CHANGING POLICY IN SCIENCE AND TECHNOLOGY IN INDIA

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Summary

Four S&T policy cultures—political-bureaucratic, industry-market, academic, and civic—are defined here in order to explore the institutional growth of science and technology in India during the second half of the twentieth century. Within this perspective, the article attempts to trace different phases and trends in S&T policies. Three main phases are identified—1947–1970 (optimism in "policy for the sciences"), 1970s–1990 (from optimism to critical evaluation), and after 1991 (new economic reforms, liberalization, and globalization)—and used when exploring the growth of S&T. Personalities in science and politics who have played an important part in shaping India's S&T policies during different phases are considered. Having traced the growth of S&T policies in historical terms, the article focuses on S&T policy challenges in the present era of market reforms and globalization. How are these factors influencing the research system? What institutional changes are being introduced? What are the implications concerning "science as public good" versus "science as market good"? And what are the current challenges?

1. Introduction

In India discussion of S&T policies emerged, in terms both of scholarly and policy relevant discourse, in the latter phase of the colonial period around the beginning of the twentieth century, and has clear roots in the anti-colonial struggle. Debates on the reception of modern western science in India, on modes of industrialization during the colonial phase, on the struggle to institutionalize and professionalize the Indian scientific community, and the efforts towards establishing some key universities and scientific and technological institutions between 1900 and 1947, were all rooted in the actions and S&T policy debates of the Indian scientific élite and political leaders led by Gandhi, Subhas Bose, and Nehru. Some glimpses of this discourse in the important decade before India's independence can be found in the first-ever Indian science policy journal, *Science and Culture*, launched by the eminent Indian physicist M.N. Saha in 1938 and still published today.

This is not the place to go into the details of the genesis of these studies in India, which is covered by much scholarly writing. The present essay attempts to map out a perspective of S&T policy cultures relevant to developing countries such as India in the context of the post-colonial and post-war period. After this brief survey, it explores different phases in S&T policies in India during the period between the late 1940s and the 1990s. This will examine the key actors, agencies, and institutions that have shaped India's S&T policies, key milestones in different periods, the main agendas pursued, and other issues. We will conclude by exploring current trends in the era of economic liberalism and globalization, placing them in the context of developments in the emerging knowledge industry.

2. Four Science and Technology Policy Cultures

In India more than 75 percent of total S&T funding, including gross expenditure on research and development (GERD), comes from the government. For this reason, government policies and attitudes play a crucial role in decision making regarding the development of science and technology. Despite this, other actors, agencies, and institutions contribute to the overall structure of S&T policy. Thomas Kuhn and Ruivo have drawn our attention to "phases" or "paradigms" of science policy. Different paradigms signify different models of the utilization and regulation of S&T research systems. Heterogeneous groups of actors—including politicians, scientists and engineers, academicians, diplomats, industrialists, business representatives, and opinion leaders from civil society—influence S&T policies or goals in science, collectively or otherwise, leading to different patterns of science and policy frameworks (*Science and Technology Policy*). We can identify four distinct but overlapping policy patterns as four different S&T cultures: "political-bureaucratic," "industrial-market," "academic," and "civic," as relevant to the Indian context. As Elzinga and Jamison observe, these policy cultures:

… might be thought of … coexisting within each society, competing for resources and influence, and seeking to steer science and technology in particular directions. These cultures, which stand out as representative of the dominant voices … represent different political and social interests and draw on different institutional bases and traditions for

their positions. Each policy culture has its own perceptions of policy, including doctrinal assumptions, ideological preferences, and ideals of science, and each has a different set of relationships with the holders of political and economic power.

These four policy cultures display differences in development priorities, policy instruments, ethos, and core constituencies with regard to science, technology and development issues at the national level. The categorization of these policy cultures can be taken as "universal" in the sense that they are relevant within the contexts of most individual nations. However, they are to be understood and framed here with specific reference to India. Each policy culture will be considered here briefly to this end.

2.1. Political-Bureaucratic Culture

The historical roots of this policy culture can be traced back to the centralized S&T decision-making processes established by the British colonial administration. In the post-independence period Pandit Nehru, India's first prime minister, played an important part and is credited with having forged an important alliance with the scientific élite. From the beginning, élite scientists who were heads of large science agencies like the *Atomic Energy Commission* and the *Council of Scientific and Industrial Research* were made part of the bureaucracy, as they were given positions equivalent to those of civil servants and thus came under the Public Service rules of the government.

In the post-independence period, the "tacit" alliance between this scientific élite (a form of technocracy) and the political leadership come to dominate the decision making system in India, and continues to do so to a great extent even today. This policy culture is dominated by science departments, councils, advisory bodies, committees, and science agencies, where the technocracy controls the S&T budgets and takes major decisions relating to S&T "in consultation" with the government of the day. Priorities in scientific research are set by the government and the political party in power, and the approach to decision making is generally "top-down." The core constituencies of decision making are centered around bodies such as ministries, S&T councils, and state planning regimes. Since political power ultimately rests on the democratic election process, "science as public good" may claim considerable legitimacy.

2.2. Industry-Market Culture

This policy culture is dominated by private business and market interests, and is generally represented by bodies such as the *Confederation of Indian Industry* (CII) and the *Federation of Indian Chambers and Commerce* (FICCI). It emphasizes entrepreneurship, the use of knowledge in businesses, liberal policies for technology transfer, and tariff concessions for local industrial firms. By and large market-related criteria are adopted for assigning priorities in R&D; and "science as market good" assumes considerable importance.

2.3. Academic Culture

This hardly needs much elaboration here. Much of the concern here is for maintaining

autonomy and scientific excellence. The academic community and its élite play a crucial role in setting priorities in science. The academic policy culture is grounded in what has been labeled "mode 1" of knowledge production, as opposed to a "mode 2" more open to influence by day to day challenges. This policy culture emphasizes the importance of science as a profession, and of scientific communities, a disciplinary-bound science, peer evaluation in scientific decision-making, and the importance of universities.

2.4. Civic Culture

As Elzinga and Jamison point out, "civic culture articulates its position through public interest organizations as well as through campaigns and movements, and its influence is obviously determined by the relative strength of the civil society in a country's overall political culture." In the Indian context, the civic culture in S&T is represented by various groups and movements. In the environment and ecological field, movements led by Baba Amte, Medha Patkar, S. Bahuguna, and C.P. Bhatt, among others, provide good examples. Then there are large popular science movements led by organizations such as *Kerala Shastra Sahitya Parishand* (KSSP)—an all-India movement. In different ways, the historical roots of such recent civic involvement can be traced to the efforts of M.K. Gandhi and the Gandhian-based Sarvodaya Movement, with regard to the application of science and technology for development.

3. Different Phases of S&T Policy

The S&T policy-making process and its bearing on society is best understood from a historical perspective. In the Indian context, three main overlapping phases in S&T policy making can be defined. The intensity or varying influences of the different S&T policy cultures mentioned above during these different phases are shown in Table 1.

	Main science and technology cultures			
Periods	**Political–bureaucratic**	**Industry–market**	**Academic**	**Civic**
1947–1970	Very high influence	Low influence	Moderate influence	
1970s	High influence	Low influence	-	Low influence
1980s	High influence	Low influence	-	Moderate influence
1990s	Moderate influence	High influence	-	Moderate influence

Table 1. The influence of different science and policy cultures

3.1. 1947 to 1970: Phase of Optimism in "Policy for Science"

In this phase the political-bureaucratic culture exerted a dominant influence, mainly through a science–politics alliance initiated by Nehru with scientists such as Homi

Bhabha, Shanti Swarup Bhatnagar, Mahalanobis, J.C. Ghosh, and D.S. Kothari, among others, who played an important role in drawing political support for building various science institutions and science agencies. The growth of Indian S&T in this initial phase cannot be understood without examining closely the relations between science and politics, particularly the close alliance referred to above. As early as 1947, when addressing the 34th Session of the Indian Science Congress, Nehru initiated the alliance with scientists by observing "that in India there is a growing realization of this fact that the politician and scientist should work in close cooperation." In contrast to Gandhi's critical stance towards modern science and technology, Nehru's modern, secular image and—most of all—his unquestioned support for science made him a "messiah" for the development of science in India. The scientific community in general, and its élite in particular, could immediately identify with his vision of science and development as they also found him a great promoter of their interests. Nehru once declared that:

It is science alone that can solve the problem of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running over waste, of a rich country inhabited by starving people. I do not see any way out of our vicious circle of poverty except by utilising the new sources of power which science has placed at our disposal.

(These statements by Nehru are quite well known, but their source is rarely identified. The first is from *Science Reporter*, July–August 1, Volume 1, 1964. The second is from "The Tragic Paradox of our Age," *New York Times Magazine*, September 7, 196])

This era witnessed a great deal of optimism about science and development. The Manifesto of the Congress Party for the first national government in 1945 declared:

Science, in its instrumental fields of activity, has played an ever increasing part in influencing and moulding human life and will do so in even greater measure in the future … Industrial, agricultural and cultural advance, as well as national defence, depend on it. Scientific research is, therefore, a basic and essential activity of the state and should be organized and encouraged on the widest scale.

This period reflects a phase of "policy for science," during which the main emphasis was on creating a basic infrastructure for S&T in the country, including the expansion of the university sector to supply the necessary human resources. It was during this period that India's finest five Indian Institutes of Technology were planned. Infrastructure development in S&T also included substantial efforts towards building what may be termed the techno-industrial capacity of engineering, consulting, design, and development organizations. There were 42 such organizations by 1970 in the private sector and eight in the public sector. These institutions were to promote partnership between science and technology in the processes of capital goods industries; absorption of imported technology into areas such as power, chemicals, and metallurgy; and to complete turnkey processing, plant design and engineering, and erection and commissioning of plants in the major sectors of S&T.

Major mission-oriented science agencies such as DAE and CSIR, DRDO were either established or rapidly expanded during this phase. Pre-independence Indian science was

focused on universities, but the post-independence expansion of science under the auspices of the government emphasized these science agencies. The postwar "science push" and "pipeline innovation" models triggered considerable optimism in the organization of science institutions in various sectors, from atomic energy to industrial research. Nehru and eminent scientists like Homi Bhabha, who is regarded as the father of India's atomic energy programme, were instrumental in getting the first-ever official Scientific Policy Resolution (SPR) passed in the Indian Parliament in 1958. This document is still an important landmark, since it has repeatedly been used to justify the funding and expansion of the S&T institutional base.

One of the notable features of the science–politics alliance of the Nehru era was that the growth and nature of the S&T institutions in different sectors was influenced by the interests of the élite scientists who were close to Nehru. These people included S.S. Bhatnagar in CSIR, Homi Bhabha in Atomic Energy, J.C. Ghosh and P.C. Mahalanobis in the Planning Commission, and D.S. Khothari in the Defence Related Organisation. In other words, the form adopted by the "policy for science" may be viewed as an informal science policy determined by the alliance.

Although Nehru was instrumental in setting out a scheme for planned economic development articulated through national Five Year Plans, and despite the fact that Nehru was one of the founders of India's Planning Commission, India's first ever Five Year S&T Plan (1974–9) only came into being in 1973. Close study of its origins shows that despite the presence of the advisory bodies created in this period, drawing scientists from various organizations and agencies, only a very small number of élite scientists close to the political leadership wielded real power during Nehru's era and that of Mrs Gandhi, extending into the early 1980s.

Even though Nehru consulted with a wide section of the scientific intelligentsia, the science-politics alliance of the Nehru era led S&T growth into very "specific" directions. CSIR had no laboratories worth mentioning in 1947, but by the 1950s S.S. Bhatnagar was able to establish a network of fifteen. The world-famous physicist C.V. Raman called this the "Nehru–Bhatnagar effect." This had a parallel in the Atomic Energy Agency, with Homi Bhabha as its head. Bhabha eventually convince Nehru to set up the Department of Atomic Energy headquarters in Bombay, where he (Bhaba) wanted it.

Thus, for about two decades after independence, the real expansion of S&T infrastructure took place in CSIR, DAE, and defense-related establishments. As Parthasarathi rightly pointed out in the early 1970s:

It is perhaps not surprising to find that decisions regarding the allocation of scientific resources, for example, have been taken not on the basis of the advice tendered to the political leadership by either of these bodies [the Science Advisory Body to the Cabinet and the Planning Commission], but as result of informal and tacit interactions between concerned individuals in the scientific community, the executive and the polity. Even today, decisions about defense, public health, atomic energy, industrial research and even agricultural research are apparently being taken almost independent of the formal national science policy.

With hindsight, the structure of Indian S&T institutional growth reflects the way in which agriculture and medical research were two important fields that witnessed only marginal development till the late 1960s. The close alliance between Nehru and élite scientists in industrial research and atomic energy had consequences for work in other areas. It is not surprising that the "grand old" agriculture scientist B.P. Pal lamented in 1977:

… how much the application of science to agriculture might have advanced if Nehru had been directly associated with Indian Council of Agriculture Research (ICAR) in the way in which he was associated with the CSIR and DAE. It is a pity that when these modern scientific organisations were set up, the older ICAR was not drastically reorganised on similar lines

Historically speaking, the university sector also suffered from this science–politics nexus, through a relative stagnation in the allocation of R&D funds. Though higher education witnessed considerable expansion, the locus of R&D was somehow restricted to the mission-oriented science agencies. By rough estimates the university component of R&D budget as a percentage of total R&D expenditure remained less than 10 percent from the 1960s to the 1990s. One reason for the domination of the mission-oriented science agencies (such as DAE and CSIR, among others) was that they were represented by élite scientists close to the political establishment, a tradition that continues today. The academic community did not come to play a major part in S&T policy issues.

Implicit in the "policy for science" perspective that was adopted was the view that most problems inherent in scientific development could be tackled once the infrastructure for research and development had been created, personnel trained, and a set of institutions and universities established. This phase of the policy discourse saw unbridled optimism from Nehru and élite scientists.

Furthermore, creating a base in science was seen as crucial for absorbing and eventually replacing foreign technology, as well as for generating new capacities in technological innovation for the industrial development of the country. While the government ethos reflected a "top-down" model of operation, the S&T policy adopted by the political-bureaucratic regime pushed ahead strongly with policies of import substitution and self reliance. The other three S&T policy cultures did not have any major part to play in setting science and development goal direction during this phase (Table 2).

1983	Technology Policy Statement issued
1984	Computer Policy
1985	Textile Policy
	Electronics Policy
	Setting up of Centre for the Development of Telematics
1987	Technology Information Forecasting and Assessment Council (TIFAC) created under the Department of Science and Technology
	Technology Missions launched in water, telecommunications, oil-seeds, etc.

1991	New Industrial Policy Statement issued
	New Industrial Policy for Small Scale Sector
	Liberal policies on MNCs and FDI
	Automatic permission to import technology up to R10 million
1992	National Policy on Education, 1986 (modified)
	New Fertiliser Pricing Policy
1995	New reforms in CSIR and other science agencies
1996	Setting up of the autonomous Technology Development Board to assist firms in the commercialization of technology from the national laboratories
1998	Phokran Nuclear Explosion II; launching of indigenous space satellites
	USA making S&T collaboration with several Indian R&D institutions
	India developing new models of super computers
	Five-year tax holiday for commercial R&D companies
	Excise duty waiver for three years on goods produced based on indigenously developed technology and patented in any of the European countries
	Income tax relief on R&D expenditure
1999	New Patents Policy confirming to WTO
	Exclusive marketing rights for five years to companies as part of WTO
2000	Information Technology Bill
	Creation of a new Ministry of Information Technology
	Introduction of Protection of Plant Varieties and Farmer's Rights Bill in Parliament

Table 2. Major S&T policy-related developments in India since the 1980s

Though Gandhian values and the sarvodaya model promoting the rural and agricultural sector had considerable influence in the 1940s, the death of Gandhi in 1948 did not have any major influence on developmental policies. The institutions involved in rural development which were inspired by the Gandhian values continued to function, but had no major influence on the political–bureaucratic policy regime.

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Dr. Krishna holds a Ph.D. in Sociology of Science from the University of Wollongong, New South Wales, Australia. He has over 24 years' research experience in the sociology of science, science and technology policy studies, and social history of science. He has published 30 research papers and four books including *Scientific Communities in the Developing Countries* (1997, New Delhi: Sage) and *Science and Technology in a Developing World* (1997: The Netherlands: Kluwer). He is the founder-editor of *Science, Technology & Society—An International Journal Devoted to the Developing World*, published through Sage Publications. Dr. Krishna is a consultant to UNESCO, Paris, for its programmes on electronic publishing in the developing countries and its World Science Reports 1998 and 2000. He is a Council Member of the Society for Social Studies of Science (4S), USA and a member of the International Council for Science Policy Studies, ICSU, UNESCO, Paris.