology and Social Anthropology (2005)

In India, the universities and industry are in the process of changing their mind-sets to gain from the collaboration thus laying the foundations of a new culture – shared values, shared research priorities and mutually acceptable norms regarding credit sharing. With a relatively large industrial base, a large stock of human resources in S&T built over the last fifty years, as mentioned above, one sees the changing R&D culture in India. The acquisition of technological capabilities has laid foundations for basic research in various industries. It should be added here that the process patent regime was an enabling institutional management that helped in making the industries achieve this. The public R&D institutions achieved successes in agriculture through the Green Revolution, Space Research and Nuclear Research. Some of the innovations occurred in the face of embargoes on technology transfer imposed by the developed countries. Networking of public sector R&D institutions and in some cases with industry resulted in innovations, which has become the hallmark of the Intellectual Property Rights (IPR) regime since mid-1990s. The transition of scientific research from being a public resource to intellectual property will be discussed in the last module.