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им. С. И. ВАВИЛОВА

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НАУКА, ТЕХНОЛОГИИ И СОЦИАЛЬНЫЕ ПРОЦЕССЫ В ИНДИИ: СОЦИОЛОГИЧЕСКИЕ ДИСКУРСЫ

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SCIENCE, TECHNOLOGY AND SOCIAL PROCESSES IN INDIA: SOCIOLOGICAL DISCOURSES

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Sociological Discourses

SCIENCE, TECHNOLOGY AND SOCIAL PROCESSES IN INDIA: SOCIOLOGICAL DISCOURSES

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Introducing the special issue

A sociological understanding of the rise and growth of modern science and technology in India could be attempted through the articulation of the phenomenon through a structural and a process approach. The structural approach and the process approach are not dichotomous, rather are complementary to each other. If the structural features determine the social processes, in return the social processes influence the structural features of the society in the long run.

Modern Science and Technology in India is enshrined in the state. It is not merely funded by the state, it also is administered by the state. It has got its legitimacy from the state and it also in return offers legitimacy to the modern Indian nation state, as the dominant form of knowledge system. Therefore, today it is state science and technology and hence it rules as part of the system of state political domination and state control over other forms of scientific and technical knowledge systems that are tradition based and community based (socio-culturally embedded).

The structural aspects of Indian science and technology could be perceived in the form of rise of university based science and technology (rooted in pre-independent India) and national institutes and national laboratory based science and technology in India (post-independent). This is of course inclusive of the rise of industrial R&D centers in Indian Industries through Government policies and programmes. This structural perception of Indian science and technology is marked by the institutional inequalities existent in terms of infrastructure and research productivity in the Centres/institutes of national importance and some centrally funded elite universities vis-à-vis poorly funded and staffed state universities and institutes of research. It not only brings into fore front the issue of unevenly existent infrastructure but also the uneven quality of research manpower existent in these institutions.

This subsequently hints at their widely uneven rate of productivity and quality of research and developmental works.

The other structural perception of Indian science and technology refer to the heavily funded research in science and technology in the areas of nuclear research, defence research and space research; but these have stayed beyond the purview of socio-economic/policy studies. Hence keeping aside these, the structural perception of science and technology in India refers to the gross unevenness at the institutional level of research; where state supports on priority basis research in areas like civil-nuclear, electronic and telecommunications (particularly ICT), bio-technology and drugs & pharmaceuticals etc vis-a-vis research in other areas. That apart, perception of structural form science and technology at institutional level, particularly in industrial R&D, refers to the highly unequal level of productivity and quality R&D carried out by the public sector industry vis-a-vis the private sector industry. Further this perception can be extended to similar differences in R&D performances existent between large firms vs. small firms.

The alternate perception of structural forms of science and technology in India is to cut across institutions and articulate the structure through various professional and formal net-works of researchers, viz: professional societies/bodies where researchers with particular areas of specialization and believers of particular theories and methodologies converge to share their works/ideas. These professional net-works often publish their newsletters and at times their journals. Often such societies are even based on the nature of their areas of research, i. e. fundamental/applied or theoretical/experimental.

On the contrary the process approach mostly rests on critical perspectives, as it tries to articulate the rise and growth of science and technology in India through social and political processes of criticism or even through radicalism. It may even otherwise take a reformist view. These processes are abstract by nature, refer to social and political responses to the rise and growth of modern science and technology over long durations. These processes refer to the People's science movements in India, the Appropriate technology movement in India, Science popularization movements in India etc that have evolved and culminated over decades. Otherwise also the systematic application of science and technology to Indian society has long term consequences of sociological nature, viz, being instrumental to social stratification (class formation). These too could be perceived as social processes, may not be independent, but being very effective as part of larger socio-economic processes of change. Emergence of these social processes has its roots in the historical responses of Indian society to the growth of modern science and technology that has been state driven. These processes are emergent of the hiatus between dominant form of science and technology sponsored by the central political ideology of the Indian state and the traditional, cultural and popular scientific and technological practices/knowledge forms of Indian Society that reflect diversity. However these are ongoing social processes that are continuously in interaction with the structural aspects of the science and technology. These processes too contribute toward the dynamic nature of social structure. This process may push for policy actions that have structural relevance. On the contrary the structural disparities may also contribute toward the emergence of such critical processes. Here in this issue, on account of spatial constraints, I would be dealing with only the process related issues discussed above and the structural issues of Indian science and technology in a subsequent issue.

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Understanding People's Science Movement in India: From the Vantage of Social Movement Perspective

It hardly needs emphasis that People's Science Movements (PSMs) in India have been very unique and such movements are not witnessed yet elsewhere although science popularization / science communication movements were witnessed in USA, Europe and Australia. As a study of unique social phenomenon catching up our academic fascination, the paper first tried to characterize the phenomenon of PSM; second, tried to locate such a phenomenon in its socio-historical contexts. Lastly, the phenomenon is empirically studied through the analysis of five extensive case studies of various types of People's Science Movement Organizations (PSMOs) from the view point of social movement perspective, i. e. Resource mobilization theory.

Keywords: People's science movements, Resource mobilizations, Civil society, Intellectual resources, Financial resources, Organizational resources, External Linkages, Ideology.

Introduction

Sociologically speaking the movement is a collective effort in a particular direction to bring change of desired type. Hence, a movement is what *moves* people toward their desired goals. PSM is people moving to achieve their objectives through science (Varma, 2001: 4796–4802). PSM seeks to bring social changes with the help of science. All People's science movements are some kind of social movements. A social movement is one form of collective behaviour in which large number of people are organized to support or bring about or resist change. Thus social movement can be seen as a collective mobilization, seeking change of structure, either through institutional or non-institutional means. The culmination of such movements is often the results of the rise and growth of interest groups, pressure groups, and influencing bodies, opportunity structures etc.

PSMs are a little studied phenomenon in India although these have been in existence for several decades now. But these are seen as wider currents of a social movements. Rooted in social reformists' thinking of the 1950s, PSMs attempt to popularize non-mystical, scientific thinking, especially among India's common masses. Many PSMs have evolved into signifi-

cant centers of activism. There is variety in the shades of PSMs. These shades can be combined under three trends: (1) humanitarian — a matter of personal conscience, without any social rationalization; (2) nationalist — an urge to contribute to the development of the national personality, coupled with realization which requires development of the economic conditions and the creativity of the broad masses of the people with whom, science and technology (S&T) must link directly; and (3) radical — an urge to contribute to the liberation of masses from social oppression as well as exploitation and through this to the release of a creative mass energy, a task mobilization which needs intellectual input and a scientization of mass culture. A mixture of these three trends generates a variety of people's science initiatives:

(a) Frontier challenges: going to the people and enquiring what their material needs are, and applying scientific and technological knowledge to meet them at costs within the means of a greater number of people;

(b) Knowledge transfer: mass education in S&T;

(c) Stimulating mass creativity: working together with the masses to devise 'appropriate technology', in the process stimulating technological creativity of the masses;

(d) Technology as a tool in political struggle: devising technology to serve as a tool in the political struggle of the exploited masses against their exploiters, more 'self-reliant' technology from the point of view of the poor, through which they may have greater control over the production of process;

(e) Conscientization: seeking to raise the capacity of the poor to analyze their environment scientifically and bringing to them scientific knowledge of wider reality to help them take appropriate courses of action for social change in their favour (Rahman, 1970).

The first three varieties are consistent with the first two trends, i. e. humanitarian and nationalist. The third of these may not be inconsistent with the radical trend and may be seen to overlap with the fourth. The fourth and fifth are explicitly radical. However, the 'conscientization' in improperly motivated hands can be reactionary or reformist aimed at preserving or marginally improving, the societal status quo.

PSMs have been widespread in India at the regional and national level since 1960s. They make an important group among Indian science movements. Indian science movements denote to all the science movements (e. g. anti science movement etc) which have emerged in response to modern S&T. However, it can be seen that the idea of PSM is evolved historically under the initiative of certain voluntary science groups. Many of these groups have multi pronged activities in areas including education, development, environment, health, science popularization, appropriate technology etc. The present study uses the term PSM in this strict sense.

PSM's critical role has been felt/recognized through the symbolic value of science. By accepting the symbolic value of science as its major political value, PSM demands for the dissemination of the scientific temper among the masses as a pre-condition for social transformation. On the other hand, these also demand for the use of scientific information and procedures in the method of decision-making and implementation of decision by the ruling elite. They even objectively probe the social and political dimensions of scientific temper that scientists provide when they underplay the hazards of nuclear technology or the use of DDT. Therefore, whether it is in the area of science education, spreading reasons and scientific temper in society, or the critical role of science in the developmental process for creating an equal and socially just society, the changed nature of relationship of science and society can no longer be ignored. Studying PSMs would examine these issues with visions and perspectives.

Locating the PSM in a Socio-historical Context

Among various people's movements, PSM is a growing and unique movement in India. It is unique to India since it is difficult to find a similar movement in other parts of the world. Parayil (1992) calls the PSM as a 'unique social movement'. He finds that it is probably the only citizen's movement of its kind, and perhaps in the whole World. PSMs have been initiated in specific contexts, by middle class intelligentsia. Guha (1988) notes:

> "For PSMs, science has been distorted by the capitalist imperialist system and the task is to free it from these chains of domination and allow it to realize its true potential. In this sense, the PSMs are attempting to bring to fruition the ideals of the French Revolution — democracy, equality, and fraternity — that were taken out but never fully realized by the classical socialist tradition. PSMs believe that modern science and industrialization are not antithetical to each other's vision– rather, once freed from the imperatives of capitalism and militarism; science can be a major instrument in the creation of a just, egalitarian and economically prosperous society".

For PSM organizations, the human society is divided into two broad sections such as majority (have-nots) which is being continuously impoverished or facing the threat of being impoverished and a minority (haves) which is continuously getting enriched at the expense of the majority. S&T have been and still are a powerful weapon in the hands of this minority in their exploitation of the majority as well as the plunder of natural resources. And PSMs are partisans towards the majority whenever their genuine interests clash with the interests of the dominant minority.

Matthew Zachariah (1989), one of the protagonists of PSM, stresses that, economically poor and politically powerless people constitute the vast majority in most of the nations of Asia, Africa, and Latin America. Although the governments of these nations are or appear to be committed to development, their policies and actions to promote development mainly by stimulating growth in certain sectors of the economy do not necessarily improve the living standards of most poor people and indeed, create large groups of victims of development. The attempts of various Western governments, institutional agencies, national governments and non-governmental organizations (NGOs) to promote development in Asia, Africa, and Latin America during post-World War II and their acknowledged failure to do so in large measure have resulted in vigorous criticisms of their motives, approaches and actions taken.

The most persistent and valid criticisms of the attempt by most Western as well as national governments to promote development is that it ignores, except in rhetorical statements, the genuine aspirations of poor and powerless people. Three other major criticisms too follow. The national and international elites use the state to put in place where policies promote their own class interests prompting the legitimate question, i. e. development for whom? These elites do not understand the real problems people face and the contextual rationality that motivates such people to think and act in the ways they do. The elites do not value the knowledge and experience of the people on whom they impose their policies for development. This has been known as the 'top-down' approach.

The phrase 'development from below' acknowledges the validity of these criticisms and argues for a perspective focusing on the, (a) importance of confrontation and conflict in any genuine development process and (b) the necessity to make genuine, deliberate attempts to improve the living standards of poor people, attempts that cannot be too hasty or too slow.

The dominant class of the society commonly referred to as elites control and manipulate all affairs of the state. They control scientific and technological knowledge hubs, i. e. the university and research institutions, which do not have any form of social commitment. They also control all developmental superstructures. This has pushed the citizens of the state into background and ultimately into oblivion.

Of late a class of intelligentsia is emerging in the society which appears to have a deep concern about growing alienation between a minority dominant class, i. e. elites with access to knowledge, resource, power and privileges, and the majority common masses that are without access to those. Such deprivations resulted into the form of 'people's organizations' in the country. There has also taken place a remarkable spurt in consciousness of common people which largely remain unnoticed and unserved by institutional structures of society. For example, when state's corporate policies destabilized the environmental balance by polluting air, water, and soil deforestation triggered the emergence of people's movements in various parts of the country.

While the servility of the elite to western paradigm of progress and modernization gave rise to academic colonialism which produced a university system and a R&D set up that are turning out a class of scientists and professionals without social commitment, many people's organizations are coming up with commitments to disseminate scientific knowledge among the masses. Many of the PSM organizations are of this kind. It is not merely intellectual critical content but initiatives from 'intellectuals' that distinguishes PSMs from other movements. Throughout Indian history these intellectuals originated and existed away from the common people. Such intellectuals have, by and large, confined to the writings in alien language which could not empower the masses with their ideas. Post 1960s brought some intellectuals who emerged from the growth of people's movements in rural areas. These intellectuals who are equipped with the direct experiences of various problems and expressions existing in the society started contributing to spread and strengthen the PSMs in different parts of the country.

PSMs organizations present opportunities to intellectuals for interacting with people. Intellectuals also learn from the life experiences of the people. They have vast unstructured experiences. They are not capable of viewing their experiences in a structured whole and consequently unable to understand the complexity of the problems in larger social context. The intermingling and interaction of intellectuals and the common people brings an enrichment of knowledge. From intellectuals' side, this leads to the democratization of knowledge which in turn helps not only in reducing the prevailing social and economic inequality in the society, but also in achieving a better quality of life.

PSMs consist of a large number of actors including science professionals, engineers, doctors, scientists and a large number of teachers, local people and communities, and in many instances the *panchayats* (elected local governing bodies of India), across the country. The movement combines stuggle and reconstruction efforts in areas of education, literacy, environment, health, rural production, energy and local governance systems and uses various forms of struggles to resist the neoliberal policies. Whenever feasible, it collaborates with the government, but also confronts it when it finds itself in disagreement. In particular, it has experimented actively in local level people's planning methods, in collaboration with the *panchayats*, as a means of resisting the centralizing tendencies of the neoliberal paradigm (Raina, 2005: 1-32). The crux of the PSM seems to be in making scientific and technological thinking and knowledge available and relevant to the common people in terms of their everyday experience.

Genesis, Formation and Growth of People's Science Movement

The genesis of the concept of PSM in Indian context is a post-colonial phenomenon. The decisive intervention came from the *Kerala Shashtra Sahitya Parishad* (KSSP). It was formed in 1962 as a Forum of Science Writers. The Science Writers Association of India (SWAI) was another independent initiative. KSSP was confined to the language of Malayalam (a south Indian Language), while SWAI, mostly in Hindi and English. In 1966, half a dozen other organizations came into existence in Bombay (now Mumbai), initiated mainly by scientists from Bhabha Atomic Research Centre (BARC) and Tata Institute of Fundamental Research (TIFR). These organizations were also networked into a Federation of Indian Languages Science Association (FILSA) in the same year. It was founded by M. P. Parameswaran (popularly known as MP) and his associates.

As an individual, he was influenced by Soviet model for science popularization while pursuing his doctoral studies in Nuclear Engineering from the Moscow Power Institute in 1965. He saw then in Soviet Union, science being popularized in native languages. It was popularized in three areas such as Turkmenistan, Uzbekistan, and Kazakhstan. In the then Soviet Union, such idea motivated Indian scientists there to meet once a week and thought of popularising science in Indian languages. This underlying philosophy provided Parameswaran a proposal that knowledge should be available in people's language. He also realised that the then Soviet Union was an inspiration to the Indian intelligentsia, as it stood before them as the model of socialist system, in contrast with the capitalism in United States of America (USA), during cold war days. The then Soviet Union had an upper hand in S&T in comparison with USA. This raised hope among the intelligentsia all over the world to utilize modern S&T for the progress of the society.

Parameswaran with this experience from the then Soviet Union and FILSA came to provide the leadership to KSSP. It was the largest[1] among all the PSM organizations in India and had been the most active one during the late1960s to early 1990s. It was formed by the merging of three groups of intelligentsia. The first strand was the *Shastra Sahitya Samithy* (Science Literary Forum) formed in 1957 at Ottappalam, by a group of activists and science writers. The second strand was by a group of Malayalee science writers who were united in 1962 at Kozhikode. The third strand was the Malayalee scientists working in Bombay (BARC, TIFR etc) who had begun to actively consider the possibilities of producing science literature in Malayalam and hence had started the *Shastra Sahitya Parishad* in January 1966. KSSP was formally inaugurated in 1967 at Thrichur Conference and in July 1968 it was registered as a PSM organization under the Charitable Societies Act.

It is witnessed that how the small local groups of science writers and people involved in activities for the diffusion of scientific knowledge in Kerala society. As a part of KSSP's activities, several publications were brought out in order to popularize science in agreement with its objectives of science for the development of Kerala society. In the 1970s and 80s, the KSSP as an organization expanded into a mass movement[2] which devoted itself to other

[1] According to AIPSN member organization profile (2002, May), KSSP had 45,051 members. *Paschim Banga Vigyan Mancha* of West Bengal, the second largest PSM has a membership of 25,000; 16,000 in Tamil Nadu Science Forum of Tamil Nadu State, *Jan Vigyan Vedika* of Andhra Pradesh State consists of 12,000 members; 5,000 in *Karnataka Rajya Vigyan Parishad* of Karnataka State (Isaac et al., 1997).

[2] KSSP achieved the status of mass movement, "the only of its kind and perhaps the whole of Asia" in mid 1970s itself (Krishnakumar, 1977; Krishna, 1997b).

concerns, such as elementary education, health, environment, literacy, energy, development and micro planning etc. In 1973, the KSSP adopted the theme 'science for Social Revolution' (Zachariah and Sooryamoorthy, 1994: 20–27, 109) and had taken up a specific issue for intensive mobilization. Till 1978, KSSP was locating all the dissemination of science activities under the very term 'science popularization' only. But the phrase 'people's science movement' was coined by K. P. Kannan, another activist of KSSP and introduced formally, for the first time, in 1978 at the Trivandrum Convention of people's science groups. A distinction can be drawn here between science popularization and people's science movement on the basis of their nature and the role these played in the Indian context. The former is apolitical by nature and the latter is strongly political. Further, although both the types of movements emphasize on the use of scientific method, the former is more concerned about the dissemination of the content and information/facts of science whereas the latter is more concerned about the method of science and use of science as a social-political critique.

The Trivandrum convention brought all the like minded voluntary groups[3] including KSSP together under the banner of a PSM who were working in areas of the interface of science and society. Some voluntary groups were attempting to popularize the natural sciences; some were engaged in focusing attention on the irrational attitudes and policies towards such basic issues as health and sanitation; some were engaged in highlighting the adverse impact of development activities as a result of wrong application of S&T; particularly in the field of environment; a few were engaged in demonstrating innovative and interesting ways of teaching science; while quite a few were engaged in the application of local/indigenous S&T in development activities in the areas of health, non-formal education, appropriate technology, housing etc. The role and experiences of these voluntary groups in the broader socio-economic and political context of the country was discussed in the convention. The deliberations were around four general themes such as (i) formal and non-formal education, (ii) people's health movements, (iii) scientific research and technology, and (iv) the utilization of science for social revolution (Vaidyanathan et al., 1979: 57–58).

The study by Zachariah and Sooryamoorthy (1994) also highlights the Marxian foundation of the ideology of KSSP. Parayil's (1992) work points out that many of the early founders of KSSP were influenced by the writings of British scientist and historians of science like Bernal and Haldane. The KSSP's leadership recognized that the development of S&T does not take place in a vacuum but within a society. The KSSP brought back science to the everyday life of the common man who is its creator and rightful beneficiary. It inculcated a genuine scientific outlook among the masses of Kerala, believing that the only beginning of real progress and change in society is science. It believes that the progress of science is related to the development and changes of social systems. Changes in the forces of production, which occur due to the progress of S&T, leads to social change and vice versa. It argues that the social change from feudalism to capitalism removed the science from chains in Europe. The progress of science led to new inventions and knowledge production that in turn helped the ramification of capitalism. As part of these changes, science became people-oriented and the development of printing technology furthered the democratization of knowledge. Thus, the stranglehold of religion on knowledge became vulnerable and liberal thought got an upper hand in Europe. KSSP points out that all these changes in social relations led to the birth of modern science and scientific method was widely acknowledged as the prominent way of knowledge production. But this process

[3] The website of KSSP provides the list of PSMs, which are the members of AIPSN.

did not happen in India and China where the feudal system persisted. Hence, the KSSP adopted the slogan "Science for Social Revolution" in 1974. As a PSM, KSSP recognized its role and responsibility for the propagation of scientific temper and the scientific method in society to foster the social revolution which is to be made possible by political movements. The activities of the movement fall in the areas of education, environment, health and development etc using science as a weapon for social change.

A second All India Convention was organized during February 9–11, 1983, at Trivandrum, which focused on the need to define the term PSM from a national perspective. In the wake of formal and informal discussions and interactions of organizations in the convention, four areas such as health, education, environment, and use of art as a medium of communication were identified for future programme of actions as a basis for initiating a PSM in the country. This led to the recognition of two forces that the movement is opposed to. The first of these forces consist of godmen who oppress the poor socio-culturally by perpetuating supernatural and superstitious beliefs; the second force is that of capitalist development which is "impoverishing the majority while enriching the few" (Jaffrey et al., 1983: 372–376). In May 1985, the KSSP and the other science-based voluntary groups organized an all India *jatha* (procession) in memory of thousands who died at Bhopal disaster. The science-based mobilizations in the states like Karnataka, Maharashtra and Andhra Pradesh had joined with the KSSP in organizing this *jatha*. As the contacts among the various groups and organizations grew, the concept of a *Shastra Kala Jatha* (Science Art Procession) took shape. The KSSP had been organizing such *jathas* since 1980 with the involvement of local artists. The 1985 *jatha* was followed by similar programmes by other PSM organizations like, Tamil Nadu Science Forum (TNSF), the Pondichery Science Forum (PSF), and the *Gujarat Vigyan Sabha* (Gujarat Science Assembly).

Also as a people's education movement KSSP formed more than 1500 science clubs in schools under its auspices. Everywhere they conducted classes on different topics related to science, technology and society. The KSSP volunteers conducted the classes in schools and libraries. Some of the topics included in the classes are: Halley's Comet; the Solar System; the Evolution of Matter; Nature, Science and Society; People's Health; Natural Resources of Kerala and the Protection of the Environment; Fuel Conservation Techniques and Appropriate Technology. The KSSP has conducted several thousands of classes so far. Summer science camps and science talent shows involved 600,000 school children annually. "Science through Folk Art" and "Science Processions" to sensitize and educate rural people about scientifically and socially important issues were other activities that KSSP promoted. The 1988 report of the KSSP shows that it has published 372 books and monographs in English and Malayalam on various topics in S&T. It publishes four widely read periodicals, three in Malayalam and one in English. The three are: *Shastragathi* (The Progress of Science) for the common masses; *Shastrakeralam* (Scientific Kerala) for the secondary school students and youth; *Eureka* for primary school students; and the periodical in English is called as *Science for Social Revolution*. According to KSSP, its publications for children intended to inculcate scientific temper among children by urging them to ask questions and search for answers. KSSP's publications for common masses also aim at the propagation of scientific temper. In 1976, KSSP started a 'school for Technicians and Artisans' (START) to equip the artisans and technicians who lack formal education.

During 1988–1991, KSSP seriously involved in the mass literacy programme organized in Kerala. The literacy programme in Kerala had started from the experiment in 1988 at Ernakulam district under the auspices of the District Literacy Council. KSSP

actively participated in it and thus, in 1990, Ernakulam district was declared as completely literate. Kerala was declared as a totally literate state on 18th April, 1991. KSSP's contribution to the success of the programme is widely appreciated. KSSP believed that the promotion of literacy is the duty of PSMs as literacy is a prerequisite for propagating science so that it is more than mere learning of the script.

The KSSP had been an active promoter and collaborator of the social forestry programme of the state forest department from 1982 onwards. KSSP is extremely conscious of the degradation of the forests in Kerala and also about the growing shortage of timber and firewood. It had, however, serious differences of opinion about the very meaning of social forestry in the Kerala context, about species selected and about the method of implementation. The 1985–1986 Annual Report pointed out how a privately owned plantation obtained a false certificate from the State forest department certifying a cardamom plantation as a coffee plantation in order to fell trees. KSSP volunteers and others stopped the activity by publicising the deception and conducting *dharnas* (sit-ins and shouting protest slogans in the place where an alleged injustice had occurred). The Report goes on to oppose the social forestry project of the state government supported by the World Bank. KSSP also initiated its own survey. Partly on the basis of work done for the survey, KSSP published in English a 12-page critique of the government's social forestry strategy in July 1986. The document questioned the selection of trees species for the programme, especially eucalyptus and on the basis of its survey, argued for planting fruit-bearing trees that the people preferred. Using relevant statistics, it mocked the government's claims on the net return from its project as 'imaginary'.

The health related activities of the KSSP, confined mainly to organizing medical camps, had drastically shifted to the agitation against the unscientific practices in medical field as well as the campaigning for people's health. In 1982–1983, one unit published a village wall newspaper against the scourge of alcoholism. In 1983–1984, KSSP organized measles vaccination with 10,000 doses of vaccine donated by the Rotary Clubs of Kerala. It had organized several Oral Rehydration Training (ORT) camps in villages (Zachariah and Sooryamoorthy, 1994). The year 1986 was devoted to conducting classes on "People's Health". The health classes of KSSP emphasising nutrition, preventive medicine, gastrointestinal diseases, cleanliness, health habits of people and first aid etc were a regular feature of KSSP's active units. Another major undertaking of KSSP was the health survey of Kerala that succeeded in the collection and analysis of the data on the health habits and health problems of Keralites in connection with the socioeconomic conditions. As a result of the survey, the KSSP asked the government to change its present health care programmes to emphasize on a preventive health care system rather than a curative system.

In 1986–1987, KSSP produced a drug information packet (DIP) for doctors and it was the first attempt to reach medical doctors. It contained data on the harmful practices prevalent in the drug industry, banned drugs and drugs that should be banned, and essential low-cost drugs that are as effective as high-priced items. The basic philosophy behind the development of DIP was that the health care must be people-oriented and not profit-oriented. During this period, KSSP started opposing the unscientific national drug policy of Govt. of India and denounced the policy as 'anti-people'. KSSP demanded that the government should minimize the power of multinational drug companies, and the doctors associated with them, to dictate unnecessary drugs for rather simple, preventable, water-borne and other communicable diseases. They argued that the present medical education should have strong social science content too (social medicine).

The KSSP's intervention in the Silent Valley[4] issue helped it to develop a new perspective on development and raised the questions such as development for whom? What is the cost of development? Who pays for it? The Silent Valley issue further raised many questions about development and environment conservation. The debates were around the need of more energy resources and the conservation of environment. It forced KSSP to take a position and it totally changed its ideological orientation. KSSP did not believe in the existent dominant development paradigm that accelerates economic disparity and environmental destruction. It felt that proper planning is indispensable for the development.

Later on Zachariah and Sooryamoorthy (ibid) assessed the achievements and dilemmas of KSSP as a development movement. They opine that the movement proposed the development vision of self-reliance and popular participation. The study shows its involvement and immense contribution in the Total Literacy Project (TLP) 1990–1991, as a qualitative transformation in its mission. For the first time, in its history, the study contended that KSSP's considerable energy was focused on mobilizing the community to achieve a positive goal instead of mostly expanding it on opposing the goals of the state and private corporations. Majority of the members of KSSP are from middle class and it hardly attracted enough poor people to its ranks. So the stagnating membership, decreasing enthusiasm among members, the passivity of good number of units and the lack of women's involvement were the serious problems the movement faced later. Certain achievements of Kerala's development such as the high rate literacy, well developed infrastructure as well as the participation of working and middle class people in KSSP due to its emphasis on people oriented development helped it to be successful.

Zachariah and Sooryamoorthy (1994: 20–27, 109) traced the various factors behind the formation of PSMs like KSSP. They mentioned that the social services provided by the enlightened rulers of the princely States of Travancore and Cochin, the social services of western missionaries, the early social reform movements in Kerala, the nationalist movement, the socialist and trade union movement emerged in mid-1930s in Kerala, the *Sahitya Pravarthaka Sahakarana* (The Literary Workers' Co-operative Society) founded in 1945 etc made significant contributions to the widespread respect for formal education among the people. The study suggests that the absence of an ideologically unified intellectual class in Kerala created space for the existence and interaction of many ideologies as well as the peaceful coexistence of many religions. Their study revealed that the migration of Keralites to other parts of the globe and their return to Kerala with money and ideas raised the living standards in Kerala. They contended that these salient features of Kerala society made possible the emergence and growth of a movement like KSSP. Zachariah's (1989) study also pointed out that ideology plays a significant role in the PSM. Ideologies like Marxism have a great influence on the movement like KSSP. According to him, during the National Emergency rule during 1975–1977, CPI (M) activists in large numbers joined,[5] and hence it became an organization dominated by Marxist mode of thought. The study finds that KSSP asserts Marxism as the science of society. It further alleges that the embracing

[4] Silent valley is a tropical rain forest with an intense biological diversity in Palakkadu district of northern Kerala, where the State government planned to start a hydro-electric power project in 1973 and the work towards it began in 1976. In 1977, KSSP took up the issue and started mass agitation for the abandonment of the project. As a result of the mass protest, the State government in 1983 gave up the dam project as Central government withdrew the sanction for the project.

[5] Communist Parties play a substantial role in Kerala's politics.

of Marxism led to emphasize certain topics and ignore others, which affected the credibility of the movement in the long run.

It was these initiatives that enhanced the conceptualization of PSM. By the mid 1980s other organizations for the propagation of science had also emerged in different parts of the country. These voluntary organizations, through mutual interaction and sharing of ideas influenced each other and these interactions empowered and equipped them to be relevant in Indian context. KSSP continued its mobilization activities at grassroots level. Along with the KSSP, 26 other like-minded organizations came together during the same year on the eve of third anniversary of the Bhopal Gas Tragedy in October-November, 1987 to organize the *Bharat Jan Vigyan Jatha* (People's Science Caravan of India) which was sponsored by Department of Science and Technology (DST), Government of India (GOI). The *jatha* covered 500 centres in 14 states of India. Five *jathas*, of five cultural or *Kala* groups from five different regions of the country, gathered at Bhopal. Even a 2000 km procession converged at Bhopal from five different directions. The message was — science for peace, humanity, secularism and self-reliance. This was a massive attempt for the development of scientific communication to promote scientific awareness through a cultural caravan. It helped for the expansion of PSM into a network of people's science organizations across the country. The success of *Bharat Jan Vigyan Jatha* (BJVJ) was followed by the first All India People's Science Conference, which was held in Kannur in Kerala in 1988. At this conference, AIPSN, a loose coalition of people's science organizations across the country, was formed. This network is one of the leading actors of contemporary social movement sector formed by the PSMs.

Conventionally the headquarter of AIPSN resides in the Secretary's office because the organizational job is done by the Secretary of AIPSN. Currently, the AIPSN is a large federation of 40 PSM organizations from twenty states (except in Jammu and Kashmir, and a few North Eastern States) and with a total membership of over 300,000 spread throughout India. The AIPSN is a fairly extensive network. It is committed to the use of science to promote science for equitable and sustainable development. The network has a reach in 18,000 villages spread over 300 districts of the country. The organizations under this network vary from each other in terms of their size, specific and local level initiatives. These PSM organizations are not only specialized in their roles but they are also localised in some part of particular province/state. The network has brought together students, school and college teachers, scientists, professional experts, writers, workers, farmers, political activists and thinkers to a single platform. The network played the role of establishing a strong communication medium among the activists from various PSM organizations.

The basic philosophy of the PSM is to treat S&T as a means to achieve the goal of an equitable and sustainable society. The PSM organizations believe that the public needs to develop a critical understanding of S&T in order to be able to participate in the application of S&T, especially in the choice of technologies in different contexts. Given the widespread literacy, the efforts to propagate science awareness and create a scientific temper among the people should go hand-in-hand with efforts in mass literacy. In 1989, the KSSP undertook a massive literacy drive in the district of Ernakulam in collaboration with the district administration. The KSSP made use of its well-honed medium of *kala jatha* to reach out to the population. This proved to be a major success. The success led AIPSN to take up literacy as an empowerment programme in the campaign mode, for which it set up a separate organization called the *Bharat Gyan Vigyan Samiti* (Indian Organization for Learning and Science) with the primary responsibility of placing 'literacy' on the national agenda. Indeed, literacy campaigns later on formed an essential component of almost all the people's science organizations.

However, the PSM activities in India can be classified into four broad categories, like:

1. ***Science Communication and Science Education***: The basis of PSM in several states has been science communication and science education. It has been the basis for the movement in several states. It involves science teachers, working scientists and the science-qualified middle-class and students. The activities include science publications, popular science lectures, street plays and school science activities. The publication of science books, periodicals, articles in the vernacular languages was the initial and central activity. Cultural forms of communication are extensively used in the *kala jathas*. One of the sustained activities of the *Haryana Vigyan Manch* (Haryana Science Forum) has been its campaign against superstitions and myths. For children, in particular, science popularization by the PSM organizations have been through children's science festivals, children's science projects, quiz contests, science tours and children's science books. An Annual Children's Science Congress is held every year by the AIPSN shortly before the Annual Indian Science Congress. Besides, innovative science teaching methods are also propagated by some of the PSM organizations. Many of the PSM organizations are the recipients of the National Awards for Excellence in Science Communication, e. g. Pondicherry Science Forum (PSF), Tamil Nadu Science Forum (TNSF), Haryana Science Forum, the *Karnataka Rajya Vigyan Parishad* (Karnataka State Science Association), the *Madhya Pradesh Vigyan Sabha* (Madhya Pradesh Science Assembly), *Srujanika in the state of Orissa* not in Italies, the Assam Science Society, the *Paschim Banga Vigyan Manch* (West Bengal Science Forum) and the KSSP (in Kerala).

2. ***Policy Critiques especially in S&T*:** The PSM organizations allow scientists and professionals not only to critically evaluate state policies on S&T and R&D but also to study their inadequacies and propose viable alternatives. The underlying idea is that a detailed critical understanding of developmental policies may enable people's organizations to intervene in scientific decision-making. Sustained interventions in the area of S&T policy and management are required if a people-oriented science-society linkage emerges. The PSM organizations have periodically intervened in this direction through the means of advocacy and campaigns. These articulated positions of the PSM organizations have played a significant role in national debates on public policy issues like nuclear disarmament, patent laws and intellectual property rights, health and drug policies, energy and environment policies, reforms in the telecommunication and power sectors, and other policies of decentralization like that on *Panchayati Raj*. The role of a PSM organization like, Delhi Science Forum, New Delhi is a burning example of this.

3. ***Grassroots Level Development Interventions:*** This has been a major component of the PSM's initiatives through mass campaigns and discussions. By developing pilot models in literacy, health, agriculture, credit cooperatives, watershed development, local level planning programmes, promotion of small enterprises and their networking, the PSM organizations have been able to intervene effectively in the decision-making process in several instances. These campaigns serve the purpose of people's resistance to bad policies and highlight their demand for appropriate alternatives. The best illustration of this kind could be the role of BGVS.

4. ***Alternative Technology and Development*:** The PSM organizations have engaged in developing and encouraging people-oriented alternative technologies that are less capital — intensive and empower a large number of people, workers, craftsmen and artisans. Some examples of such initiatives are: wireless in local loop for telecommunications, the computer and village information software, bio-mass as replacement for cement/concrete in civil constructions, windmills and bio-mass based energy systems, organic inputs to boost agricultural

productivity, improved small-scale mechanized looms, small-scale oil presses and other food processing units, and mechanized black smithy. Roughly, once in every two years, the PSM organizations come together at the All India People's Science Congress (AIPSC) to review their actions, interact with experts, and learn from their experiences and plan ahead.

Thus, the PSMs have come a long way from merely disseminating scientific information to involving the people in advocacy, discussions, and interventions in science-related policy and developmental issues. The movement has gone from strength to strength to become a vibrant mass movement with practically every Indian State having an active people's science organization. The efforts of the PSM are becoming more relevant in contemporary Indian society as the adverse impact of liberalization and globalization is felt increasingly by the common masses and the state is gradually abdicating its responsibilities in education, employment, health and social welfare.

In India, people's science (voluntary) organizations do refuse to identify themselves under the generic banner of non-governmental organization (NGO). To them, understanding the notion of NGO requires two definitions. First, the people's definition of NGO which has certain characteristics such as: (a) normally limited membership, (b) mostly paid activists, (c) for many of them it is a livelihood, (iv) they get funding, (v) with the funding they do developmental activities, (vi) knowingly/unknowingly they are the members of agents. Second, United Nations (UN) defines a NGO which is a legally constituted organization created by private persons or organizations with no control or participation or representation of any government e.g. trade unions, and non-profits. These PSMOs do not adopt either of the definitions to be considered as NGOs. Consequently the votaries of PSMs claim that a PSM organization is the contrary to an NGO as it does not engage itself in any contractual services to any third party (even not on non-profit basis). Of course like an NGO it may does advocacy.

Rather people's science organizations prefer to call themselves as "public trusts", "activists groups", "pressure policy agencies/groups", "professional research consultancy agencies", "membership and non-membership based organizations" etc. All these come under the broad category of voluntary organizations (VOs) and based upon the act of voluntarism. The term voluntary organization encompasses a wide range of agencies, i. e. societies, co-operatives, trusts, trade unions, forums of activism etc. The voluntary organization as it stands can be defined as an organization rooted in civil society domain; that is non-profit and voluntary in nature and need to be registered under an Act such as: a society registered under the Societies Registration Act 1860; a trust registered under the Indian Trusts Act 1882; a cooperative under the Co-operative Societies Act 1904; a trade union under the Trade Union Act of 1926; and a company under section 25 of the Companies Act 1956 in order to meet the judicial requirements. To avail foreign contribution, they need to register under Foreign Contribution Regulation Act 1976. The absence of a common and concrete definition of voluntary organizations has led scholars to use other synonymous terms such as Non-Profit Organizations (NPOs), Action Groups (AGs), and Voluntary Development Organizations (VDOs) interchangeably.

Ideologies, Worldview and Discourses

Ideology is a particular type of understanding reality and a movement can not keep itself alive unless it develops its ideological frame and identity. An ideology of a movement relies on sets of ideas that explain and justify its purpose and methods. Moreover, ideology

provides legitimacy to the action programmes of a movement. The ideological underpinnings help acquire the movement acceptability and recognition among like minded organizations and even people at large in a society. It also helps to generate involvement to the cause and becomes a rallying point to assemble people to consolidate the gains of collective mobilization.

The ideology of a people's movement is very similar to the ideologies of political parties in India (although people's movements usually have no objective to capture political power). Many actions of people's movements are similar to the actions of political parties. Yet, people's movements do not directly take part in the electoral process and generally avoid overt identification with political parties for several reasons even when there is considerable overlap in membership. However, people's movement can be purely non-political. These can be subtly political or covertly political and not overtly. People's movements wish to appeal to broader segments of the population than political parties typically do. They are not limited by their appeal only to one class, one caste, one religious group or one gender group. They do not wish to be tainted by association with the 'dirty tricks' every political party inevitably indulges in sooner or later (Zachariah and Sooryamoorthy, 1994). Too close an association with political party may compromise their ability to criticise it when the party comes to power. People's movements do collaborate or cooperate with other groups, including political parties, on specific issues, to increase their strength as pressure groups, to marshal mass support and so on. These employ different action methods to accomplish their specific goals such as group study sessions, propaganda (including publications and street theatres), legal actions and massive protests. These too tend to identify and then personify an adversary in order to focus their active energy. In their actions, these will have a clear sense of the limits and possibilities of their capacity to bring about change. But it must be noted with a caveat that people's movements may in the long run become a political party depending upon its scope and mass base.

People's movements act as pressure groups against the state to accomplish their goals. Such movements may be without any overt ideological affiliation but the role these play in the process of bringing change is greatly determined by their ideologies. Contextualizing Andre Beteille's (1980) notion of ideology here one finds that to criticize a movement for having no ideology is also to say that the movement has no clear vision of a better future and hence neither the will nor the ability to construct a better society. Based on their vision of a better society, people's movements raise radical questions about the current authoritative allocation of human and financial resources to maintain or change a society. One of the constant problems in relation to the PSM ideology is whether the leadership of the movement genuinely believes in the ideology which drives the members or whether it merely uses the ideology as a tool to control and manipulate those members. This ideology is, of course, in competition with other ideologies and this creates many tensions within the movement.

Although every movement evolves its own body of ideas and goals, it is frequently under the powerful influence of already established ideologies like Gandhism and Marxism. Both Gandhism and Marxism have influenced people's science movements in India at different times. Gandhism and Marxism are two distinct, mutually contending ideologies with distinct praxis in India. They have been responding to Indian reality in the different ways. Though they are evolved within, and as response to modernity, in different ways, apparently they do not differ on the epistemology of science. Marxism holds the progressive nature of science while Gandhism argues for the development of rural technologies and utilization of it. Gandhi opposed mechanization and industrialization since it displaces labour and

exploit poor rural folk. The overall philosophy of PSM in India broadly follows the works of Marxian scholars like J. D. Bernal, J. B. S. Haldane, Joseph Needham and Hogben. The philosophy of these groups sees modern science as a tool of socio-economic transformation. They held modern science as a progressive and liberating force when freed from capitalist interests. These scholars further shaped the understanding of the role of science in society. PSMs in India were based on Gandhian notion of *seva* (service) in its formative years. However, in its formative years, KSSP, a PSM organization in India, was also influenced by J. D. Bernal's writings particularly *The Social Function of Science* (1939) and *Science in History* (1954). With a definite left leaning, the PSMs in India have emerged as one that has tried to be inclusive of people from all shades, i. e. from centre to left, and its intellectual efforts, have tried to synthesize Marxist and Gandhian thoughts.

The scientists of Bombay unit of KSSP who had spent years in the erstwhile USSR for their higher studies had immense influence in this regard. The 1970s was marked by the development of this ideology around science-society relationship. It was Marxian class analysis of society as well as historical materialism that helped the movement to define the science-society relationship. PSM is a middle-class movement because a consciousness realized among the middle class people, particularly intellectuals, for the first time resulted in the initiatives by them. PSM also has been a progressive movement since its inception. Hence AIPSN has been claiming to be an alliance of progressive forces. AIPSN does not accept the ideology of *Sangh Parivar* (right-wing ideology) of India. Consequently, AIPSN rejects the PSM organizations having a definite right-wing ideological leaning or even a centrist ideological leaning. Broadly, the activists of the PSMs are affiliated with two left-ideology based political parties such as Communist Party of India-Marxist (CPI-M) and Communist Party of India Marxist-Leninist (CPI-ML). The former holds the liberal worldview and the latter holds the radical worldview towards the science-society relationship. However, both come under one platform to bring the hope of socialism. With the emergence of Communist Party in 1957 as a major political force that championed the cause of peasantry, the struggles were further consolidated and politicised and assumed a nation-wide character.

On the one hand, PSM links science with society and studies the impact of modern science on society and vice-versa. On the other hand, it envisions a better, egalitarian society and believes that modern science can be used as a tool for the revolution to transform the social system from capitalism to socialism. It believes that science has the inherent potential to change society. S&T are developed by sharing of the experiences of the community and is the result of the generalization of the experiences. Therefore, science is the common property of humanity.

PSM and Subaltern Discourse: The subaltern discourse has unfortunately remained neglected at least by the mainstream sociology in India as well as the PSM studies, particularly. In this study, we took cognizance of this discourse and entered into paradigmatic dialogue for the dissemination of modern S&T in India. There are two distinct discourses flowing in the investigation, documentation, and dissemination of S&T in the post-independent (1947 onwards) India (Jain, 2002: 4–20). One, the 'elite' discourse of S&T that focuses high profile R&D and visibility linked to big industry, adopting the Nehruvian model of development, is shown to have emerged as a dominant stream. Two, the 'subaltern' discourse of S&T which argues that the elite discourse has always overstated the roles elites have played in building Indian nationalism compared to the role played by common people. It acknowledges the contributions made by the people (masses) on their own, independently of the elite. The principal actors of the subaltern classes and groups are consisting of the labouring population and

the intermediate strata. This discourse seeks to restore a balance by highlighting the role of the politics of people as against elite politics played in Indian history. Thus, the 'elite' and 'people' are viewed as two binary domains to constitute a structural dichotomy. Of course the elite discourse of S&T is the dominant one with state support. But although socially powerful subaltern discourse is less visible, closer to ground realities and linked to village and cottage industries, although based on the Gandhian model of development, still remains dispersed and in the fringe of the state apparatus.

The term "subaltern" is adopted from writings on the history of colonialism in India by Ranajit Guha. Subaltern discourse treats people as an autonomous domain which neither originates from elite politics nor depends on them. Therefore, the mobilizations in the domain of elite and subaltern politics achieve vertical and horizontal alliances respectively. It is admitted that given the diversity of its social composition, the ideological element in the subaltern politics is not uniform in quality and density. Thus, such diversities lead to pursuit of sectional interests, economistic diversions as well as sectarian splits which tend to undermine the horizontal alliances in this domain. Guha (1982) also clarifies that the two domains have not been sealed off from each other but often overlapped mainly because the elite discourse always tried to mobilize and integrate the subaltern discourse but primarily to fight for elite objectives. However, the subaltern masses managed to break away from the elite control and put their characteristic stamp on campaigns initiated by the elite group. The whole thrust of subaltern discourse is on reconstructing 'the other history', i. e. history of people's politics and movements and their attempts to make their own history.

Subaltern discourse in the S&T system in India consists of entities which are dispersed and connect S&T capabilities of smaller voluntary groups to undistributed and unorganized production units (Jain, 2002: 5). Entities in this discourse are embedded in culture that is sensitive to local community practices. According to subaltern discourse, the PSMs rooted in a concern for people are strong and widespread. However, by the very nature of the movement and dispersed local actions, those engaged in these movements have been concerned with establishing their accountability to the communities they work with; little time and efforts have gone into either interacting with fellow activists or with higher policy echelons. Guha (1998) finds that the discourse thus remained 'subaltern' and ignored much the same way as the colonialist and nationalist perspectives in the historiography of colonised countries had ignored the peasant revolts, popular insurgencies and complex processes in a variety of institutions and practices of evolving modernity.

Science Movements in Europe, USSR, Australia and United States

In Europe

The thirties generation of twentieth century working in the period of the Great depression and the clash of Fascism and Communism questioned the society but tended to take science as they found it. In 1930s, the increasing awareness of the social consequences of science, produced an enlargement and intensification of concerns for the same which led to the social responsibilities of science (Barber, 1953: 5, 154–155). This increased concern was more manifest among the scientists themselves; especially among the British scientists. They were facing discrimination as they were excluded from the high-level Government appointments. The politicians also did not show any interest in the social impacts of scientific research.

Therefore, it was the concern of British scientific community to raise their social status out of which shaped the Social Relations of Science (SRS) movement (Werskey, 1971: 67–83). The SRS movement of British scientists was active between 1932 to 1945. As an offshoot of this period, the Society for the Protection of Science and Learning (SPSL), London came into existence in 1933 (Zimmerman, 2006: 25–44). It became a key agency in the international effort to rescue refugee scholars. The SPSL also raised political awareness among British scientists, uniting many voices in the struggle against the Nazi assault on academic freedom. This assault produced one of the greatest challenges that confronted British science.

Paul Gary Werskey (1971) argued that the SRS movement was neither monolithic nor cohesive. Ideologically, there were two polemic groups within the movement; the Reformists and the Radicals. The former group accepted the social order as it was, but the latter believed that only a society transformed along socialist lines would be prepared to make the fullest and most humane use of scientists and their discoveries. The Reformists consisted of senior scientists some of whom were experienced political 'insiders'. The nucleus of the Radical group that emerged in the United Kingdom included natural scientists like J. D. Bernal (1901–1971), Joseph Needham (1900–1995), J. B. S. Haldane (1892–1964) and others. These natural scientists called themselves 'scientific humanists' and actually attempted to find a systematic sociology of science. The presentation by Nikolai Bukharin, Boris Hessen and other Russian delegates at the Second International Congress for the History of Science in 1931 provided a dialectical approach to the development of S&T which was a formative event for the Radicals group (Gummett & Price, 1977: 121–143). This radical nucleus attracted other prominent scientists including P. M. S. Blackett (1897–1974) and C. H. Waddington (1905–1975) and by the coming of the war, it was disseminating its viewpoint through the conferences of the Association of Scientific Workers (ASW) and its journal *The Scientific Worker*, and *The Modern Quarterly*.

The Radicals were inspired by Marxism and argued for the alliance of scientific community with those political forces who were most committed to the advancement of science for the benefit of the whole society. They exemplified the Russian scientific community and contrasted it with the scientists in Nazi Germany. It is pointed out that in Soviet Russia, unlike Nazi Germany; there was a mix of favourable and unfavourable social conditions for science (Barber, 1953). Bernal, Haldane and others repeatedly emphasized the superiority of Soviet scientific organizations, the scientific ethos of Russia's leaders, and the comparatively high status accorded scientists in Russian society. Above all, they stressed the way in which scientific resources were devoted to the solution of basic economic and social problems (Werskey, 1971). It offered an answer to accusations against the social uselessness or even harmfulness of science. This background made the Radicals aware of the importance of the organizational and institutional setting of scientific work.

The most important sociological result of the work of this group was Bernal's classic, *The Social Function of Science* (1939) which epitomised the Radical's standpoint. Bernal was the main protagonist among the Radicals. In *The Social Function of Science*, he studied the organization of scientific knowledge and its social force, and almost predicted the crucial role that science would play in post-war history. Furthermore, he argued that science was for everybody and it had a function in society. In his book, he appealed to science teachers to change science education, and to adopt a leadership role in the community when scientific issues arose. Bernal's proposal for the restructuring of science assumed that science was a value-laden activity. If used in a planned way, he contended that, it could improve the life of the people. This work led to his involvement with the ASW. During the 1930s this association became very influential.

Later in *Science in History* (1944), Bernal traced the interrelations between science and society and how they progress, by influencing each other. Bernal was a leading force in a new movement for social responsibility in science. To popularize his ideas, he built up and associated himself with social organizations among which note worty were ASW, the Division for Social and International Relations of Science (DSIRS), Intellectual Liberty, the World Federation of Scientific Workers (WFSW) and the World Peace Council (WPC). He was a founding member of the WFSW and the WPC, of which he was chairman from 1958 to 1965.

Bernal was a Marxist and considered the Marxist philosophy of dialectical materialism to be the most suitable philosophy for science. For Bernal, dialectical materialism was the most powerful intellectual current of the time. It provided the basis, not only for a revolutionary social movement, but also for the enhancement of science. It was a philosophy derived from science that brought order and perspective to science and illuminated the onward path of science. He saw dialectical materialism as a science of the sciences, a way of integrating the sciences, a way of contextualizing science in deep socio-historical perspective. He witnessed Marxist philosophy of science as a means of overcoming overspecialization and achieving the unity of sciences. His association with the British Communist Party (BCP) lasted from his student days to 1933, which was also damaging his influence on the politics of science. He was extraordinarily impressed by the attention given to science by the Soviet government and consequently became a protagonist of the USSR in the period of the Cold War. Bernal was the embodiment of the socially responsible scientist, a fine product of the immediate after-years of the Russian Revolution, where the new Soviet Marxism captured Europe's intellectuals. In his life, he sought to show how atheist ethics and socialist morality could be combined in a liberating rational humanism. The dominant idea that inspired him was a belief in the possibility to achieve human perfection with reason. He believed that science should only be neutral ethically, but that scientists themselves should be committed ethically. This is applicable to the Radicals generally.

In contrast to the Marxian inspiration of the Radicals, the premises of the Reformists were broadly Saint-Simonian (Werskey, 1971). Moreover, the Reformists were pessimistic about the systematic social control on their profession. They pointed out the total integration of scientists into the political systems in both Nazi Germany and Stalinist Soviet Union and believed that the fervent nationalism which informed scientists' attitudes in the two countries was opposed to the values of an international scientific community. Richard Gregory, who edited the journal *Nature* from 1919 to 1938, acted both as coordinator and advocate for the Reformists group. He was constantly advocating the application of scientific expertise to the whole range of national economic, technological and administrative problems. Thus, the objective of the Radicals for a comprehensive central plan was contrdictory to the decentralized functional control desired by the Reformists.

Before 1938, both Reformists and Radical groups were working through separate organizations. Reformists actively participated in the British Association for the Advancement of Science (better known as BA) and British Science Guild (BSG). On the other hand, the Radicals involved not only in the ASW and the Cambridge Scientists' Anti-War Group (CSAWG), but also in Labour and Communist parties. CSAWG was an initiative of Radicals at Cambridge, consisted of about eighty scientists and the graduate students at Cavendish Laboratory and the Biochemical Laboratory in 1933–1934 (Elzinga, 1988).

Paradoxically, in the midst of such intense political disagreements, both the factions came together in 1938 and formed the Division for the Social and International Relations of

Science (DSIRS) within the British Association in order to study the effects of the advances in science for the well-being of the community, and reciprocally, the effects of social conditions upon advancement in science. The idea for such a division originated in the Committee on Science and its Social Relations (CSSR) set up in 1937 by the International Council of Scientific Unions (ICSU). There it was decided on the logic that the kind of problems related to the social relations of science would best be handled by a division set apart from the parent body. In spite of all the ideological differences, they could work together until 1945. Most of the prominent members of SRS movement belonged to the London Dining Club, the Tots and Quots Club (Gummett and Price, 1977). These clubs were founded before the war and organized by Professor Solly Zuckerman, a sympathiser of J. D. Bernal's manifesto of 1939 for the planning of science. The Tots and Quots Club's own Penguin Special of 1940, *Scientists in War*, aimed towards the effective national utilization of science which was blocked by vested interests within the government and the scientific establishment. Both Radicals and Reformists joined their hands in the Tots and Quots club also. The shared concern of both the groups about the effective utilization of scientific expertise for the victory of Britain in the World War II was a unifying factor.

After the closure of the DSIRS, in 1950s many groups mushroomed, notable among them were WFSW, Science for Peace and the Campaign for Nuclear Disarmament were the prominent ones. The WFSW was formed in July 1946, and they started a journal, *Bulletin of the Atomic Scientists*, which was an important voice on science and politics (Elzinga, 1988: 87–113). The WFSW was broadly drawn from and consisting mostly of trade union type of affiliates. It was to provide a forum to promote the political responsibility of scientists, the international collaboration of associations of scientific workers, and to lobby for disarmament and the abolition of nuclear weapons. The scientists who were the members of WFSW tried to make clear the general public about the significance of hydrogen bomb. Their comments and warnings were widely published in the newspapers as authoritative statements by scientists in a special position to enlighten the public.

The WFSW acted as the conscience and the vehicle of social responsibility for the global scientific communities. As a result, it helped to bring about the first Pugwash meeting in 1957 (Cross & Price, 1988: 49–50, 152–159). The meeting facilitated for the emergence of the Pugwash movement. The movement got its name after its first meeting in the village called Pugwash in Canada. The movement was shaped in the wake of the declaration issued by eminent scientists like Albert Einstein (1879–1955), Bertrand Russell (1872–1970) and eight other scientists in July 1955 condemning the development of the hydrogen bomb. The objective of the movement was to foster friendship and understanding among international scientific communities in order to facilitate peace and disarmament. The Pugwash Conferences deliberated on all the aspects of the social relations of science and the social responsibilities of scientists. The Pugwash movement believed that peace is more than merely the absence of war. It encompasses issues of economics, the environment and human rights.

The British Society for Social Responsibility in Science (BSSRS) was a group established in 1969 to stimulate an awareness of the social significance of science. Members were primarily scientists and those active in academic politics. The BSSRS was concerned with the issues of; (i) scientist's individual and collective responsibilities, (ii) political, social and economic factors affecting S&T, (iii) drawing the attention of the public toward the implications and consequences of scientific development, for making an informed public. When the members of BSSRS became explicitly radical and transformative in their policies,

almost all of the scientists with established careers resigned and formed a new Council for Science and Society (CSS). For example, John Ziman, a professor of Physics, among others who resigned from BSSRS and was a founding member of the CSS. They saw their role as elite whose job was to oversee science that least it be abused. In an essay, 'The Impact of Social Responsibility of Science', Ziman writes:

> "The BSSRS people, for example, have been telling the chemical and biological warfare (CBW) boys that they were all monsters because they were using scientific knowledge — 'which is for the good of mankind' — in an evil cause, i. e. war. Now there is no clause in the *Social Contract*, the *Talmud*, the *Koran*, or the *Analects* of Confucius stating that scientific knowledge is for the good of mankind or even that scientist must be a cosmopolitan pacifist & internationalists. To this, CBW gang have had every right to reply that they love their country, that they don't propose to see their sisters die horribly of enemy anthrax, and that they will go right on with their patriotic (if unpleasant) duty (1971)."

The problems of science, like those of the legal and medical professions, are best dealt with by self-policing professional bodies. If such bodies do their jobs well, the public will be in good hands. Advocates of this position are caught between the deep conservatism of orthodox scientific colleagues and radical critiques of science and expertise.

The SRS movement had impact as well as opposition. The opposition came in 1940, when a group of conservatives inspired chiefly by Michael Polanyi (1891–1976) and John Randal Baker (1900–1984), formed the Society for Freedom in Science. The Society for Freedom in Science (SFS) devoted to the defense of 'pure science' and the absence of any form of social control of science. But Bernal believed that all science was inextricably enmeshed in social forces. The Society was formed in specific opposition to the views of Bernal and his colleagues (Barber, 1953). Both Polanyi and Baker provided a liberal alternative to the radical position of Bernal. They were more inclined to Reformists, though occasionally attacked the Reformists. The Radicals were strongly criticised by the group, for their uncritical admiration of Soviet communism and Stalinist regime. John Baker was intimately connected with the SFS and wrote bitter attacks on the radical scientists. Baker, an Oxford Biologist wrote the 'Counterblast to Bernalism'. In this remarkable attack Baker refers to "gangs of scientists being told what to discover... Let the gangsters work always in gangs... Let there be freedom, nevertheless, for those who lack the gang instinct..." (Cross & Price, 1988). Bernal's reply was:

> "It would be sheer waste of time and ink to attempt to continue a controversy on Dr. Baker's terms. But the issue itself is real enough, although it can not be seriously discussed till the caricature of it is cleared away. What science is for and how it can be best carried on, are vital questions to discuss and act on. The first question has really two distinct parts, according to whether we consider science as a social activity, part of the general complex of activities, or as the personal interests of an individual. No question arises as to whether or not science should be used for social ends. It is being used for social ends and largely for bad ends. Now what ultimate ends do we set for science *as it is the body of* the old indissoluble human trinity, goodness, truth and beauty (ibid)."

In his book *The Scientific life* (1942), Baker lists some of the aims of the SFS. The foremost among these was the preservation of academic freedom, central to Polanyi's attacks on the SRS movement. In the *Foundations of Academic Freedom* Polanyi (1947) states:

> "Academic freedom can claim to be an efficient form of organization for discovery in all fields of systematic study controlled by a tradition of intellectual discipline. The unity between personal creative passion and willingness to submit to tradition and discipline is a necessary consequence of the spiritual reality of science (Cross & Price, 1989)."

Though the Society had a stake in the disintegration of the popular front launched by the rival groups, the major reason, according to Werskey (1971), was the gradual improvement in the Government's treatment of science and scientists. Polanyi was considered to be the chief architect of the Freedom in Science Movement. It is believed that his persistent advocacy for freedom opposed the emerging SRS movement and had a profound impact on the structure of post-war science. He went to extraordinary lengths to oppose the SRS movement and thus linked it firmly with Soviet style planning, Marxism and the horrors of dialectical materialism.

Social Relations of Science (SRS) Movement in Australia

The influence of SRS movement also extended to Australian science. The small scientific community in Australia was largely composed of Oxbridge graduates and a significant number had come under the direct influence of Bernal himself. Under the influence of Bernalism, the Australian Association of Scientific Workers (AASW) was formed in 1939 by Eric Ashby at the University of Sydney. Ashby and his associates founded the AASW modelled on the radical British movement inspired by figures like Gregory and Bernal (Fawns, 1985: 166–175). The aims of the Association included the development of science for Australia and promoting science for the welfare of people through planning. Other concerns were the development of science teaching and the status of women in science. The membership of the AASW included teachers as well as academics who were interested in the development of the social and biological sciences. With the publication of *Australian Journal of Science* from Sydney in 1939 the Association was able to signal their engagement in social planning particularly in public education about science. The social relation of science was a prominent theme for the *Australian Journal of Science* to organize a national voice for scientists.

Things began to change during the 1960s to 1970s. The liberator' face of science was lost from view. The radical social movements that emerged in the United States and Europe around late 1960s out of the anti-Vietnam, anti-imperialist, ecological, feminist and student protest movements were divided over the question of science (Beckwith, 1986). These movements epistemologically broke away with positivism and scientism (Elzinga, 1988: 87–113). The radical science movement, which arose in this period, not only changed the lives of many people working in science, it also altered the course of debate over public issues involving science e. g. occupational health hazards, academic agricultural research, weapons development, socio-biology, genetics, intelligence and race.

Radical Science Movement in the United States

Initially the radical science movements offered a mostly political critique of science which did not challenge the epistemology of science. But the New Radical Science Movement (NRSM) in USA, which emerged in 1968, brought the conspicuous ideological dissent with the old movement. In 1969, several events that contributed to the formation of new the radical science movement were: First, students at universities around the country on March 4 initiated a one-day research strike against the Vietnam War, protesting the use of science to develop technologies for the war. A group of academic physicists protested

such uses of science at the meeting of the American Physical Society (APS), and out of this meeting grew the organization of Scientists and Engineers for Social and Political Action (SESPA), later to become Science for the People. Members of SESPA were then invited to make a presentation at the 1969 meeting of the American Association for the Advancement of Science (AAAS) held at Boston. The AAAS meeting catalyzed the formation of a group in the Boston area which organized a number of events and sessions, including a panel discussion called as "The Sorry State of Science". Organized mainly by science graduates and postgraduate students, this forum launched a broadside attack on the ways in which science was being used. It dealt not only with specific problems such as weapon systems, but also with fundamental flaws in the relationships among science, government, industry, and the people (Beckwith, 1986).

Second, in Europe groups of scientific workers from Rome, Naples, and Paris were attempting to democratize certain research institutes by demanding collective decision-making about scientific projects, equalisation of pay, upgrading of the education of support workers, and changing of research priorities to meet the needs of poor and oppressed people. In 1970 the radical group in Naples occupied the International Laboratory of Genetics and Biophysics for several months in an effort to win these demands.

Third, developments internal to science in the 1950s and 1960s also played a role in the generation of a new radical science movement. In the post-Sputnik era there was a tremendous influx of young people into science, and the size of the scientific community mushroomed. The new young people with ample financial support for their research challenged the hegemony of older, established scientists. The balance of power in science was shifting away from the elite few to this new generation. This situation extended beyond strictly scientific matters to a challenge for the older and more elitist ways in which scientists had dealt with social controversies in science. For instance in Wisconsin, while university faculty members testified for the use of DDT in agriculture, graduate students presented the case for the banning of DDT.

Finally, a trend in the philosophy of science was also exerting its influence. Thomas Kuhn's *The Structure of Scientific Revolutions*, published in 1962, and the subsequent publications of *Against Method* in the year 1975 by Paul Feyerabend, were challenging the classical view of objective science. In other words, they raised awareness of the non-objective factors in science. These philosophers pointed out the psychological, social, and political forces that determined the very conception and practice of science.

In 1969 all these factors combined to generate the radical science movement. The largest and most prominent group was Science for the People (SftP) of the United States in 1970s. The SftP group was composed of professors, students, workers and other concerned citizens who sought to end potential oppression brought on by pseudosciences, or by the misuse of science. This movement quickly developed characteristics which sharply separated it from the scientific activism which has preceded it, notably an anti-elitist politics. While many of the new activists were younger academic scientists, others who played an important role were students, laboratory technicians, high school science teachers, industrial scientists, computer programmers, and nurses. In accordance with their New Left Wing politics, the issues with which these groups dealt expanded into realms not treated by the earlier movements. These new activities included, scientific aid to socialist countries; technical assistance to the poorer sectors of society, including workers threatened by automation or wanting to learn about occupational hazards, farmers confronting pesticide poisoning; radical groups such as the Black Panthers dealing with community

health problems; and the combating of scientific arguments used to justify the inferior social position of women and minorities. These programs were paralleled in the newly emerging radical health movement which included such groups as the Medical Committee for Human Rights and Health PAC (Beckwith, 1986).

The theme of the radical science movement was four-fold. First, the movement was to develop an overall critique of science. For example, it expanded its focus beyond military questions and saw each issue as a manifestation of the fundamental problem of control of science under capitalism. Second, the radical science movement extended the analysis of the non-objective factors in science. In other words, the subjects scientists chose to work on, the way they carried out their research, and the conclusions or products they developed were all heavily influenced by political and social factors. Out of this analysis, "Science is not Neutral" became one of the themes of the radical science movement. Third, the movement saw science as an ideology. Finally, the radical science movement attempted for a "people's science" which no longer would serve the rich; rather to benefit the needy.

The theme of the people's science is quite relevant in the present context and it has been carried on as the radical science movement. For example, The New World Agriculture Group (NWAG), an organization comprised of academic agricultural scientists and Science for the People, sent its members to help people in Nicaragua to fight plant pests while avoiding the destructive overuse of pesticides. Thematically, the movement focused on issues where S&T were having an impact on poor and working-class people. The exposure of workers to occupational health and safety hazards attracted the attention of the radical science and health movement. Consequently, Committees on Occupational Safety and Health (COSH) groups were set up to provide the information on industrial pollutions, and other hazards to workers (ibid).

A faculty statement issued at the Massachusetts Institute of Technology (MIT) in early 1969, resulted in the founding of the Union of Concerned Scientists (UCS). This document was originally signed by 50 senior faculty members, including the heads of the biology, chemistry, and physics departments, and was later circulated to the entire faculty for endorsement. Scientists formed the organization to initiate a critical and continuing examination of governmental policy in areas where S&T are of actual potential significance and devise means for turning research applications away from the present emphasis on military technology toward the solution of pressing environmental and social needs (Founding Document: 1968 MIT Faculty Statement).[6] In other words, the statement called for greater emphasis on applying scientific research to pressing environmental and social needs rather than military programs. The UCS gradually widened its membership base. In 1992, the UCS's Conference on World Scientists' Warning to Humanity on the environment was signed by about half of the living Nobel laureates in the sciences, for a total of roughly 1,700 researchers (Sorensen, 2007: 374–375). Now the UCS is an NGO, multi-issue interest group with memberships as large as 250,000. Its membership is no more confined to MIT faculty and students alone; it is inclusive of faculty and students from all over US, concerned citizens and corporates etc. It interests now on cover issues like, Global warming, clean vehicles, clean energy, nuclear weapons and global security, food and agriculture etc.

Working to bridge a gap between scientists and the media, the Scientists' Institute for Public Information (SIPI) was established in 1963 in the United States to disseminate expert

[6] The Founding Document: 1968 MIT Faculty Statement is available on the website (URL: http://www.ucsusa.org) of Union of Concerned Scientists: Citizens and Scientists for Environmental Solutions.

information on S&T to journalists through a variety of means.[7] SIPI's best-known program was the Media Resource Service (MRS), which was founded in 1980. The MRS serves as a referral service for journalists seeking information from scientists, engineers, physicians, and policymakers. In addition to the MRS, SIPI operates the Videotape Referral Service (VRS), another free resource service which aids broadcast journalists in finding videotapes to accompany S&T related stories. The VRS also provides a list of videotapes for an annual SIPI conference called "TV News: The Cutting Edge", a meeting of scientists, television news directors, and science reporters. The activities of SIPI have focused on issues such as nuclear waste disposal, military technology and budget priorities, and human gene therapy.

Thus, the new radical science movements like SftP, UCS, and SIPI focused their attention on the abuses of science by the military-industrial complex, rather than on the biases in the content of science. Besides, the new movements provided an alternative organizational ideal — a democratic or participatory ideal — for the construction of knowledge.

The new movement also was not monolithic and at least three ideological stands were evident in it. A moderate position held by Jerome Ravetz among others criticized the old movement for its attempt to extend the scientific method to all spheres of life, for overlooking the multiple effects of S&T both beneficial and harmful, for their ecological insensitivity, and for the propagation of an idealistic picture of science. In the second group, the radical position was represented by Hillary Rose and Steven Rose. The science vs. use/abuse and science vs. ideology distinctions remains firm, in the books of Rose and Rose entitled, *Science and Society*, *The Political Economy of Science* and *The Radicalization of Science which* canvass Marxist views on science. They pointed out that the question of the abuse of science is deeply rooted in the contradictions within science itself and it is a non-neutral, ideology-laden activity. Instead of a science formed in the hierarchical, ruling class-dominated, sexist institutional arrangements, they anticipated a self-managed science which is a collective enterprise: a "science for people". The third group, the ultra leftists was represented by people like Robert M. Young and David Dickson. They proposed that science is not part of the economic base of the society, but that of the ideological superstructure, and denied the proposition of scientific knowledge as truth and technology as a tool. Dickson (1974) proposed for utopian or alternative approaches to S&T through his book *Alternative Technology and the Politics of Technical Change*. Robert M. Young popularly known as Bob Young (1977) argues that the entire scientific enterprise — theory included — is based on an ideology. To him, scientific enterprise does not reflect, therefore, in any sense just social relations.

This is how science movement is enrooted in the western societies. But the way in which it is received and systematised in other parts of the world, especially in non-western societies, still remains the primary concern of the present study. Before proceeding to our study of Indian PSMs, it is essential to have a cursory glance on the science popularization movement in the non-western, non-capitalist and non-democratic societies.

Science Popularization Movement in former Soviet Block:

In the early 19th century, imperial Russia experienced a reading and publishing revolution outside the purview of the state. With the hope of expanding the commoners' scientific horizons an enlightened publicist named Nikolai Novikov had built an entire enterprize

[7] Scientists' Institute for Public Information (SIPI) from Environmental Encyclopedia. 2005–2006, Thomson Gale, a part of the Thomson Corporation, available at URL: http://www.bookrags.com/research/scientists-institute-for-public-inf-enve-02/.

around the publications of popular scientific tracts and text books. By the late 19th century, scientific societies, the academy of sciences, popular editors and pedagogues got involved in a vast movement to popularize science throughout the then Soviet Russia. This movement was very much about the content of popular science tracts as it was the method of popularizing this material to the larger audience of commoners. That apart, during the imperial period S&T had received the patronage of the Russia emperor Peter the Great.

As expected, in the after math of 1917 Bolshevik Revolution, the science popularizers found the support of the Marxist state as a partner in spreading science among the less educated masses. This was true at-least until 1928, as during this period the pre-revolutionary editorial boards, museums, scientific societies and even individual publicist were recalled and supported to become the part of the cultural revolution of the Communist Party.

The Bolsheviks therefore wanted to particularly use the pre-revolutionary scientific elite in their mass educational campaigns. But with the unleashing of Stalin's Industrial and Cultural Revolution from 1928 onward, the science popularization movement took a different turn again. The then communist state desired the science popularization movement to coalesce with communist party's utilitarian goals and needs, i. e. to revive the industrial sector of the Russian economy. This took the form of a new Stalinist technologically oriented popularization campaign that emphasized particularly the Soviet technology and its glorification. Thus the earlier enlightened imaginative public science that had aroused the 1917 divide got transformed after the 1928 into an applied S&T for the working class. This applied S&T of Stalin regime became the symbol of Soviet pride and glory vis-a-vis the capitalist waste. More emphatically after the World War II, with the successful detonation of nuclear bomb in the central Asian Steppe in 1949 and with the lunching of Sputnik-1 in 1957, Soviet Politicians became increasingly aware of the competitive edge of Soviet technology and campaigned to politicise the Soviet scientific and technological feats keeping in mind both the domestic audience and capitalist west. In the event of launch of Sputnik-1, there was a celebration of technology in Soviet Russia then, a host of journals and newspapers (including military's Red star) published laudatory articles on Soviet Rocketry, Space flight and new Cosmonauts. Mass public spectacles and events commemorated new technologies of space age, and fitted into the paradigm of the ideological and technological race with the capitalist west during the cold war period (Andrews, 2009: 129–132). Not surprising that in the Soviet Block especially in the USSR and Poland, scientific and technological information/achievements served as an essential element of political propaganda. Since science in the Eastern Block had to show the superiority of the Real Socialist Political system over the capitalist system, science popularization was the main tool to demonstrate and prove it, may be in a vulgarized way.

When the Soviets represented the hardliners in science, the Polish represented a politically controlled liberalism in science. The post World War II science popularization in Poland is worth mentioning as it came under the so called ideological offensive in 1948. Administrative system of science popularization came into being on the model of USSR. One central institution was founded in 1950 named the Society of Universal Knowledge. But the science issues were managed conclusively by the central committee of the Polish Communist Party. The Polish Academy of Sciences, as the apex scientific body of Poland, was established in 1952 again on the model of USSR.

This was not only to determine the course of scientific research, but also to serve as the highest sate office for all the Polish universities and advanced academic studies. Of course

a certain part of the Academy's concern was diffusion of science. The major concern of the Academy was of course overwhelming scrutiny and censorship in the academic and scholarly output and hence to decide the character of books in print, articles in press, and broadcasts. After 1956 this role of the Polish Academy declined greatly. No doubt that Poland was still much more liberal compared to others in the Eastern Block. Polish scholars were allowed to interact with the West, very few scholars/scientists were dismissed, forced to work as care takers, doormen, bus and tram drivers etc; as it happened in many countries in the Eastern Block. Those scholars not allowed to work with students were allowed to do research in the Polish Academy of Sciences. Even after 1956 they were allowed to publish books and articles. With permission some of them also could travel abroad. Slowly the political situation improved, some were allowed to get back to the campus and teach. Some non-government channels gave them the opportunity to publish too. Yet there were restrictions on the scientific conduct of the scientific community.

Nevertheless popularization of science did not decline in Poland in the post World War II period. As noted by Zasztowt (2009: 139), over half of the books produced in Poland during 1944 to 1951 were connected with science and its popularization. The best known scientific publishing houses, those officially supported the state were, The Reader, Universal Knowledge, The State Institute of Educational Editions, The Co-operatives of Books (of Communist Party) and the Cooperatives of Knowledge (of Socialist Party). A few private firms like Gobethner, Wolf, Trazska, Michalski, Evert etc were also publishing then but were independent.

But in 1949 all collapsed. Of course in 1953 the state liberalized the control. Good number of scientific journals re-appeared but only those ones which stressed the value of science dissemination and those advertized and propagated the materialistic point of view. In the mid-1960s although the Party's Central Committee declared that it had no intention of interfering in specific jobs or workshops for men of letters, the Socialist Realism was declared as the preferred mode of expression. In 1964 March 33 intellectuals from universities had written to the Polish Prime Minister protesting on the issue of 'limits in rationing papers' but were reprimanded. The Soviet influence persisted. However university professors/scientists got some limited amount of freedom. Most prominent among the scholars were allowed to have their own materialistic philosophy without repercussions. Link with western capitalism was renewed slowly through scientific writings. The efforts to create a new 'homo-Sovieticus' in Poland did not succeed. However the Soviet influence continued. Yuri Gagarian and the Soviet space explorations became great success stories and dominated science fiction literature in the Eastern Block too. This too linked the Eastern Block to the West. Stanislaw Lem, a Pole and author was a pioneer as his novels like, *The Astronauts, The Magellanic Cloud, The Star Diaries, The Invasion from Aldebaran etc* had broken the barriers from both the sides of Iron curtain. In the beginning of 1970s, Poland, under a new regime opened the door to the western capitalistic and democratic ideas that infiltrated into young minds. After 1968 there was an exodus of Polish intellectuals, of course state triggered, which earned the opposition of the university milieu. University circles began their underground activities. In 1977 came into existence the so called 'Flying Universities' and the 'society for Scientific Courses' was founded. Both got connected to the committee for the Defense Workers and began programme for open lectures in the universities. Through the independent Editions (Samizdat) large number of books were published which could not be cleared by the censor in the past years. There came a flow of new crisp breeze. Those books published from outside state

controlled press (Samizdat) became very popular, of course most of these books were in popular science and social sciences. Zasztowt (2009) claims that this 'samizdat' stream idea brought huge social change in Poland as it made a section of younger generation people reminiscent of the old traditional Polish culture and hostile to the communist regime.

In the beginning of 1980s, 10 million Poles chose freedom. Very few knew that science communication was probably one of the most forgotten and hidden elements to influence this process that resulted in the collapse of the communist system.

Having said so, we are now to present five case studies (of radical shade) of PSMs in India, based on data that are empirical as well as secondary source based. The case studies are PSMOs like; All India People's Science Network (AIPSN), *Bharat Gyan Vigyan Samiti* (BGVS), *Jana Vignana Vedica* (JVV) (all based on science activism through mobilizations), Eklavya (a PSMO with nuance, having a radical science teaching method implying pedagogic revolution and alternative curricula) and Delhi Science Forum (DSF) (purely discursive movement).

Methodological note: The analyses of five case studies are based on the use of both empirical and secondary data collected from these PSMOs through extensive field visits by the researchers. Further the five case studies do make a representative sample of the radical type PSMOs in India. Of the five one is the umbrella organization of the rest four and it flexes its muscle in the civil society domain with the help of media and intellectual resources. Of the four two are activist organizations which involve in grassroots mobilizations of people for science and the third one is also a radical organization that is suggestive of pedagogic revolution and mobilizations through school science teaching and novel teachers' training programmes. Of the four the fourth one is a voluntary organization, which is a critique of Government S&T policies and engages only in discursive type mobilizations through its intellectual resources.

Before we analyze the five case studies from the vantage of Resource Mobilization Theory, it becomes almost an imperative to explicate as to why these PSMOs be treated as 'social movement organizations', as per the theoretical requirements of resource mobilization theory by McCarthy and Zald' (1977, 1212: 1241). Following are the reasons: (i) Each of these organizations has a set of specific goals to attain, (ii) Each of these organizations has its own strategies, tactics to mobilize resources be it material or immaterial, (iii) Leadership (both from inside as well as outside) played a major role in each of these organizations, (iv) Each of these organizations also have small membership and full time staff intended to speak for an aggrieved section/group without involving the group itself, and (v) Each of these organizations also possess sufficient resources to strengthen the movement and to accomplish its limited goals. Further, the large number of PSMOs (those affiliated to AIPSN and those not) do make a strong 'social movement sector', in the true sense of McCarthy and Zald (1977). And the vast domain of social movements of various kinds prevalent in contemporary Indian society like, the environmental movements, protest movements against development induced displacements, tribal movements for rights over forest land, regional identity based movements, anti-globalization movements, feminist movement, and ongoing class based movements like the Maoist/Naxal movement etc make a perfect 'social movement industry' in the sense of McCarthy and Zald (1977). Thus a perfect 'social movement industry' subsumes a true 'social movement sector' which in turn is inclusive of several 'social movement organizations'. But it is need less to drive home the point that the resource mobilization theory focuses more upon the 'social movement organizations' for analytical purposes.

Case Study. 1: All India People's Science Network (AIPSN), An Umbrella PSM Organization

It has become popular to talk about networks in social movements generally and the science movement specifically. Indeed Diani argues (1995) that it has become the rule rather than the exception to talk about social movements as networks in recent years.[8] This trend began, one could argue, with the seminal work of Gerlach and Hines (1970) on the loose, dispersed networks of social movements in the 1960s. Just after two decades, PSM in India created AIPSN, a network of organizations for science, environmental, education, health, social justice and civil rights organizations. Here in this paper we are not going to dwell upon too much on how the idea of AIPSN emerged and evolved over decades, rather we will analyze its strategies and how it made alliances as well as shared resources among diverse organizations. It thereafter discusses how networks like AIPSN created a space within the civil society; and how it advertised the movement's causes. Finally, it examines some of the difficulties in, and disparagements of AIPSN.

The Conception and early Mobilization

The idea of AIPSN can be traced back to the very early days of a conceptualization of the people's science movement in India. The decisive intervention came through a Forum of Science Writers (later known as KSSP) in 1962 followed by The Science Writers' Association of India (SWAI). KSSP was confined to the language of Malayalam (spoken in the southern state of Kerala), while SWAI was, mostly in Hindi and English. In 1966, half a dozen other organizations came into existence in Bombay (now Mumbai), initiated mainly by scientists from establishments like Bhabha Atomic Research Centre (BARC) and Tata Institute of Fundamental Research (TIFR). It was the same year, when these organizations were networked into a Federation of Indian Languages Science Association (FILSA) led by M. P. Parameswaran ("MP", as he was affectionately called by the science activists), a left-leaning nuclear engineer. The headquarters of FILSA was located in BARC. Initially, FILSA took up popularization of science by translating into various Indian languages such as Malayalam, Tamil, Kannada, Telugu, Hindi, Gujarati and Marathi. However, FILSA was active only for two years, i. e. from 1966 to1968. During its functioning period, even it didn't have a formal office and funding source. Only three workshops and half a dozen meetings held over this period. Even the then organizations under FILSA are almost dead now except *Hindi Vigyan Sabha* (Hindi Science Assembly). FILSA was the pre-formation of the present AIPSN. In a way, FILSA was the proto type of AIPSN. Therefore, these Bombay intellectuals who had pioneered FILSA and also KSSP were the 'Conscience Constitutents' (McCarthy and Zald, 1977) of this SMO called AIPSN.

By the early 1980s, number of voluntary organizations in the field of S&T communication also emerged in different parts of the country. These organizations, through their mutual interaction and cultural capital influenced each other which empowered and equipped them to be relevant in communicating science in Indian context. In May 1985, KSSP organized in collaboration with other organizations from the Indian states like Tamil Nadu,

[8] Diani's work, especially his definition of social movements as networks (1992), has certainly aided this trend in the sociological literature.

Karnataka, Andhra Pradesh, and Madhya Pradesh, an "*All India Shastra Kala Jatha*" in the memory of the innocent victims of Bhopal gas tragedy of 1984 (accidental release of huge toxic chemicals from Union Carbide factory). This *jatha* (caravan) was a resounding success. Fortified by it, KSSP along with 26 other like-minded organizations planned up a more ambitious project the *Bharat Jan Vigyan Jatha* (BJVJ: People's Science Caravan of India) during September-December, 1987 which was later supported by the India Government's Department of Science and Technology (DST). The *jatha* covered 500 places in 14 states of the then India and 5 million public in villages and small towns. Five *jathas*, with cultural (*kala*) groups from five different regions of the country, assembled in the city of Bhopal. Even a 2000 km procession converged at Bhopal from five different directions. The message was — "science for peace", "science for humanity", "science for secularism" and "science for self-reliance". This was a massive attempt for science communication in Indian context to construct a culture of science through caravan. It also helped the expansion of voluntary organizations working in S&T communication into a network of people's science organizations across the country. At that time, it was absolutely unique event and the largest experiment in science communication, ever undertaken anywhere in the world. It also was perceived as one of the greatest experiments in India's history of radical S&T. Though estimates of BJVJ's popularity are hard to gauge, it is fair to say that the *jatha* spread to both rural and urban India, and this *jatha* gave birth to a pan-Indian People's Science Movement and led to the formation of the AIPSN.

From Mobilization to Institutionalization: Formation of AIPSN

It was born in 1988, as a loose coalition of PSMOs during the first All India People's Science Conference, that took place at Kannur, Kerala. The objective behind the formation of AIPSN was to sustain the coordinated activities of all PSMOs in India and to bring together these PSMOs on a single platform. Thus it is a PSMO where several PSMOs found a point of convergence. Besides, AIPSN members include scientists, science journalists, science museum and science centre producers, academic researchers, public information officers working in scientific institutions, political activists, teachers, educators and many others interested in S&T issues. Conventionally the headquarters of AIPSN resides in the Secretary's office because the organizational business is done by the Secretary of AIPSN. Currently, the AIPSN has been linked with 26 PSMOs[9] from over twenty states (except in Jammu and Kashmir, and a few North-Eastern Indian States) and with a total membership

[9] AIPSN Members are (as per 2008 data): *Jan Vignan Vedika* (Andhra Pradesh), *Assam Gyan Vigyan Samiti* (Assam), *Bharat Gyan Vigyan Samiti* (Bihar), *Bharat Gyan Vigyan Samiti* (Haryana), *Bharat Gyan Vigyan Samiti* (Himachal Pradesh), *Gyan Vigyan Samiti* (Jharkhand), *Bharat Gyan Vigyan Samiti* (Karnataka), KSSP (Kerala), *Bharat Gyan Vigyan Samiti* (Madhya Pradesh), *Bharat Gyan Vigyan Samiti* (Maharasthra), *Bharat Gyan Vigyan Samiti* (Odisha), Pondicherry Science Forum (Pondicherry), *Bharat Gyan Vigyan Samiti* (Rajasthan), Tamil Nadu Science Forum (Tamil Nadu), *Bharat Gyan Vigyan Samiti* (Tripura), *Bharat Gyan Vigyan Samiti* (Uttaranchal), *Bharat Gyan Vigyan Samiti* (Uttar Pradesh), *Paschima Banga Vigyan Mancha* (West Bengal), Society for Technology and Development (Himachal Pradesh), *Madhya Pradesh Vigyan Sabha* (Madhya Pradesh), *Navnirmiti* (Mumbai), Assam Science Society (Assam), Federation of Medical Representatives Associations of India (Kolkata), Delhi Science Forum (Delhi), Forum of Scientists, Engineers and Technologists (Kolkata) and *Eklavay* (MP).

of over 300, 000 spread throughout India. AIPSN has a reach in 18, 000 villages spread over 300 districts of the country. National level bodies like Federation of Medical Representatives Association of India (FMRAI)[10] and Forum of Scientists, Engineers & Technologists (FOSET)[11] are also members of AIPSN. AIPSN along with the former have been campaigning for a Rational Drug Policy and access of essential medicines for Indian public and the close association with the latter towards a campaign for self-reliance of S&T in India. In totality, the birth of AIPSN is an outgrowth of a middle class movement which is closely linked to the opening of the Indian economy, first in the mid 1980s when curbs on internal capital were reduced and then in the early 1990s when foreign capital (with private corporations) was allowed to enter in India.

It organizes All India People's Science Congress (AIPSC), every two years. The biennial meetings used to bring together around 500–1000 science activists, local farmers, PSMO representatives and delegates from governments. The aims of the participants to share knowledge on S&T for sustainable development, identify new challenges, review their actions, interact with experts, and learn from each other's experiences and plan ahead. These meetings are interdisciplinary in nature. The topics of the Congress revolved around peace and science, women's empowerment, education and health, natural resources management, science and development. The primary objective of this Congress was to trigger collective thinking process for organizing a series of interactive sessions where in socially committed scientists from India's R&D institutions interact with local level institutions and meet their demands for technology, thus ensuring the well-being of the society. Thus, the intention of the Congress is to bring together for a dialogue, all those, who demand knowledge, all those who may be able to supply them and also those who can interpret such demands into the language of scientists. AIPSN also assists the National Council of Science and Technology Communications (NCSTC) of DST to organize the Annual Children's Science Congress.

AIPSN celebrated the occasion of 50th anniversary of Indian Republic in the year 2000 and focused the issue of science and self-reliance. It decided to hold five regional seminars on the issue of "Science and Self-reliance" in southern, eastern, north-eastern, northern and western regions of India. So far, there have been four regional conventions already held in Chennai (Southern), Calcutta (Eastern), Hisar (Northern), and Agartala (North-Eastern) respectively highlighting the issue of self-reliance and science in contemporary India. The AIPSN in the year 2010 stressed the need to develop an alternative trajectory of sustainable development against the neo-liberal economic policies. As the neo-liberal policies are bringing about massive inequality in the country, Amit Sen Gupta, current general-secretary of AIPSN urged scientists to fight against the 'anti-public' S&T policies. He further argued that the corporate forces have been trying to commodify science and research findings. Consequently the common public has been denied the fruits of the scientific inventions. B. Ekbal, a public health activist, said "the responsibility of the AIPSN had

[10] FMRAI was first formed at Hyderabad in 1962 for improving the living conditions of Medical Representatives in India. It is the only national trade union of the Medical and Sales Representatives in India having its affiliates in each states of the country and offices in 300 cities and towns. FMRAI publishes its organ FMRAI News every month which has a circulation of 25,000 each issue. Further details see http://www.fmrai.org/.

[11] Forum of scientists, engineers & technologists (FOSET), started its journey in the year 1987, is presently having nearly two thousand conscious and socially committed scientists, engineers and related professionals in its fold directly as members and operating through 12 sub-centres scattered in and around the state with its central office in Calcutta (now Kolkata).

increased against the backdrop of environmental deterioration with the potential of ecological disasters in several parts of the country". *People's Science*, a bi-monthly magazine, is being regularly published by AIPSN since 1999. This magazine is the mouth-piece of AIPSN where member PSMOs share their ideas, style of functioning of various PSMOs, and the discourse on various related issues to AIPSN.

Organizational Resources

Ideological discourses & worldview: AIPSN's ideology is predominantly based upon the discourse of the Left, which has made a strong imprint on, for instance, the choice and the definition of the themes for its meetings. This use of a very particular discourse — more commonly, the use of language, the choice of terms, and an approach to analysis — has also played its role in alienating even those who may feel sympathetic to Left opinion and positions but do not feel themselves as *being* part of the Left and do not want to be fitted within the leftist discourse. AIPSN is antagonistic to the ideology of *Sangh Parivar* (right-wing ideology) of India. Consequently, it rejects the PSMOs endorsing explicitly/implicitly right-ideology leaning. The confrontation between AIPSN and Sangh Parivar is apt when a conclave of the Sangh Parivar way back in 2003 had termed this umbrella kind of network as an emerging threat (Jayan, 2003) and in response to this a prominent AIPSN activist said "it shows we are moving ahead in the right direction". It claims that most of its agenda appear to be perfectly compatible with a Gandhian free-market approach of nurturing economic entrepreneurship and independence at the community level. It further argues that if the right wing fails to see Gandhian entrepreneurship as free-market that is their own failing. Ideologically AIPSN does a great amount of balancing, as it claims to be believer of Gandhian economy but has a strong leftwing political affiliation.

AIPSN is a fairly extensive network which is committed to the use of science to promote science for *equitable* and *sustainable* development. It believes that the public needs to develop a critical understanding of S&T in order to be able to participate in the application of S&T, especially in the choice of technologies in different contexts. Given the widespread literacy, the efforts to propagate science awareness and create a 'scientific temper' among the people should go hand-in-hand with efforts in mass literacy. The PSMOs affiliated to this network vary from each other in terms of their size, specific and local level initiatives. AIPSN plays an instrumental role towards establishing a strong relationship among various PSMO activists. The success of BJVJ led AIPSN to take up literacy as an empowerment programme in the campaign mode, for which it has set up a separate organization called the *Bharat Gyan Vigyan Samiti* (BGVS) (Indian Science Knowledge Association) with the primary responsibility of placing 'literacy' on the national agenda. Malcolm S. Adiseshiah became its founder president and MP Parameswaran served as secretary along with several leadings scientists, technologists, educationists and social activists as its members. It was acting as a crusade against illiteracy conducted by AIPSN and supported by the Government. Indeed, literacy campaigns later on formed an essential component of almost all the PSMOs of India.

AIPSN expands the scope of science by taking it beyond just the study of external nature on which the laboratory experiments are carried out. To them it also includes the environment that people live-in, work, and play-in. It addresses 'S&T' issues as they relate to a broader

agenda which includes development projects, environmental pollution, occupation health hazards, health care, drug abuse, the danger of nuclear war and other issues of social and economic justice.[12] K. K. Krishnakumar, executive member of AIPSN, said that 'although the AIPSN had grown remarkably in the last decade, it has faced new challenges and issues in the context of globalization and the rise of communalism. Because of this linkage of issues it is also argued that AIPSN is not strictly confined to deal with science. Instead, they challenge multiple lines of domination, and it is difficult to discern where the science part of the struggle begins and where it ends' (address at the 9th Congress of AIPSN, Dec 19–22, 2001 at Chennai).

Such understanding of science activism with diverse issues and an assertion of linkage calls for a broader movement — one that must necessarily forge a camaraderie among a range of organizations and movements. AIPSN provides for a platform cutting across issues and organizations. It is a key characteristic feature and organizing strategy of the umbrella PSMO. Examples of these issue based linkages, and the concomitant networking, are numerous. Individual member organizations of AIPSN often deal with the interrelationship issues among the state, science and development. Activists battling with nuclear power projects often have to deal not only with issues of contamination, but also with the politics of power and exploitation by the capitalist countries. Of late, whether on the RTI (Right to Information) or the debate on genetic seeds, AIPSN in collaboration with NGOs, has sought to experiment with participatory frameworks where stakeholders openly debate the politics of expertise. AIPSN — if seen as a body of activists and lobbyists — contribute greatly to the intensification of the controversy over S&T in which they bolster and augment their arguments or reasoned out opinions with non-scientific discourses such as human *rights*, democratic governance, *colonialism and imperialism*, postcolonial or post-independent *development*, and *globalization*.

External and Internal Resources

***Internal linkages, Making alliances, Sharing resources & Role of intellectuals*:** Networks and alliances in the PSM depend as much on their differences and autonomy as they do on unity. In the formation of AIPSN, this is an important notion that there is not necessarily one single unifying commonality, a single glue or mortar. Instead, a network holds itself together along the common edges of its pieces — where there is similarity or solidarity. The resulting mosaics itself — the movement-becomes the major reflection of commonality. Within a network, there remains both multiplicity and commonality. Organizations that share PSM concerns may still have radical differences. Yet the commonality of PSM experiences serves as the mortar, even when there are differences in ideology, style of functioning, and tactics or strategies. Respect for differences goes hand in hand with the building of an alliance. For example, even the constituent PSMOs of AIPSN are not having same priorities. Some are working chiefly on science popularization in vernacular and local languages, a few

[12] An initiative of the Tamil Nadu Science Forum (TNSF), for instance, has been the reclamation of abandoned large water tanks across the State in order to make them usable once again. The Pondicherry Science Forum (PSF) intervened effectively in the unbridled practice of aquaculture in Tamil Nadu, which was causing severe damage to the coastal ecology. This resulted in the enactment of a regulatory framework. The *Himachal Gyan Vigyan Samiti* (HGVS) has initiated a project to study the frequent occurrence of flash floods in the State.

are constantly working for alternative models of development and decentralized participatory planning, and another few are involved in translating public's aspirations in Weberian bureaucratic terms for policy advocacy. Part of the crucial task of building network is building cooperation across numerous groups — geographic, cultural, gender, social, ideological — and numerous organizations have come to see part of their task as the building bridges between/among diverse organizations (Anthony & Cole, 1990: 1–2; Williams, 1993: 18).

AIPSN acts as an interest group pushing for plausible legislations. However, its political strategy of networking strengthens the movement with the mobilization of divergent groups. Networking provides a movement many points of attack, positions from which to argue, and tactics to use, while helping to pool resources efficiently. Local PSMOs involved in a project, campaign, or action require a variety of resources. PSMOs need technical information, advice on, and analysis of specific issues. Assistance is needed on organizational issues like, structure, leadership and participation. Assistance is also needed either in the form of advice on locating funding sources or getting direct monetary support. And there is always the issue of how to approach, use and deal with the media. It is the networking of AIPSN which makes the mobilization of resources possible externally, by linking with other groups or networks that can provide for various access points to resources.

The internal sharing of resources is one of the basic reasons for organizing networks. AIPSN can be seen as a 'support mechanism' that assists thousands of grass-roots PSMOs around the country. But resources flow not only from the centre to the network outward, for example, from the main office of AIPSN, but from organization to organization within AIPSN as well. One PSM activist argues that the point of networking 'is that we can teach each other. And that is how we begin to pool resources, monetary, intellectual and strategic'. Network also helps in exchanging ideas and pooling of resources of various kinds from among PSMOs to assist one another with their respective expertises (e. g. with expertise in law, in government processes, or in particular areas of S&T policy research etc).

AIPSN is a network full with intellectuals who are practitioners of certain professions uniting together by mutual consent to deliberate, determine and act jointly for a purpose. As a result, AIPSN is full of cardiologists, public health professionals, scientists both physical and biological, engineers, lawyers, economists, even creative writers or other professionals, who feel at ease in deliberating, determining and acting jointly towards the dissemination of scientific knowledge. These intellectuals are largely involved through voluntary action, with a view to establishing their identity in which these intellectuals have a common interest. These intellectuals are an important component of the AIPSN because the network provides them with an opportunity to express themselves outside the public system of S&T (establishment) which is well organized. The network being part of the civil society within a democratic polity acquires *suo moto* the role of a stakeholder. Hence these intellectuals work proactively through AIPSN and use it as a platform to contribute to the public domain. This helps in bridging the gap between science and society as the criticism brings out the social relevance of the scientific issues to the forefront.

***External Linkages, Acquiring Media Favour*:** New social movements have moved much ahead over the last few years, in the direction of involving media and public communications. They demand democratic access to the media in order to be on even ground with the rest of the news sources. And if they are denied of this right, they immediately set out to conquer it as they believe that being part of civil society the public sphere belongs to them as well. The media is an inseparable part of AIPSN's protests, sit-ons and demonstrations. Of the various technological tools, AIPSN have found the internet as the perfect platform

through which it tries to reach out its audience. However, its biennial conferences are largely ignored by the mainstream media. The collective mobilizations by its constituent PSMOs usually gets due coverage in the print media. Often, PSM sympathizers write on the role of AIPSN, its struggles and its wider implications. Since the mid-1980s, there has been a virtual explosion of PSM writings in English and Indian language newspapers and magazines.

***AIPSN and its external linkages with the civil society*:** Social movements work as a network and defend collective interests which frequently lead them to clash with the establishments of powers that be (Piscina, 2007: 66). AIPSN is an umbrella kind of network organization involved largely in science activism in India. Since it is a social movement, it is generally conceived of as instantiations or elements of 'civil society'. The term civil society is applied to the group of social movements and voluntary organizations that is not linked to the State and economic world (ibid). The question of the origin, or provenance of 'civil society' has been a subject of extensive debate, especially about the meaning, applicability and use of the idea of civil society in non-Western contexts like India (see, for example, Bteille, 2000; Chandhoke, 2001; Deakin, 2001; Ferguson, 1980; Gellner, 1990; Howell and Pearce, 2001; Khilnani, 2001). AIPSN's slogan "Another world is possible" in the context of anti-globalization brought a new paradigm into force. It is said that some sectors that are in favour of institutional reform place emphasis on the word "possible" more than "another" whereas another significant, growing trend turns the terms around and emphasizes "another". The latter took up the ideas of the anarchist anti-capitalist movement and proposes a socio-political method of organization on establishing networks with a popular base.

Disparagements & Debates: The various roles of AIPSN as a 'network' activities, lacked coordination and did not have the kind of impact it could have had nationally, or even at the state-level. Each organization did it in its own isolated way, as one among its other regular activities. Many PSMOs although agreed to launch common programme activities/actions, failed to do so. There were no indications of any attempt to widen or expand the group by inclusion of more members. On the contrary, there were reports that PSMOs desirous of joining the network failed to elicit any response. Towards the end of 1988, it became quite clear that the AIPSN had no intention of letting any other agencies join the network. It was at this juncture that NCSTC, DST's autonomous body, decided to make a move for a draft proposal towards the formation of NCSTC-Network. This proposal was also presented in the "NCSTC Communications" issue of January, 1989. Currently this newsletter circulates every month to over 5,000 addresses, including all voluntary organizations on NCSTC's S&T communication database.

Separate and parallel efforts were made by the NCSTC to elicit views and suggestions on the draft proposal from the 26 PSMOs which had assembled for the *Bharat Jan Vijnan Jatha* project, not once, but several times; however it was of no avail. Only a fraction of the 26 organizations responded; others did not even bother to acknowledge the receipt of communications (after repeated reminders through speed-post and circulation of copies of the draft proposal at the Second People's Science Congress at Calcutta during mid-March 1989). In fact, the Second People's Science Congress concluded without discussing issues or questions in this regard which had been left unanswered at Kannur event even though AIPSN member organizations were present. The views and suggestions of AIPSN member organizations were characteristically different from those of the other organizations. According to AIPSN, the structuring of the network may lead to erosion of voluntarism, freedom of action, and autonomy of member organizations. The threat of withdrawal of membership, on not performing "network functions" could lead to undesirable trends. Such a thing is likely to be harmful to the commitment and devotion with which voluntary organizations work. The very

style and character of functioning of the voluntary organizations may get adversely affected through rigid structuring and compulsion in performing tasks and functions which may be in basic disagreement with PSMOs' philosophy and ideology. The AIPSN members perceived this as the Government's effort to coopt this voluntary movement with radical teeth.

On August 17, 1990, various Govt./semi-govt organizations including PSMOs were invited afresh to join the network named NCSTC-Network. Unlike AIPSN, this network was registered itself with the Registrar of Societies Act, 1860 with a governing body and office bearers. Of the original 94 applications received 34 were retained after scrutiny to become members. Of the 34 members of the NCSTC-Network, nine were also members of the AIPSN. Over the years, the membership of the NCSTC-Network has grown to over sixty now.[13] In this, at present, there are 13 members who also are members of the AIPSN. About a fourth of the members are government or semi-government organizations (both of the central and state varieties) and remaining ones are registered voluntary organizations of good standing in their own right. The oldest among them is the *Bangiya Bigyan Parishad* (Bengal Science Association) which was formed way back in 1948 and the largest number of Network members is in the State of West Bengal.

In (formal organizational) structural terms, however, the structure of AIPSN is dominated by one particular stream of ideological discourse, the left, as represented by the DSF and the BGVS. The organization that is by far the most dominant in AIPSN is the DSF and the latter is also affiliated to the CPI (M). Some of DSF members have been the members of CPI (M) periodically. The DSF and the BGVS together have made extensive use of the available people and network bases, including physical infrastructures and funds of the AIPSN. No other organizations have been able to do this. It can be argued that at times their dominance is not surprising and in some ways even well 'deserved'. But the problem with the dominance is that the expression of a difference of views are suppressed, if not actually eliminated, and others with more independent points of views, keep away when they see this character of AIPSN. Our understanding is that this has happened in AIPSN quite often. For instance, both the DSF and BGVS never accepted the *Marathi Vidyan Parishad (MVP)* (Marathi Science Association) as a PSMO. There is the tactical question of whether simply taking a position that one must keep the MVP out of the AIPSN, by not inviting them to participate, can ever be sufficient to achieve the objective. There are two questions here: one, the question of the problematic of open space, and two, the question of boundaries and exclusiveness. The two questions are of course interrelated. It is correct to feel that MVP by character and ideology is different from those left wing network organizations. And more importantly MVP has a large pool of highly qualified and accomplished scientists and engineers, some of them are of very high repute and served high positions, who may not necessarily share the ideological underpinnings of AIPSN, but have to be given space in this radical activist forum.

Case Study. 2: *Bharat Gyan Vigyan Samiti* (BGVS) a PSM organization for Literacy

The conception of BGVS could be articulated in the backdrop of *Bharat Jana Vigyan Jatha* (BJVJ) of 1987 led by KSSP. In the next year 1988 AIPSN was formed. Having seen this success of mobilization for literacy, when KSSP was preparing the Total Literacy Campaign

[13] Further details please see http://www.ncstc-network.org/.

in Kerala, the Govt. of India (through advisor Sam Pitroda) approached M. Parameswaran to help out in national literacy campaign. Parameswaran and group agreed and organized 400 buses and visited 60,000 nodal villages. But to take it beyond and organize as well as operate such a nationwide literacy campaign, the concurrence of National Literacy Mission (NLM) was taken. It was agreed to form an organization named BGVS (in the footsteps of BJVJ 1887). And the NLM authority became the sponsor of BGVS. The project was approved by MHRD (GOI) and with MHRD representatives in the council the organizational framework was setup and it became functional in December 1989 with noted educationist Malcom Adiseshaiyya as the then chairperson and Parameswaran as the then Secretary.

Further, in order to understand cognitive process of formation, it may be useful to divide the BGVS into three major phases with defined characteristics. The first phase, from 1989 to 1993, a period of awakening, was characterised by mobilizations for literacy, starting from the formation of the BGVS of 1989 followed by three major *jathas*, like *Bharat Gyan Vigyan Jatha*, Nov. 1990, *Samata Jatha* in 1993 and a nation wide campaign called *Hamara Desh* (Our Nation) in 1993–1994. The second phase, from 1994 to 1997, a period of movement building, was marked by a transition from literacy to other development initiatives and an attempt to establish a strong interface between the two. These were mainly in the areas of natural resource management, health, initiatives in basic education and the generation of social awareness through publications and the formation of saving groups. After having organized major programme on development of local economy, natural resources, called *Desh Ko Jano, Desh Ko Badlo,* (Know the Nation and Change the Nation) and BGVS went for major women's mobilizations through *Samata Vigyan Utsavs* (Samata science festival) from 1996 to 1998. Of course during 1995 BGVS had organized a huge scientific awareness building campaign called 'Cosmic Voyage' on the eve of 24 October, 1995 total Solar eclipse, in the north India. The third phase, from 1998 to the present, is defined by an attempt to consolidate through decentralized institutionalization, around continuing education centres and *Gyan Vigyan Vidyalayas*, i. e. centres of non-formal education and interface with formal schooling.

An assessment of the history of BGVS (Saldanha, 2003) suggests that there were two primary factors that influenced its trajectory; the external environment and the organizational dynamics along with strategies internal to BGVS. Factors related to the external environment may be seen as those related to the socio-economic contexts of intervention and those resulting from the interactions with the other major agency in the literacy campaigns, e. g. state/government. The strategies of the BGVS were largely in response to the spaces provided to it by the government.

The Organizational Resources

Perspective and Ideological Formulations:

Given that the process was visualized as being essentially democratic in character (towards strengthening people's power), it was clearly conceived as being a people's movement with the collaborative participation of various sections of society, at most time on a voluntary basis, i. e. with no payment for part time services. The intervention of BGVS was primarily within the social developmental sector, generally considered as a sector with low political legitimacy and salience. The long term perspective of the BGVS was influenced

by the issues of egalitarianism and social change thrown up by its actors. Of Course a few of them believe in being part of the political economy of agitation-based struggles on livelihood issues (land, resources and distribution) and the political representational struggle of an electoral character. The key perspectives of BGVS are explicitly as follows:

1. *Equity and Self-Reliance:* Access to literacy and basic education itself was seen as access to equal opportunities. A perspective on self reliance was especially required in a growing unipolar and militarized superpower context and where other basic educational programmes were tending to be flooded with 'foreign aid'. This perspective was increasingly being influenced by liberalization and privatization of the economy in contexts of globalization. It further justifies the restructuring of economies and innovation in communication and knowledge distribution.

2. *A People's Movement Approach, Decentralized Democracy, Secularism and National Integration*: The mobilization process and organizational structures for implementing the literacy campaigns emphasized these values. The very structure of Village Education Committees was an operationalization of this principle where an attempt was made to put together major social forces such as the government, the voluntary organized and unorganized sectors and the teaching-learning community. Secularism and national integration were important in a context where dominant national hegemony was increasingly being influenced by sectarianism and communalism.

3. *Voluntarism and Scientific Awareness*: The main body of the literacy campaigns worked on the principle of voluntarism. This involved at different times over more than a decade, voluntary activists that might number over 10 million persons. Involving these persons in acting through popular, electronic and the print media in the spread of literacy and critical scientific awareness was one of the important features of the literacy campaigns.

The Organizational Structure

Having been founded in 1988 and located at New Delhi, BGVS is now having branch offices in 22 states of India. It has outreached 306 districts, 2009 blocks and 21064 *Panchayats*. Its general body consists of 100 members (3 members from each state, 13 Executives Committee (EC) members, outgoing EC members and 15 EC nominated members and two invited members from the AIPSN). It has 13 members EC with a Chairman, a Secretary, and representatives of NLM. As it started with the then government of India initiative, it made use of Government infrastructure, and received indirect support for its literacy campaigns, its status as a PSMO is questionable. Even if a radical ideologue like MP Parameswaran is providing leadership to BGVS even today, its radical teeth and identity as a voluntary PSMO is at stake. This could easily be perceived as Government of India's effort to co-opt the radical ideologue and his campaign.

Objectives of BGVS

The objectives of the BGVS are very broad to cover the entire spectrum of socio-economic political issues. These macro objectives also reflect the nature of this *Samiti*. BGVS has concretized these objectives in the form of certain specific programmes, but it remains largely a movement for the comprehensive restructuring of society. It is a nation-wide mobilization leading to a mass action. It aims to communicate the basic problems such as water, nutrition, health, environment and literacy through a self-reliant, humane, participatory process and a scientific approach. Further it directly addresses these basic problems through deeper intellectual interaction with physical environment. It promotes the formation of

groups at the *gram panchayat* (village local bodies) level, block level, district level under the three tier system of *panchayati raj* institution (PRI) that will understand the use of S&T for the benefit of the common man. To make the movement sustainable BGVS has a participatory resource mapping system which allows people with the help of scientist to identify all natural and human resources in their *Panchayats* and plot them on revenue maps to be subsequently used by them for local development planning.

Mobilizations; Campaigns and Strategies

The technical dimension of the BGVS consists of the tactics, strategies and techniques of protest such as campaigns and mobilizations through which the specific objects are opposed. The two kinds of tactics used by BGVS include *jatha* and *kalajatha*. In *jatha*, there will be approximately 12 to 15 amateur performers, elocutionists and the like in two groups, selected from various districts on the basis of acting and speaking ability. They hold a camp to develop the ideas to be presented, the scripts, the roles, and to learn their parts. The puppet plays, short plays and songs they develop would constantly be revised on the basis of group and self-criticism. To minimise costs, events are held in locations as close as possible to major routes, e. g. National Highway. The objectives of *jatha* are to promote scientific thinking and awareness of society's problems through the arts that the people of India can understand and identify with.

The very idea of *Kalajatha* for science communication began to evolve in KSSP in 1977 while conducting a science cultural caravan. The first *Kalajatha* was launched in 1981 and still the people's science movements in India consider it as an effective method to reach common masses (Narayan, 1999). The *kalajathas* were developed during the 1977–1988. It consisted of displays of posters, banners, hoardings, stickers; *padyatras* (marching on foot), street theatres and songs. The *Kalajatha*, a powerful medium, that packed its messages in the popular cultural idioms and forms, its message was hard hitting, linking literacy with many basic livelihood problems and even with questions of exploitation, oppression and discrimination against women. They attract an audience and convey messages in an aesthetically pleasing and emotionally inspiring manner. Importantly, cultural events create a forum for meeting, discussion and planning. The experience of the *kalajathas* indicates that traditional cultural forms generate the requisite social energy for a mass mobilization like the literacy campaigns. The messages and the cultural forms that were utilized demonstrated a healthy combination of centralized initiative together with decentralized creativity through adaptations. According to Dighe et al. (1991: 84), the ideological thrust of the *kalajathas* was such that the problem of illiteracy was for the first time being perceived from the perspective of the poor.

The BGVS used different strategies for raising people's awareness on various scientific and social issues. These strategies were:

• developing a set of centralized messages but allowing for enough flexibility to encourage adaptation to suit local needs, problems, aspirations;

• evolving an organizational structure that is pyramidal in nature with a broad base of activists at the local or village level tapering off to smaller numbers at the taluk, district and state levels;

• involving activists on a voluntary basis and sustaining their missionary zeal through on-going training;

• undertaking meticulous planning of activities and time schedules to be followed, but allowing for corrections and modifications on the basis of feedback received from the people;

• involving leaders and workers of political parties irrespective of ideology, and eliciting their involvement and participation in the programme;

• carrying on the whole campaign, in a time bound period, i. e. almost on a 'war footing' and sustaining the tempo of the campaign and finally;

• involving the entire community in different ways, thus generating a mass support for the programme.

The major initiatives involving large scale popular mobilizations on the part of BGVS were: The *Bharat Gyan Vigyan Jatha* of 1990, *Bharat Jan Gyan Vigyan Jatha* 1992, The Campaign for *Hamara Desh* 1993–1994, *Samata Jathas* 1992–1993 (Samata network, Samata Vigyan Utsav), Science Popularization Activities: JOL and Cosmic Voyage 1994, *Gyan Vigyan Vidyalaya* Movement (2006–2007), People's Health Programme (*Jan Swasthya Abhiyan)* 2003–2004, People's Reading Programme (*Jan Vachan Andolan)* 1994–1996, and Developmental Action Programmes 1990s, Watershed development programme 1997, Integrated Drinking Water and Sanitation with People's Participation (WATSAN) 1993–1994, Watershed Development Project 1995–1999, Science Communication programme on the occasion of Transit of Venus on June 8, 2004, Observing International year of Astronomy-2009, *Rozgar Adhikar Yatra* (Right to work caravan) 2005, *Janadhikar Kalajatha* (Right to information Caravan) Nov. 2007, Campaign against Female foeticide 2007, and 100 years of International Women's day March 2010 etc.

Intellectual Resources

Intellectuals have played a pivotal role in social movements and are continuing to shape ideas and biliefs of the SMOs. Their major role is to articulate and couch the terms of the movement for making a broader appeal. For instance, BGVS was seen mobilizing a wider support for a people's science movement. In our study of BGVS, we have identified a range of intellectuals who have been united in the social space created by this movement. In BGVS, intellectuals come from diverse social origins such as teachers, educationists, literacy activists, medical professionals, technocrats etc and hence their orientations were different. M. P. Parameswaran, Vinod Raina, K. K. Krishnakumar, Malcolm S. Adiseshiah, Venkatesh B. Athreya, T. Sundaraman, Komal Srivastava, and Kuldip Singh Tanwar are the intellectuals involved in BGVS. These intellectuals who make the 'Conscience Constituents' and 'Conscience Adherants' (McCarthy and Zald, 1977) of this PSMO, agreed that the nature of organization to be a mass based movement.

Case Study. 3: *Jana Vignana Vedika*: A PSM Organization

The Genesis and Objectives

Being greatly inspired by the *Bharat Jana Vigyan Jatha* (BJVJ) 1987 of Kerala, *Jana Vignana Vedika* (JVV) was formed on February 28 (national science day), 1988 by a group of intellectuals comprising of academics, medical doctors, scientists, and teachers at Vijayawada in Andhra Pradesh. The formation was as a result of the idea gathered from the BJVJ, 1987 with the following set of objectives:

• To popularize science and to promote scientific temper among public;

• To eradicate obscurantist, superstitious and paranormal and mystical practices from public by means of popularization of science;

• To understand the scientific basis behind several of the problems faced by the public and to explore remedial solutions for the same;

• To facilitate the benefits of science among the larger public which are otherwise confined to the certain section of the population;

• To encourage quest for knowledge and to strive for national integrity, self reliance, world peace, social progress and cultural vibrancy;

• To encourage research in divergent areas with public welfare;

• To design programmes corresponding to the objectives set as above.

Organizational Resources and Domain

JVV is widely acknowledged as a PSMO in Andhra Pradesh and at present JVV have more than 30,000 members. JVV is a non-governmental and cadre-based PSM organization with its units functioning actively in all the 23 districts of the state of Andhra Pradesh. It is a constituent member of the AIPSN and also linked to the BGVS. It relies on the philosophy of volunteerism and its funding comes from individual donations and through projects. It has a 4-tier organizational structure, i. e. village/local unit, mandal unit, district unit and state unit. Every unit holds Conferences once every two years and elects the respective committees. It's membership strength is now more than 40,000. The State Conference is held after the lower units are done in with their hierarchical order. Neither the President nor the General Secretary holds the post for more than one term consecutively. It organizes a variety of programmes to create awareness and to draw the public attention on various socio-scientific issues. It also conducts training camps for teachers, students and science volunteers on the trends of S&T. It wages relentless but peaceful struggles against all kinds of superstitions and obscurantism. It elicits public opinion against the rhetoric of paranormal, quackery, unhealthy and spurious medical practices and other unfounded claims of prevention and cure. It educates public about ecological balance and sustainable agricultural and industrial development while uncovering the real culprits behind the abuse of the environment.

JVV's Perspective on Science and Society

Being a leftist PSMO, JVV views that Indian society is divided into two classes: the exploiting and the exploited. It opines that the powers and capabilities of S&T have been under the control of the exploiting class. Thus the advantage of S&T are being enjoyed exclusively by the exploiting class of the society while the exploited majority class, the producer of science and technology is bereft of its advantages. Whenever its control over the productive forces is likely to slip, the same exploitative class abuses S&T to unscrupulously arm itself with war machinery and jeopardizes the world peace. JVV draws its functional ideology to negate this lopsided, unscientific and unjustifiable social order fogging the S&T spheres of life. Hence, JVV's main slogan is 'science for Socialism' (science for self-reliance). It considers that popularization of science and promotion of scientific temper among people would sensitize and empower them to usher in a new public-friendly and democratic social order sans exploitation.

Intellectual Resources

JVV has been led by a group of intellectuals, but the most active leadership has been provided by academicians and scientists who come from several universities of the Andhra Pradesh like, Osmania University, ANG Agricultural University, National Institute of Technology Warangal, CSIR laboratory like CCMB Hyderabad etc. To name a few of the academicians involed were Profs. Balasubramanian, K. Venkat, B. N. Reddy, L. Pratap Reddy, N. Venugopal Rao, P. K. Satya Prasad, L. Muralidhar, A. Ramachandaiah, K. Vijaylakshmi, and Ch. Mohan Rao. These academicians/scientists could rightfully be treated as the 'Conscience Constituents' and 'Conscience Adherants' (McCarthy and Zald, 1977) of this PSMO.

Activities of JVV

JVV involves in three kinds of activities such as: educative, agitative and constructive and such activities spread over areas like environment, health, education, energy, development, literacy, science awareness, campaigns against retrogressive social practices such as untouchability, child marriages, superstitions etc. JVV works on mainly issues related to science and society, however, education, health and science communication are the major three operational domains of JVV.

JVV and Education: With the strength of several thousands of teachers as its members, the JVV organizes teachers' training to make them enjoy teaching and promotes pedagogic innovations to make learning an enjoyable activity for children. It also assesses curricula contents, textbook contents and concepts. It also organizes children's science festivals, such as joyful learning, *bala melas*, (children's fair) etc, frequently on massive scales. To promote quest for knowledge and bent of socio-scientific and technological awareness among school children, the JVV has been running the largest circulated Telugu children's science monthly magazine, *Vidyarthi Chekumuki*, since 1990. It conducts Chekumuki Science Talent Test in every year for high school children. As many as half a million students participate in this test. The Literacy Movement, spearheaded by JVV, and one of the many short stories written by V. Balasubrahmanyam (its former General Secretary and Executive Member of the AIPSN) for the illiterates, sparked the anti-Arrack movement in the Andhra Pradesh. It has been a milestone in the successful chronology of events of *Jana Vignana Vedika*.

JVV and Health: Over the last few decades, JVV has actively been campaigning for people-oriented healthcare health policies. Led by a group of committed medical professionals and science activists, the organization conducts surveys and analyzes the ground realities of healthcare at all levels while preparing village level health plans and cost-effective solutions. As an active partner of *Jana Swasthya Andolan* (People's Health Movement), JVV has been critically examining the health policies of the government of Andhra Pradesh and formulating alternative health policies.

JVV and Science Communication: Popularization of science and inculcation of scientific temper among the people is JVV's major task and priority area. Its modes of popularization of science among people include use of folk arts, street plays, dance, magic, sound and music and other art forms besides the usual lectures, book exhibitions, demonstrations, debates, presentations etc. JVV's TV programmes against the godman Satya Sai baba in vernacular medium were well known. Even note worthy was JVV's initiating legal action in Andhra Pradesh high court against the Goud brothers for not revealing their method of curing Asthama (suspected of practicing faith healing).

Some of the activists of JVV regularly contribute articles and science features in vernacular media (both print and visual) and magazines. JVV has developed a series of radio episodes on the chemical sciences and other areas of science with a collaboration of the DST's *Vigyan Prasar*. Whenever astronomical events such as eclipses, meteors, comets etc occur, JVV goes to people at their habitats and make them understand the underlying principles of such phenomena lest they should attach obscurantist attributes to those and continue to be eternal slaves of paranormal and superstitious belief systems. It earned the National Award 2005 for the best efforts for S&T communications. In recent times JVV is actively campaigning against the use of asbestos for housing purpose and also India's growing nuclear power projects.

JVV and Publications: JVV has published many books and literature for children and adults. One of the major strengths of JVV is its publication wing. It has been publishing and circulating different kinds of books on science, culture, history, education, health etc for all levels of people. Promoting reading habit among the childhood has been a regular and ongoing activity of JVV. It organizes book exhibitions, reading festivals and readers' clubs. Most importantly, it publishes and circulates booklets, pamphlets, bulletins contextually too whenever socio-scientific, natural or astronomical events take place.

JVV and Women: Samatha is the name of the women's wing of JVV. It strives to empower women so that they are aware of their rights, sensitive to their problems and prepared for the remedial measures. JVV organizes frequent counseling and teachings to educate adolescent girls about mysteries surrounding their own physiological changes such as menstruation, sexuality, pregnancy, menopause, and aging. These are experienced as fear and taboos. JVV felt that women's health issues hadn't become one of the main activities of PSM and there was a need to explain to women in a simple way all of their physiological functions and changes, which JVV did undertake. *Samatha* opposed the sex-determining technologies in Andhra Pradesh on the health ground. Other than the risk of late abortion, normal health services pose a health hazard for Women. *Samatha* supported the Forum Against Sex Determination and Sex-Pre-Selection, formed in 1985 in Bombay, which sought ban on the sex-determining technologies and female foeticide. The nine years of campaign eventually led to the national laws in 1994 for banning the practices of sex-determining technologies and female foeticide. The *Samtha* and PSM activists welcomed this law as a first stepping stone towards women's empowerment. They, however, did not question who would benefit from these laws. Their campaigns did not address the basic question of power balance between men and women, the existing patriarchal relations within family, economic dependence of women, and the role of women in society.

JVV and Campaigns against Environmental Issues: JVV organizes several kinds of programmes to bring in awareness of environmental degradation, ecological balance, sustainable development etc, among public policy makers. It sensitizes people against the ruthless consumption of natural resources. With the National Forest policy of 1988, JVV educates the villagers how to manage their forest. With a pro-poor people discourse, it even supports industrialization and technological automation.

External linkages of JVV (with civil Society and state)

Apart from linking itself to other PSMOs, JVV maintains widespread linkages with several civil society organizations like, Sri Ram Rural Educational Institute, SCOPE, CMS India, Association for Human Development (catalyst project), Council for Science Editors,

Centre for Science and Environment New Delhi, Human Rights Forum, and with semi-government organizations like *Vigyan Prashar*. JVV also works in close cooperation with the Govt. Of India's ambitious school education programme named the *Sarva Shiksha Abhiyan* in Andhra Pradesh.

Thus it seems JVV is not different from other radical PSMOs of AIPSN. Above all those PSMOs that have affiliation to the umbrella organization named AIPSN do share their ideology and desired end state. Hence it would not be surprising to observe that they work on similar action programmes, of course with minor variations.

Case Study. 4: Delhi Science Forum (DSF) a Unique PSM Organization (for S&T Policy Critique)

Genesis: The government does indeed make some good and progressive policies, but through the implementation, these policies get distorted over the period of time. The state does not consult the people and its organizations while framing policy, yet expects these organizations to assist in implementation. Even when the people's organizations come forward to help in implementation of some progressive policies, this is soft peddled because the real agenda of the state is often different from the rhetoric. In certain cases where the people's organizations are consulted for policy formulation, this is carried out at the abstract level, and when the concrete policies are framed, the state reverts to its own pro-capitalist agenda. In this context, making the right noises is not enough; rather what is needed is a political will of the government to implement a people's agenda. In this backdrop, the genesis of DSF was realised as a PSMO in Indian context.

DSF is a noted PSM organization concentrating on policy issues related with S&T. Though it started functioning in 1978 but was registered as a non-profit public interest organization under the Societies Registration Act in 1981. The organization is based in New Delhi. It is engaged mainly in issues related to S&T policies and science popularization. DSF works in areas of interface between science, technology and society, focusing on S&T policy issues, their impact on India's self-reliance and sovereignty, and their societal implications, particularly regarding interests of underprivileged sections of the Indian society. DSF also works to promote peace and disarmament, utilization of S&T for environmentally sustainable development and a scientific temper including awareness of the potential of S&T. Unlike KSSP and BGVS, DSF is not a mass organization. It is a catalyst organization and the movement it runs is of discursive type only. It is not a mass based organization; rather it is a nodal agency among other PSM organizations in India. In fact, it is a pressure policy group among people's science movements in India.

Organizational Resources

Philosophy and Ideology of DSF:

According to DSF's philosophy, development is long-term, sustainable and equitable with respect to both present and future generations. It is possible only by holistically integrating environmental concerns into all stages of the developmental process. DSF therefore views any environment policy as an instrument towards achieving sustainable and equitable

development with particular emphasis on the interests of the poor and deprived sections of the society, especially those whose lives and livelihoods are inextricably dependent upon or linked with natural resource bases.

It is found that the members of DSF are ideologically close to the Left-wing in Indian politics, in particular the CPI (M). Though DSF is oriented toward the Left, it operates outside the platform of Left-wing politics. DSF believes that except the Left parties and groups, there is no real force in India at the moment which can claim to be genuinely concerned with the real question of the struggle of the Indian people. It has been observed from the opinions and perceptions. Of many DSF leaders and members who are CPI (M) members. Not only they are leftists but also modernists in their attitudes. It is no secret that CPI (M) personnel and resources are made available to the DSF and vice versa for the activities. The *People's Democracy,* weekly mouth piece of the CPI (M) provide wide and favourable coverage of DSF activities. DSF takes up S&T policy issues and provides factual inputs and arguments to the CPI (M) for formulating its policy stand points.

Both DSF and CPI (M) share the common ideology of popular mobilization on certain issues like education, health, and other social sectors for building popular struggles. The ideological similarity between CPI (M) and DSF and the extent of fraternal cooperation between them do raise certain legitimate concerns. Its ability to maintain a distinction between politics and party politics is often in question. If a S&T promotion organization enters the political fray often, as DSF does, observers would find it difficult to believe that it is a professional organization. Curbing the tendency to read political meaning into many major events and spending more energy investigating them carefully would help enhance DSF's credibility.

Objectives of DSF:

According to the constitution of DSF, the objectives of the forum is to provide a platform for discussion on, (i) social, economic and political implications of S&T policies, (ii) the problems of organization of scientific and technological institutions, and (iii) the role of S&T personnel in the development of the country. It further argues for (i) traditional/indigenous scientific and technological knowledge and achieving self-reliance, (ii) democratization of the work of scientific and technological institutions/organizations in the country to further the creativity of S&T personnel and people, (iii) promoting scientific temper amongst the masses, and (iv) promoting awareness amongst people about the implications of S&T policies for the society. It collaborates with other organizations both inside and outside the country with similar objectives to achieve its objectives (DSF sources).

Mobilizations; Campaigns and Strategies:

The technical dimension of DSF includes campaigns among working scientists, technologists, other professionals and academics on the one hand and campaigns among the general public, especially directly affected sections, for their empowerment and informed participation in decision-making by acquiring greater awareness of S&T issues. In order to do this, DSF employs various means of communication such as street plays, slide shows, exhibitions and workshops etc. The material produced for the communication addresses different target audiences, including policy-makers, activists, academics and general lay public. While the major content of this material is nationally coordinated, the same gets transcribed and produced at state/regional levels in local languages. The strategies of DSF are for creating material for campaigns on policies related to drug industry, health, the nuclear holocaust, the disaster like Bhopal gas leak and the WTO issues. Some of the specific and major

campaigns of DSF were the following: Against Indian Drug Policy (1984), Against Bhopal Gas Tragedy: industrial policy, health & safety (1985), Against New Seed Policy (1985), Against PepsiCo license in India (1986), Total Literacy in Delhi (with Delhi Literacy Society) (1991 - 1993), Health for all and IPR-related Issues (1995), Against Enron's Dabhol Power Project (1997), Against Privatization of Power (1997), Against Privatization of Telecom (1998), WTO-related Issues (2000), *Jatha* for Peace & Sovereignty (with AIPSN) (2003), Use of primates in scientific research: investigation into NII Primate House and CPCSEA allegations (2003), Against Privatization of Water Utilities (2004) etc. Of late the DSF has developed newer areas of research and activities. The more recent areas of interest for DSF have been MNC monitoring in India, Disinvestment in Indian corporate sector (public), R&D in drugs and pharmaceuticals, WTO, IPR (patents wars in India), Mega-power projects, Indo-US nuclear cooperation for power generation, Telecommunication policy (BSNL), and Climate Change related policy.

Intellectual Resources

Publications and conferences/seminars organized:

The 'Conscience Constituents', and protagonists of DSF on S&T policy are Prabir Purkayastha, Amit Sengupta and D Raghunandan. Research and Publication is the major work of DSF which brings out the critical studies of S&T policy related issues. Here DSF plays a leading role because its distinctive leadership lays in publications on several policy issues involving S&T. For DSF, 'a good state policy can do more good than many hundreds of NGOs working in small pockets, a bad state policy can do a lot of harm and undo the gains from several years of efforts'. Therefore, there is a need to understand policy inadequacies and pose alternatives. Developing well-studied and detailed critiques of developmental policies is essential for empowering people's organizations to seek participation/consultation in the decision-making process. S&T policies have social, economic and political implications on the people. Publications of DSF's policy work fall in the areas of; (i) nuclear disarmament**,** (ii) IPRs and patent laws (iii) health policy and policies on pharmaceuticals, (iv) educational policies, (v) energy and environment policies, (vi) sectoral policies — telecom, power, R&D, (vii) Panchayats and decentralization policies. That apart DSF has organized large number of seminars/conferences to pursue its agenda. Some of these were: Import of Technology & Impact on Development (1978), India and the International Drinking Water Supply & Sanitation Decade (1981), Indian Pharmaceuticals Policy (1986), Scientific Temper Workshop (1986), J. D. Bernal Centenary Seminar (1989), Sovereignty & Self-Reliance (1991), Development, Equity & Globalization (1996), Present Trends & Prospects of Drug Industry in India (1998), Technological & Scientific Self-Reliance (1999), Science & its Public knowledge, movements and images (1999), "Endless river": Joseph Needham Centenary Seminar with National Institute for Science Technology and Development Studies (NISTADS) (1997), International Patent Regimes (2001), Towards a New Indian Climate policy (with TISS Bombay) in Sept. 2009, public meet 'Against Corruption and corporate loot' 2th July 2011 (with PRAGOTI) etc. Although a small PSMO and with limited physical resources, DSF has initiated many valuable debates of national importance in India. While doing so it truly reflects its commitment to left wing thinking, as it has opposed India's reforms in (privatization of) telecommunication sector, reforms in (privatization of) the power sector etc.

Case Study. 5: *Eklavya,* A Pedagogic PSM Organization

The context of study:

The beginning of 1960s was a turning point in the arena of science education in India. It was then that University Grants Commission (UGC) of India and newly established National Council for Educational Research and Training (NCERT) started revamping science education in a big way. Many summer programmes with British and American consultants were organized, with the purpose of keeping teachers at all levels aware of recent developments in science. The enthusiasm exhibited through these programmes went a long way in innovating science teaching and in preparing for textual materials etc. National Council of Science Education (NCSE) sprang into existence, and it helped in many ways, to boost up science education through study tours, study group projects, support for journals in science education etc. The Education Commission, a massive effort since independence, was the first of its kind; to put it succinctly that science education has to be strengthened so as to make it an effective instrument for national development. UGC started with a great vigor its own programmes for improvement at the college level on science education.

In India, at the school level, because of a national pattern of 10+2+3, science has come to be included as a compulsory part of education upto Xth class. Even though not compulsory, science education constitutes the bulk of higher echelons of education. But one can hardly deny the existence of non-governmental science agencies which are engaged in the spread of science literacy at the school level. A significant lead taken, by a PSMO named Eklavya, a few decades ago concerns science education even today. The outcome of this development came to be known as the Hoshangabad Science Teaching Programme (HSTP). It further became the basis of formation of Eklavya (located in Central Indian state of Madhya Pradesh at Bhopal) a Non Governmental Organization (NGO). Except Eklavya (and to a limited extent KSSP & TNSF), no other PSM organization has been involved in rewriting the syllabus and training the teachers to transact it, that too in government schools. Hence it becomes an obvious choice for our case study. The following section outlines Eklavya's formation as a PSMO and its radical large-scale intervention in the state-run middle schools of Madhya Pradesh.

Early Intellectual mobilization of the Movement

Many of the PSM organizations adopt slogans such as "science for peace", "science to eradicate diseases", and "science to counter exploitation", which are contextualized through street theatre, plays, art forms and songs as a part of the ideological orientation of "science for social transformation". The earliest point of reference of this case study can be traced back to the HSTP, an innovative effort to use experimentation as the primary pedagogic tool in science teaching. HSTP[14] was initiated in the year 1972 in the schools of Hoshangabad district of Madhya Pradesh. It was operating in the field at a macro-scale level over a thousand schools and more than two thousand teachers. It stemmed from dissatisfaction with the existing mainstream practice of science education and continued for over thirty

[14] It is also locally known as *Hovishika* (from the corresponding acronym in Hindi) or Hoshangabad *Vigyan* or Rasulia *Vigyan* (Vigyan in Hindi means Science).

years. Its entire dynamic was affected through the confrontation or through the dealings with the mainstream of science education by providing a space for an alternative conception of science education. First, the entire conception of the programme was influenced by the larger trends in thinking about science education. Second, it was an attempt to reinterpret those ideas in the Indian context and also engage with the mainstream school system to evolve workable models of practice. These two factors in addition to the larger ideas enable us to understand the existence of the programme over thirty years.

The dismal pictures of science teaching in the mainstream schools brought the context of reforming school science teaching. It was mainly textbook-based rote learning with little emphasis on understanding concepts or the process of science which was contested. There was even a tendency to introduce advanced abstract concepts in a compact manner, without sufficient preparation or adequate elaboration of the subject. Conciseness and brevity couched in scientific terminology was confused with simplicity of presentation. It was dominated by the teacher-to-student 'chalk and talk' method with virtually no scope for experimentation, hands-on-experience, exploration or discussion. Textbooks have tended to become content heavy, with no scope for relating to the local environment and local issues. Examinations and tests consist largely of questions aimed at information recall, which reinforces rote learning. The organic link among discovery, experiment, hypothesis, theory and knowledge in science is totally ignored, with theoretical descriptive texts narrating concepts with little light thrown on how they were discovered. Thus learning science becomes drudgery devoid of perceivable meaning for students. It leads to loss of interest and students are totally deprived of the excitement and sense of wonder that science arouses.

It was believed that good and effective training during the early years in the method of science would help children develop their inherent analytical powers, their ability to formulate and observe problems, make logical analysis and draw conclusions from their experiences (Ganguli, 1976; Eklavya, 2005). It was further argued that the valid science teaching in a village must necessarily involve interacting with the whole life pattern of people living therein. Thus school science teaching could provide an effective channel for work in areas like agricultural productivity, development of local intermediate technologies and in areas of health and family welfare. It could also influence social attitudes, enabling children to begin questioning the traditional structure around them.

PSMs drew attention to the need to connect education with their struggles. For instance, Gandhi's vision of decolonization was linked to an alternative vision of education. Tagore's vision of education was related to a cosmopolitan ideal that went beyond narcissistic nationalism. Freire envisaged dialogic education as a means to create an egalitarian society. He advocated daily, continuous innovation in the classroom. He suggested that teachers move beyond the text to enable the child question its sanctity. Teachers should be empowered to develop a symbiotic, dialogic relationship with students, instead of the mindless brutality of most classroom situations. Learning can be a joyful, aesthetic experience instead of a source of oppression.

It was argued that HSTP for the first time used a universally acknowledged pedagogical approach to the teaching of science. Essentially, the pedagogy was based on 'learning by doing' emphasized on the process of science leads to discovery, and critical thinking. This practice replaced textbooks full of information with workbooks facilitated actual experimentation by children, and helped them to deduce inferences. The objectives of HSTP was to help improve the quality of science teaching in middle school (classes VI to VIII)

within the existing government school system, and within the mainstream syllabus, based on the principles of 'learning though activity' in contrast to the prevailing textbook-centred 'learning by cramming up/rote learning'. This innovative pedagogic approach used experiments performed in the classroom by the students to learn through observation and discussion, i. e. executes the 'method of science' in the classroom.

Both the contexts and the issues of pedagogy motivated HSTP and mobilized participating groups and organizations. HSTP was an outgrowth of two voluntary rural development organizations; Friends Rural Centre (FRC) and the *Kishore Bharati* (KB). The two organizations looked upon an inquiry-oriented environment-based science teaching in schools as an important input for social, economic and cultural transformation in rural areas. FRC was a Gandhian institution established under the direction of Sudarshan Kapur and the KB was founded by Anil Sadgopal; a Caltech trained molecular biologist. Sadgopal was aware of the then efforts of Doon School[15] teachers, who had started a Physics teaching programme based on experiments. It was inducted into four middle schools run by the Bombay Municipal Corporation (BMC), but didn't sustain due to the traditional examination system. Sadgopal contacted these two Doon School teachers (B. G. Pitre and Chandra Kant Dikshit) along with two professors (viz. Prof. Yash Pal and Prof. V. G. Kulkarni) of the TIFR, who had supported the Bombay experiments and discussed the idea of a new experimentation in rural schools of Hoshangabad district (Masih, 1998: 31–32). Though none of the people in FRC and KB had formal training in education methods, but both FRC and KB consulted and received the assistance of the All India Science Teachers' Association (AISTA) and scientists from TIFR (Mukund, 1988: 2147). These initial efforts by FRC and KB made HSTP possible and thus HSTP began as a grassroots science curriculum reform initiative on an experimental basis and the state government permitted the two agencies to conduct their teaching experiment in 16 rural middle schools in Hoshangabad district.

In July 1978, HSTP got a boost when the Department of Education of Madhya Pradesh Government decided to extend the programme in all the middle schools of Hoshangabad district and also took the responsibility of running it. Since the programme needed an autonomous organization to serve as a nodal agency and to develop the curriculum, Eklavya[16] was formed in 1982. With the formation of Eklavya, the responsibility of consolidation and expansion of HSTP was taken up by this organization with the help and collaboration of KB and other resource groups. Eklavya has organized science and literacy programmes on a state wide basis. However, Eklavya's main focus has been in the rural regions of the Madhya Pradesh. Eklavya has placed particular emphasis on the development and use of science kits, tools, equipment and methodologies for teaching science as a part of the literacy programme.

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[15] Founded by Satish Chandra Das in 1935, the school was based on an adaptation of the English public school system on India's tradition-enriched soil.

[16] The organization takes inspiration from the story of Eklavya in Mahabharat. The story of Eklavya from the Indian epic, Mahabharat, illustrates the association between education and elites. In this story, a tribal boy is openly denied the opportunity to learn archery from a famous teacher who was appointed to train the local princes. Refusing to be discouraged, the tribal boy attains mastery by self-practice, in the symbolic presence of a clay idol of the famous teacher. When this surreptitious-training was found out one day, the teacher asks the boy to cut off his right thumb and give it as a ritual gift. This way, the teacher reinstates the social order which allowed only the royal sons to receive archery instruction of the highest quality. This story inspires the organization to bring the best in education within the reach of everyone; to support each one's effort to learn and discover, question and create.

Later Intellectual mobilizations

Role of Intellectuals and Wider Circles:

For sustained and meaningful change, intellectuals have to reconstruct the way they see the world. This means that groups of intellectuals need to become agents of change by reflecting on everyday activities and by acting to resolve the tensions and ambiguities that confront them in their daily lives (Freire and Shor, 1987). The intellectual underpinnings of Eklavya often came from those two action oriented research groups, namely, Friends Rural Centre and Kishore Bharati and partly from the emerging community of teachers and scientists. To Eklavya, intellectuals came from elite institutions such as Tata Institute of Fundamental Research (TIFR), Indian Institutes of Technology (IITs), Delhi University (DU), Centre for Cellular and Molecular Biology (CCMB) and National Institute of Immunology (NII). Later, the involvement of other college and university professionals was facilitated through a formal intervention of the UGC. Consequently, a score of science professionals was seen at *shivirs* and in schools in remote areas of the district, rubbing shoulders with village teachers to create an activity, discovery and environment-based methodology for science teaching.

Intellectuals like Anil Sadgopal, Sudarshan Kapur, Sadhna Saxena, Kamal Mahendroo, Vinod Raina, C. N. Subramaniam, R. N. Shyag, Arvind K Gupta and Anwar Jaffrey, the 'Conscience Constitutents' (McCarthy and Zald, 1977) of this PSMO have shaped and reshaped itself in different ways. They formed Eklavya to launch innovative programmes attempting to connect S&T capacities with the aspirations and competences of communities in rural and semi-urban areas and communities. They further realized that these communities either by design or by sheer negligence have been left out of the benefits accrued out of modern science and its applications. Yet, they acted as resource persons of Eklavya and were actively involved in its activities and programmes although in varying degrees. They believed that education does not occur in isolation from society and environment. Rather education can help to build a scientific-historical understanding of the structure of society and its development.

Anil Sadgopal was the prime mover of this experimental science education project in India which later on took the shape of Eklavya. He worked at the TIFR, in Mumbai for some years and moved to Madhya Pradesh in the early 1970s to address the nitty-gritty of development. Sadgopal's sense of what is possible and what is problematic in Indian context stems from his experiments with the low-cost, high-intensity HSTP. Along with Sudarshan Kapur, Sadhna Saxena and Kamal Mahendroo, he persuaded scientists at the TIFR and professors at the premier IITs to come to Madhya Pradesh villages and towns. During the early 1970s and 1980s, they sat with personnel from the Regional Colleges of Education, the NCERT and government middle school teachers of Madhya Pradesh to find new ways of teaching science. He was influenced by Gandhi's idea of unifying the world of work and the world of knowledge. Sadgopal and his associates pushed towards decentralization of the curriculum, drawing directly upon the local environment, and persuading teachers to tap into the experiences of the community. From the teaching of science, HSTP expanded into social teaching and in the process, languages teaching began to be looked at in a more creative way. The Hindi language, for instance, grew leaps and bounds as HSTP recorded and amplified the work experience of whole villages, linked it with formal scientific theories, and coming up with new teaching ideas and teaching aids, and more constructive approaches to problems of discipline, monitoring

and evaluation. Sadgopal places school at the very centre of society. He envisaged a common school system — the *Lokshala* (People's School) — funded by the State, with each local community at the administrative block level running its own complex of elementary and high schools within a guaranteed framework of equal rights for all children.

For Eklavya, pedagogical innovations that take the local context into account and the popularization of science and its method to make people understand the local socio-political situation as a part of PSM are important vehicles for empowering people and building countervailing forces against the hegemony of modern S&T systems. Vinod Raina, a founding member of Eklavya, stresses that counter-hegemonic is already implied while seeking alternatives to the status quo in areas such as S&T, pedagogy and culture. As a theoretical physicist, Raina resigned from his job in DU in 1982 to devote full time to grassroots science initiatives, i. e. initiating a PSM activities with a nuance in India. He had been advocating alternative school curriculum for rural areas for almost two decades. In the context of localization of syllabus and science teaching of Eklavya, Raina quoted examples of how language plays an important part in children's success in science education. Often, the children have a very clear understanding of scientific concepts, but the terminology used by them in local dialects differs with the standardized requirement of centralized textbooks. The differences in language and terminology is often mistaken as ignorance and needed to be handled with understanding and sensitivity to local conditions. He further argued that the state is inevitably the only prime-mover in the field of science education due to the scale of institutional structure, activities and funding required for the vast numbers of India's children. While voluntary organizations and NGOs cannot match the impact of the state in providing accessibility, however, organizations like Eklavya could carry out the important task of inventing and experimenting with new ideas and strategies in education, which the state can then be convinced to adopt.

R. N. Shyag, a core activist of Eklavya, had a specialization in microteaching and completed his Ph.D. at Punjab University. To him, micro-teaching is a training technique for teachers which simplify the complex tasks. He joined Eklavya in August, 1983. Since then he has been working with Eklavya as a key resource person. Shyag emphasised upon Activity-based science Teaching programme, ASTP in Eklavya. He believes that since ASTP is an experimental-learning, it is useful for small classrooms, primary and upper primary schools. He says "education is common and acceptable to all. There is no direct contradiction or confrontation involved and it is an entry point for working with people."

The widespread view that Eklavya is a 'leftist' organization arises from several facts and perceptions. Many Eklavya leaders hold partisanship in left-wing political parties like CPM (Marxist-Communist Part of India). The identity of Eklavya as a leftist organization is neither new nor false, although every attempt has been made, especially in the recent past to disown this identity and to keep Eklavya's public discourse purely academic. Shyag says that 'working on education enables them to be engaged in some radical agenda. If they talk about minimum wage, they cannot mobilize many people. Moreover, one would face off opposition'. Rather education is common and acceptable to all. There is no direct confrontation involved and it is an entry point for working with people. In essence, educational work does not require the backing of a large political party.

Organizational Resources

Eklavya as a Social Movement Organization

The formation of Eklavya can be seen as a new social movement by sharing some of the features of NSMs: (1) Multiple actors like students, intellectuals and activists played significant roles in the formation and functioning of Eklavya. Those who led the movement were of course intellectuals. The composition of these intellectuals was that it was drawn from middle class background. It is the intellectuals with a middle class origin that made Eklavya proliferate. (2) These intellectuals tried to bring about the changes through different means such as scholastic writings, mobilizing public in a methodical/strategic manner, using media favouritism. (3) The structure of the organization was compact, it was not hierarchical in functioning. (4) Eklavya worked on diverse issues such as innovation in science teaching, promotion of scientific knowledge among the common people, opposition to big developmental projects of global corporations and World Bank, researches related to natural resources and health care. (5) Eklavya has been engaged with various like-minded civil society groups like *Digantar Sambhav*, *Srujanika*, *Vidya Bhawan Society* etc to help them in designing curricula, training teachers and other educational activities. Such collaborations helped Eklavya to disseminate its ideas about education and its innovative work in curriculum development and teachers' training. (6) Eklavya did not work with any political ambitions and political goals. Rather, its goal was to bring a novel science teaching method at the school level by introducing alternative pedagogy. (7) It used science in Freirian notion of 'literacy', began to mobilize the extensive network of teachers and children, who, if meaningfully motivated, can act as potential agents of social change (Rampal, 1992: 70). (8) It is a social movement organization which began as a programme and later on started taking up the issues like education, health, environment, ecology, sustainable development, *panchayati raj*, community development programme etc.

Eklavya is staffed with more than 100 full-time members. It has a three-tier organizational structure consists of Governing Body (GB), Academic Council (AC), Coordination Centres (CC) and Field Centres (FC). The GB was the supreme body of the Eklavya organization which elects the chairperson, secretary, and treasurer. It must hold at least two meetings every year, with half of its members continuing a quorum. It has a membership not exceeding 15 persons and not less than five persons at any given time. Of these members two are nominated in rotation by the AC for a period of two years from among the faculty members of the organization, while the Eklavya director is an ex-officio member. All members have tenure of five years. The AC meets, once in two months. The AC is further divided into the Academic Body (AB) and Executive Body (EB). The former looks after the administration cum academic matters and the latter holds the management side of the organization. FC is a catalytic unit for initiating, testing and diffusing innovative ideas in both formal and non-formal education. The location of the FC maintains a close proximity to a large number of village schools. Each FC has a few resource persons and is expected to involve local manpower and resources. Eklavya has four each FCs and sub-FCs in Madhya Pradesh. The job of coordinating the FCs has been entrusted to a CC and the office of the administrative coordination centre is located in Bhopal city.

Aims and Objectives of Eklavya

According to its constitution, the aims and objectives of Eklavya are to:

- evolve and implement an educational system for social change and general upliftment of Indian society;

• evolve an educational methodology and curriculum for building up a scientific-historical understanding of the structure of society and its development;

• develop problem-solving skills, the spirit of inquiry and scientific temper in society;

• explore new directions in both formal and non-formal education for all sections of the society, including children, youth and adults;

• conduct research into the environmental problems of different regions with a view to developing awareness of the need for conservation and scientific management of natural resources;

• conduct research into the factors which prevent the growth of scientific temper as well as into the mechanisms for spreading scientific outlook in society;

• conduct research in agriculture, forestry, technology, health care and social welfare with a view to relate education with employment potential, the nature of production and the needs of deprived sections of society;

• conduct research in both formal and non-formal education and in all branches of social sciences, pure sciences, languages and communication;

• conduct research in literature, fine arts and cultural traditions of different regions in order to enrich the educational curriculum;

• prepare a historical review and critique on Indian education;

• train educational and research personnel;

• conduct field-level testing of innovative ideas in education;

• identify and utilise various mechanisms and structures, Government or voluntary, and to create structures for the diffusion, expansion and multiplication of educational innovations;

• establish and maintain libraries, information services, museums, workshops and laboratories;

• organize seminars, symposia, discussions, lecture demonstrations, youth camps, exhibitions and other such activities;

• collaborate with other institutions and individuals, including youth centres, voluntary groups and trade unions, in pursuance of the above objectives and finally;

• promote and organize institutions/field level centres/branches/sub-office wether independently or in collaboration with the government, wherever and whenever necessary, for undertaking work in fulfilment of the above objectives (Eklavya Sources).

Financial Resources: The Funding Streams

The major funding of Eklavya camed through DST, Government of India and State Government of Madhya Pradesh. It receives funding from various governmental organizations such as Ministry of Human Resources and Development (MHRD), NCSTC, UGC, CSIR, Indian Council of Social Science Research (ICSSR), Indian Council of Historical Research (ICHR), NCERT etc. In the recent years, Madhya Pradesh Council of Science and Technology (MPCOST) started funding for various projects to Eklavya. In the year 1995–1996 the funding of Eklavya from all Govt. sources was to the tune of Rs. 5,450,000/ and by the year 1997–1998 it moved to the tune of Rs. 7,658,000/. In addition to these in the year 1995–1996 and 1997–1998 the incomes of Eklavya from different sources like sale of publications, donations etc amounted to Rs. 1,120,000/ and Rs. 822,000/ respectively

(Eklavya — A Profile , 1999; and Eklavya Annual Reports, 2004). The activities of Eklavya became so vibrant that by the year 2003–2004, its income from publications, donations etc, reached a hopping amount of Rs. 10,863,000/ (A three year report of Eklavya, 2001–2004).

The charitable trusts of corporate houses like Sir Ratan Tata Trust (SRTT) and Sir Dorabji Tata Trust (SDTT) provided support of which Eklavya built a corpus fund. In 2001, major software firms like Wipro through their corporate social responsibility (CSR) activities, provided funding, research and development, experiments to bring out educational reform in schools. Eklavya along with support from WATIS[17] is running whole school transformation programme in schools of districts. Another major source of funding is through the sale of publications & scientific toys. A few minor sources of income were membership fees and voluntary donations. It is a matter of policy and principle that Eklavya refrains from accepting from foreign institutional contributions.

Human Resources

The most predominant group among its members is of teachers. In addition to a large number of teachers, the other resource pool consists of actively involved scientists, social scientists, educationists and research students from institutions/universities of advanced research and higher education. A large group of scientists, and teachers from DU and a few, from IITs etc joined Eklavya. There were people on fellowships from colleges of Madhya Pradesh to participate in the science teaching programme on a regular basis. And much later, scientists from the prestigious R&D instituions like CCMB, NII and National Physical Laboratory (NPL) etc were also involved in Eklavya. This involvement shows that how a large number of academicians play instrumental role in the improvement of school science education at rural level. Eklavya classifies its members on the basis of their occupational careers such as teachers, students, scientists, social scientists, political activists, social activists etc. In Eklavya, around 35–40 % employees are women. Nonetheless it cannot be substantiated with empirical data, it seems that majority of the active members and leaders of Eklavya were from salaried middle class background.

External Linkages: Liaison with other Civil society/Social movements and the State

Eklavya envisions the emergence of more people's movements against globalization and to do this, it participates in the World Social Forum (WSF) and Asian Social Forum (ASF). Specifically, the global WSF movement milieu is a network of networks, linking multiple social movements (Castells, 1996) constituting a movement of movements. As such, WSF movement explicitly and implicitly engages with the North-South issues. That

[17] Wipro Applying Thought in Schools (WATIS), a WIPRO initiative to improve the quality of education partnering with social organizations, works with schools in all spaces, urban, semi-urban and rural. While the Azim Premzi Foundation (APF), an implementing organization of WIPRO, partners with state governments working for government schools space. For more details see http://www.wiproapplyingthoughtinschools.com.

apart Eklavya showed its solidarity with *Narmada Bachao Andolan* (NBA), a loose confederation of groups from the country as the latter is against the anti-people development policies of the state. Eklavya supports the NBA from the vantage point of its environmental and development perspectives. The NBA has also been supported by the academic community. Eklavya has been associated with other PSM organizations like DSF, KSSP, MVP and *Madhya Pradesh Vigyan Sabha* etc. It was associated with KSSP in 1978 due to its common interest in the areas of education and development. As mentioned earlier Eklavys collaborates with various like-minded civil society groups like *Digantar Sambhav*, *Srujanika*, *Vidya Bhawan Society* etc for curricula designing and teachers' training etc.

Eklavya's networking efforts and alliances with other voluntary organizations, and Governmental programmes in other states (e. g. Bihar, Chhatishgarh and Delhi) as well as the NCERT has brought national credence to the organization. The Students' Educational and Cultural Movement of Ladakh, a strong local organization, sought resource support in preparing a set of textbooks in Science and Social Science and chapters in EVS. Eklavya participated in mobilizing a group of resource persons from outside Ladakh for a continuous period of about six months, involved local primary school teachers for feedback, illustrations and trial of chapters. Eklavya was involved with NCERT for developing the National Curriculum Framework (NCF) in 2005. It has been a forerunner in establishing an effective collaboration within the Government school system. It has created networks of trained Government teachers and developed systems for feedback and support at the field level so that teaching and learning processes can continuously evolve.

Intellectual Resources: Approach to Innovation in Science Education

Intellectual antecedent: Hoshangabad Science Teaching Programme (HSTP):

Prior to the formation of Eklavya, HSTP had begun in 1972 with the aim of bringing innovation in curriculum and pedagogical renewal for science teaching in Hoshangabad district of Madhya Pradesh. It had pioneered the concept of activity-based science teaching (AST) in 1978 which was *contextualized* science through local knowledge and use of local materials. Such kinds of innovations associated with child-centred education and social change was initiated outside the state-system and later demonstrated the need to work intensely with government school teachers through the curriculum and textbooks. Consequently, through the NCERT, the programme was extended to cover all the middle schools (around 220) of the Hoshangabad district in 1978. In 1982, Eklavya, was formed as an NGO with the support from the Government of Madhya Pradesh to carry forward the HSTP model to other districts of the state, and into other subjects and classes of the elementary school. By 2002, thirty years after its inception, the collaboration between the Government of Madhya Pradesh and HSTP-Eklavya had extended the science teaching programme to over 1,000 government schools in 15 districts across the Mahakaushal, Nimad and Malwa regions of Madhya Pradesh. Involving over 2,000 teachers, about 200 resource teachers and a number of resource persons drawn from leading research and higher education institutions in the country, it directly reaches out to over a hundred thousand children annually (HSTP Group, 2002). It had also established 1,500 rural science clubs in these 15 districts of Madhya Pradesh. It was then that the Government of Madhya Pradesh decided to call off the collaboration,

asking all its schools where HSTP was running to revert back to the state books and examinations, as in the long run the HSTP model of teaching did not bring any different result for those schools and for the recipients of this experimental science education.

The objective of HSTP was to help improve the quality of science teaching in middle school (classes VI to VIII) within the existent government school system, and within the mainstream syllabus, based on the principles of 'learning though activity' in contrast to the prevailing textbook-centred 'rote learning'. On the basis of objectives and perspectives of HSTP evolved from 1972 to closing down of HSTP in 2002, the thirty years of HSTP can be divided into four distinct phases (HSTP, 2002; Eklavya, 2005). The phase I (1972–1977) designed for science teaching for rural transformation had involved 16 schools of the rural areas in Hosangabad. The phase II (1977–1983) demonstrated the pilot phase of evolving a holistic science education in 16 schools. The objective of the second phase was to evolve systems for introducing innovations in school education at the district level. The phase III (1983–1990) forwarded the objective of the second phase of creating and disseminating the system from micro-level experiments to macro-level. The phase IV (1990–2002) focused social validation of HSTP approach through evaluations and public advocacy. Public advocacy was needed to improve the HSTP approach through press and other media as well as by organizing interactions at various public spheres.

It was a remarkable fact in the Indian social context that scientists and other academics from the elite institutions in the country went into the countryside and taught science at the village level. One could be impressed by this display of idealism among these academics. The government also supported the effort. Why then did the effort fail (as HSTP was forced by the then MP government to close down in 2002)? Firstly, since periodic scientific evaluations of the HSTP pedagogy were not carried out which could have suggested that the programme was running amateurishly and relied too much on the subjective judgements of the participants? Secondly, the programme was not running in the state as a whole. It was taught only in 560 schools but not to all the schools in the state. In this context, an active member of Eklavya said that as far as up-scaling HSTP to the entire State and other states are concerned, was purely a political decision. He further opines that the then bureaucratic personnel failed to find the significance of HSTP. It was also argued that the concentration of HSTP confined to the districts having huge tribal populations. Thirdly, members of Eklavya drop dark hints that the closure of the HSTP was the result of a plot by right-wing parties. If so, then at the time the programme was discontinued, there was a non-right wing party, i. e. Congress government in power in Madhya Pradesh. Why should they have succumbed to right-wing pressure, if they felt the programme was doing something useful? Fourthly, the programme totally dissociated from needs of the local people. It was a programme where a bunch of elite people (those closest to the former colonial masters and product of western education as well) descended on the villages to teach economically insecure people about lofty things like "scientific temper", when what the natives/localites expected from education, was a job or at least improved practical skills to survive off monsoon-driven agriculture of the rural economy, and to negotiate with the local government. Finally, HSTP demonstrated the possibility of innovation in government educational structures, and the public-private partnership (PPP) is one way of implementing changes that neither might achieve on its own. This innovation phase was the preoccupation of many Gandhians and scientists working on science education and technologies at TIFR, IITs, DU, and other Indian universities. It had, however, set the tone for an alternative discourse and fostered a climate of debate on science education that addresses the relationship between child, teacher, classroom and learning.

Eklavya's Innovative Approach:

Eklavya's approach to innovation in school science education can be seen through *curriculum development*, *teachers' training* and *school development*. The curriculum development is made through a participative and collaborative process involving subject experts, teachers, researchers, field level workers, designers, artists etc. They usually begin by developing a critique on the existing curricula and consequently, an alternative framework gets formulated. This is largely based on accepted principles and objectives of education. It is also informed by latest research on the learning process and the subject area. These innovations are first field tested at a micro-level in a few selected schools and later expanded to more schools and other regions. Along with text-books and work-books, kits and other teaching-learning materials were designed for children. With an attempt to structure the content of the courses around the environment and life of the students, the activities relied heavily on use of locally available materials and take care of factors like cost reduction and procurability. For example, Eklavya science teachers identified *Babool ka Kanta* (thorn of Babool) available locally in the regions of Madhya Pradesh as an instrument for puncturing and dissection and included it in a science kit they developed for biology students. They further developed an inexpensive way to explain basic machines. This involved using spent ball-pen refills, flattened paper clips as "axles" and ordinary buttons sealed back to back under candle flame to provide multipurpose wheels and pulleys. The standard curricula for middle schools, as found in the science literacy maps, follow a strong "bottom up" approach. Concepts are introduced often at very early stages, such as in the first or second grade and then developed by revisiting the same in greater depth in the upper grades. Connections between topics are also exposed through this development process. This approach is obviously effective as it follows for the time taken to absorb and develop each topic.

For, Eklavya, the teacher is the pivot in which innovative educational changes in schools hinge. Hence, teachers' motivation and orientation were the most important inputs in any process of educational changes. To do this, Eklavya devised appropriate re-orientation and training programmes for the teachers in the methodology and content of the new curriculum. To ensure further back-up at the classroom level, a system of regular visits to every school by resource persons had been set in place. Such visits were also a major source for feedback on the curricular package, an essential input for further improvement. Teachers met once every month to discuss and sort out their classroom problems. These meetings also provide a forum for continuous training and feedback collection. Thus, increased peer group interaction and improvement in their subject knowledge base as well as their understanding of educational philosophy, helps improve the self-image and self-esteem of teachers. By contributing to all aspects of innovation, from text-book to educational administration, teachers become the authors and owners of these innovative practices. Eklavya evolves teacher training techniques that transform the teachers from fountainheads of knowledge to facilitators.

School development means looking at change holistically and approaching the problem from all fronts simultaneously, e. g. if the science teacher introduces experiment-based learning and a questioning attitude in children, the language teacher complains of indiscipline in classroom, of students being unruly and noisy. Students who move freely in a social science classroom, working in groups and interacting freely with the teacher feel stifled in the mathematics classroom. Hence, the evaluation methods and examination system have been designed according to the learning objectives as they tend to become major determining factors of classroom practice. Eklavya has developed alternative systems of open-book, written as well as practical examinations.

Activity Types and Audience Reach

Since its inception, Eklavya's PSM activities aimed at community involvement. It has been undertaking a wide-range of activities like teaching programmes, popular lectures, the joy of learning campaign, posters and street plays, *jathas* on specific issues (e. g. Bhopal gas tragedy, health and medicine, literacy, women's equality, rural technology etc), and publications for promoting scientific literature. The target audience of these activities has been adults, especially middle-class youth.

***Primary Education Programme**:* This programme began with the growing realization that a proper grounding of children at the primary level enhances the quality of learning in middle classes. The primary education programme (PEP) of Eklavya is popularly known as *Prashika*, an acronym stands for *Prāthamik Shikshā Kāryakram*. The programme was rooted in the initial discussions of HSTP members and students of the Department of Linguistics in the University of Delhi in 1983. *Prashika*, an experiment in making primary school education a joyful one, was started in 1987. The underlying premise was that the unfriendly and unattractive package of education offered to poor rural children was responsible for the low levels of enrolment and high rates drop-out. Hence, in 1987 a book of ideas entitled *Khushi Khushi* (Happy Happy) was put together along with a guide to the teacher as to how to use it. The programme demonstrated how primary school children in rural India can be made to feel that their school has a utilitarian function. The experience of PEP contributed to the design of a formal school programme called *Seekhna-Sikhana* (Learning-Teaching) developed under the aegis of the Madhya Pradesh State Council of Educational Research and Training (SCERT), with Eklavya's active collaboration. This programme now covers almost 80,000 primary schools in the state.

***Forums and Popular Lectures**:* In the last 25 years of Eklavya, over 300 discussions and lectures have been organized on topics such as, 'what is a comet', 'Darwin's theory of evolution', 'the world of the blind', 'the forest policy', 'role of women in social change', 'Narmada Sagar dam project' etc. These lectures provided various critical discourses, talk about what they think and understand each other's viewpoints. The observation of science lectures and science classes at schools revealed that the students were imparted knowledge of science in their mother tongue. The students were provided opportunities to make themselves acquainted with scientific knowledge in their native language which might not otherwise be available to them. Active interaction between the resource persons who presented the programmes and the participants were also observed. Eklavya established a discussion forum called *Ambedkar Vichar Manch*, (Ambedkar Discussion Forum) in collaboration with Dr Babasaheb Ambedkar National Institute of Social Sciences, Mhow, MP.

***The Joy of Learning Campaign**:* The joy of learning (JOL) is a means of developing interest in children towards education in general and science in particular. The JOL was designed in such a way that the main thrust goes to children of two age groups from 6–7 years and 12–14 years. The programme was consisting of a series of children science festivals (CSFs) at village, block and district levels. The JOL festival at national level was organized in October-November 1994 by BGVS along with Eklavya. It was attended by 1,000 children (500 host children from Delhi and 500 guest children from other parts of the country), 300 resource persons. Students visited important S&T institutions, Nehru Planetarium, National Museum, and Rail Museum etc as part of the science tours organized under the programme. The science tours formed an integral part of the JOL festival. The basic objective of the

tour was to promote the observation skills of the children and to expose them to actual life situation. More than 30 scientists from different scientific institutions conducted interactive sessions on various science related topics. A second round of JOL programmes were undertaken between August-October 1995 on the theme of Total Solar Eclipse. Themes like 'sky Watching' and 'Eclipse Watch' were added to the regular JOL programmes later on. Based on past experiences, Eklavya undertook the preparation of materials on science education and low cost experiments for JOL. Science teaching through simple experiments, teaching social science through interesting activities, mathematics learning through games and puppetry, creating works of art from waste material etc was the foci of these trainings.

Posters and Street Plays: Eklavya uses posters to inform the people through a media-controlled, unified language of objects that recognizes the meanings and affiliations associated with the contents of these posters. Posters have been developed on issues like 'Bhopal gas tragedy', 'what are miracles', 'people's health and medicine', 'literacy, women's equality', 'Narmada dams' etc. These are mobile programmes going from one village to another, often on cycles. An audio-visual workshop was organized at Bhopal during 6–12 April, 1984 to evaluate the relative effectiveness of such medium. The workshop was based on the theme of 'Evolution of Machines' and supported by the MPCOST and Department of Teaching Aids, GoI. During the workshop, it is understood that scientific principles of machines are adequately dealt with various levels in many existing books and films. Scientific principles of machines per se are of interest only to a very specific category of people, e. g. science teachers, professionals, students. The objectives of the audio-visual workshop were thus formulated to raise pertinent questions regarding the role of technology in society. Eklavya also uses the mode of street play to communicate scientific messages. In street-plays several artists performed on the issue of drug addiction and alcoholism, girl-child education, ecology and environmental pollution, child labour, developmental issues, exploitation of consumer market by MNCs, consumer protection, female foeticide, national integration and illiteracy etc.

Publication and Promotion of Science Literature: The objective of the publication programme of Eklavya is to generate and promote science and educational publications in local languages. Emphasis on the local language is the major reason for its success in drawing support from the local people in the region of Madhya Pradesh. Eklavya provides the reasons for publishing books and magazines in local language, i. e. Hindi. First, the market publishes books in English languages and there is a shortage of books published in local language. Second, as the local language of Madhya Pradesh is Hindi, publishing books in Hindi can be easily grasped by the readers. Third, it publishes the books and magazines for school going children, in particular, for rural as well as urban poor children. Finally, Eklavya understood that it would be rather difficult to translate from Hindi to English due to the developmental problem of the context.

The publication activity of Eklavya started with *Hoshangabad Vigyan*, a quarterly science magazine for teachers, parents, educationists and people associated with different programmes of Eklavya. *Chakmak*, a monthly science magazine for children was launched in 1985 to reduce the dearth of good reading material available to children, especially in rural areas. The role of *Chakmak* in science education is to inculcate scientific temper among children. In in the 2000, the publication of *Chakmak* had a print order of just 3,000 copies per month and a tense debate was on at the editorial office over its fate. In its heydays, *Chakmak* had a print order of 50,000 copies as the Madhya Pradesh Government brought them

for distribution in schools. Sushil Shukla of Eklavya believes *Chakmak* is different from others of the genre in that it has a bit of science and other details apart from the 'once upon a time' tales. At the Bhopal office, Sushil Shukla was not also sure if advertisements from foreign companies should be accepted as he believes the editorial contents could get affected. It need not be so but then he is not convinced though one cannot agree with him. Apparently, Eklavya is averse to diluting the pristine purity of its ideological commitment even if it means suspending printing of *Chakmak*. Eklavya's *Srote*, a weekly science news feature service has been catering to newspapers, radio and television. *Sandarbh*, a bi-monthly on education and science magazine helps to widen science teacher's understanding of the subject. The following Table provides information about the number of titles published and the print run of these titles from 1993–1994 and 2003–2004.

Table 1

Showing print run of Eklavya Textbooks during 1993–2004

Year	Titles	Copies Printed
1993–1994	4	25,000
1995–1996	15	35,000
1996–1997	5	22,000
1997–1998*	24	91,000
1999–2000*	15	112,000
2000–2001*	14	144,000
2001–2002***	34	171,000
2002–2003**	60	228,600
2003–2004*	35	71,000

Source: *Eklavya Annual Reports 1993–2004.*
* Includes new titles and reprints of the title publications.
** Includes new titles, reprints of the title publications and textbook reprints.
*** Includes new titles, colour titles, reprints of the title publications and textbook reprints.

Eklavya's publications emerged from the field experiences in different programmes, or have been tried out in the field independently. The publication efforts of Eklavya are essentially for the promotion of readership of progressive and scientific literature. Books were mainly marketed through PITARA, a storehouse of over 1,500 innovative educational resources from all over India opened in the year 2000.

Kabir Bhajan Mandalis Programme: In the year 1993–1994, there was a shift in PSM activities by Eklavya. Firstly, Eklavya initiated activities with strata of population hitherto untouched by them, i. e. illiterate agricultural workers etc this was done through *Kabir Bhajan Mandlis* (Kabir Devotional Songs Circle), a very old network of traditional *Bhajan* (devotional) singers in Malwa region of Madhya Pradesh. The simple yet scientific thought behind all *Kabir Bhajan Mandalis* programme explored the oral tradition and Kabir's[18] verses that existed

[18] Kabir, a Bhakti saint, ranks among the world's greatest poets. Back home in India, he is perhaps the most quoted author. The Holy Guru Granth Sahib contains over 500 verses by Kabir. The Sikh community in particular and others, who follow the Holy Granth, hold Kabir in the same reverence

in the Malwa region of Madhya Pradesh. This programme created a sense of unity in diversity, an integral part of Indian culture. People, both artistes and listeners, got a chance to come together under one umbrella and exchange ideas, perform, watch performances as per their own needs and liking. Gradually it took an organized character and turned into *Kabir Bhajan Evam Vichar Manch* (Kabir Bhajan and Discussion Forum). Most of the *Kabir Bhajan* groups consist of people from Scheduled Castes (SCs), very lowly placed in the social hierarchy.

Over a period of time, Eklavya kept in touch with these groups and established a dialogue with them explaining their mission and objectives. Eklavya believes that the underprivileged and *dalit* sections of society are completely engrossed in their daily lives and in meeting their basic needs. Eklavya further argues that unless they are involved with the programme at intrinsic level, the programme can not achieve any meaningful success. In a sense, there was popularization of the radical and highly secular thoughts of Kabir. Eklavya examined that Kabir was rampantly misinterpreted by sects that created a magical aura round him and used it to perpetuate the same orthodoxies. This trend was the game-plan of powers that did not want his real message to percolate down to the masses. Eklavya also identified the progressive contents in the songs of Kabir and his followers.

Rural Technology and Artisan Development: Eklavya has initiated programmes in fisheries, low cost construction, watershed development etc. These initiatives are meant to serve as training facilities as well as models of appropriate technologies. For instance, Eklavya has set up leather production centres in cooperation with local leather artisans for rural development. The methodology of work involves trying out improved methods and techniques in specific areas of productive activity without harming the environment. On the other hand, Eklavya develops strategies for wider people's participation in developmental and productive processes using these methods and techniques.

Eklavya was conducted in 1992 a base study of socio-economic conditions and production techniques of 8–10 artisan groups in three blocks of Hoshangabad district (Eklavya, 1999). It has initiated a rural leather tanning project in December 1994 on the use of adapted techniques in vegetable tanning to upgrade local leather and for skill development amongst local flayers and tanners. This tannery provides improved leather to local artisans for manufacturing leather goods. It has also used improved cooker techniques for utilizing cattle carcasses for obtaining fat, bonemeal and meatmeal. Eklavya identified the major problems and limitations of the existing practices in house-building in local field areas by poorer sections. By providing a solution to this, Eklavya has taken up a study on the low-cost construction with the objective of planning possible support work. Besides, Eklavya has formulated a fisheries programme to set up a Fisheries Resource Centre to support the development of fish breeding in two districts, i. e. Hoshangabad and Dewas. This is to be achieved through production of fish seed, fry and fingerlings as well as training programmes in fish breeding.

It can be summarised that Eklavya's members tried to make people aware of the utility of local planning and use of resources at panchayat level. They tended to advocate that centralised planning and development activities of the government by themselves can not make best use of the local resources. And that panchayat level planning by panchayat people themselves might be best suited for optimum use of local resources.

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as the other ten Gurus. Kabir openly criticised all sects and gave a new direction to the Indian philosophy. This is due to his straightforward approach that has a universal appeal.

Protest on Bhopal Gas Disaster: A significant intervention by Eklavya was in the case of the 1984 Bhopal disaster when lethal methyl isocynate (MIC) gas leaked from a Union Carbide Plant at Bhopal into the densely populated city. Hundreds of thousands of people were seriously affected; the number of deaths so far is estimated at several thousands. Eklavya took upon itself the task of creating a *Jan Vigyan Samiti* (People's Science Society), a network of science-society groups in order to support the victims through technical, medical and scientific information and intervention, which included a spot survey of the water, air, flora and fauna, particularly vegetables. Eklavya also commissioned independent scientists to monitor Bhopal's fields, gardens and water supplies for MIC breakdown products and published a *People's Report* on public health concerns in the city. With the official organs woefully unprepared to handle such a massive tragedy, and with no factual information on the gas leak and its toxic effects coming forth to the public, the disaster had brought home starkly the relevance of PSM.

During post-Bhopal Gas leak incident, in association with Medico Friends Circle (MFC), Eklavya tried to bring S&T of the tragedy into the public domain. In so doing, they accused the government of withholding information regarding cyanide being a component of the gas and brought to question the competence of its scientific establishment. It is in this context, an alternative scientific establishment was visualized rather than presenting two sides of science. First, the modern reductionist attitude sees advances in S&T not being inexorably harmful to the environment and modern science does not have to be diametrically opposed to ecological health. Second, it could prompt the formulation of new international standards/protocols, for risk-regulation and the 'Right to Know' policy. Eklavya exhibited how people's lives are threatened, they are denied knowledge of the threat so that they can neither anticipate nor resist threats, nor can they cope with the destruction of human lives. The entire Bhopal gas leak tragedy questions these assumptions in fundamental ways.

Addressing the Gender Question: Eklavya has identified the minimal participation of women in the PSM. This was pointed out in the wake of the declaration of women's decade from 1975 to 1985 by the UNO. During the year 1983–1984, Eklavya started working on awareness of women's health with local relevance. From 1992 to 1995, Eklavya engaged in the annual workshops, called as *Sakhi Samavesh* (gathering of girls) where 'Health' was the major theme and 'women's rights', 'women's employment', and 'training in utilitarian skills' etc were other themes. The Adolescent Health and Education programme started in 1997 for girls was meant to sensitize girls as to how gender is the basis of many relationships and how they can develop healthy relationships with family, friends and male members of the society. The book *Beti Kare Sawal* (Queries by the Daughter) was an outcome of this programme. The topics covered in this programme were 'anatomy', 'reproductive health', 'reproductive system', 'menstruation and menstrual problems', 'puberty in boys' and girls', 'pregnancy', 'contraception', 'sexuality', 'rape', 'infertility', 'sex-determination', and 'HIV-AIDS', and 'primary healthcare'. In 1999, Eklavya organized training workshops in 21 middles and higher secondary schools for girls. The focus was on 'how the fertility of a woman affects her social statuses'. Such workshops were done through innovative methods like debates, games, story-writing and group discussions. Eklavya was also extending the concept of people's health to include health care, nutrition, safe drinking water, sanitation, employment and basic housing rather than equating health with disease, doctors, hospitals and drugs.

Transformations and Renewal

As the new areas of work get added into Eklavya's activities, the debate raised within Eklavya certain questions: Should one management council look after policy and decision making of education, publications and development? Do programmes in education and those in development require a different environment, in the sense of work culture, organizational setting, types of manpower etc? In response to these debates three alternative organizational forms were suggested to house the development programmes. These alternatives suggested that development should be:

(a) carried out as another set of objects within Eklavya, to be coordinated by the existing 'coordinating and decision making' systems;

(b) to organize a set of activities in development under a separate institution within Eklavya;

(c) to form an independent organization, especially for this purpose.

Consequently, Eklavya was bifurcated into two autonomous units such as a school education and publication unit and a rural development unit in the year 2003. The rural development unit was registered as a new society on August 11, 2003 as the *Samavesh* Society for Development and Governance. The literal meaning of the word *Samavesh* is inclusion. Like Eklavya, it is also an NGO. A total of 32 staff members of Eklavya left to join the new society in 2004.

Several implications emerged from Eklavya's experiments. First, the understanding of the field and the community of science activists get constituted by it. Science teaching programmes like HSTP was a critique of the modern Indian S&T education which had a British origin. Drawing from Pierre Bourdieu's notion of the "(scientific) field", the field of critique can be seen as constituted by various science activists, teachers, actors/intellectuals who exhibit competing societal knowledge interests, in which the specific issue at stake was the mobilization of various kinds of resources to counter the forces behind the hegemony of modern western S&T education. Second, it has attempted to address a range of issues related to science curriculum reforms; its implementation as well as the continuation. HSTP reminds us how tenacious one has to be to challenge the 'system' or the status quo persists. Third, the hegemony of the formal state curricula (Rampal, 2003) on alternate non-formal initiatives like HSTP has continued to force non-governmental schools to be relegated to the margins of unrecognized institutions, with no systems of accreditation and certification. Finally, it adds an alternative mode of knowledge conception, production and utilization to the larger Indian science movement.

Conclusion:

The five cases of radical PSMOs and the like have survived and thrived in India, because of the vibrant democracy there. The Indian democratic state is not only forced to concede enough space in the public domain to the civil society elements but also rendered tolerant of their divergent ideological shades. The PSMOs are of course an active and vocal lot among the civil society elements. The present exercise makes it abundantly clear that these PSMOs have of course managed to achieve their own goals and have thrived in a limited sense. But as a whole these have made certain note worthy but subtle points that deserve scholarly attention. Having formed an umbrella organization like AIPSN the various people

science movements in India have proved to be capable of renewing themselves and adapting to changing economic and political dynamics of Indian society. By adopting newer action programmes (e. g. issues of ecology, issues of pollution, climate change, issues of reproductive health of women, drug abuse, IPR, anti WTO and MNC, anti-Indo-US nuclear deal etc) apart from their original programmes (e. g. literacy, indigenous knowledge systems, nuclear radiation/leakage, and the like) these have proved their adaptabilities. The very origin of AIPSN from KSSP lead *Kala Jathas* is evident of the fact that the PSM could renew itself through diversification and move ahead. And by forming an all India umbrella organization like AIPSN with large number of affiliated PSMOs, these also proved that the movements can make alliances among themselves and renew the movements over decades and even reorganize and strengthen themselves by coming under one bigger umbrella organization when the original PSMO (KSSP) fades away. Similarly the subsequent birth of BGVS from the same movement of course with an initiative from the central government entails that the PSM had developed enough adaptabilities and even it could mend fences with the central government against which it had set out the movement itself. The other noteworthy evidence to corroborate our view could be the case of Eklavya where the two grassroots level organizations like the *Kishore Bharati* and the *Friends Rural Centre* merged together to bring into action the well known HSTP for a radical science teaching programme. And before completing thirty years to become obsolete and unable to continue further it renewed itself by forming another PSMO named, the Eklavya. Although Eklavya carried forward part of its activities but subsequently went for expansion with newer agenda and later bifurcated itself again to renew itself. Thus it should be clear that the locus of the movement continuously renews itself through its adaptabilities and this impetus accordingly takes the form of organizational renewals and reformulations. The locus of the movement of course constitutes the movement intellectuals who have been rich sources of creative ideas and hence successfully could add to the dynamism of the movements (without letting these die down). The movement has revealed its own dynamics over decades.

Another note worthy point in the context of this movement is the response of the Indian state. As the movement was growing wider and involving more and more intellectuals as well as people a centrist Govt. at New Delhi of course could not ignore it. It becomes too obvious to say that it would certainly like to relate itself to such a movement if not try to completely take over it. Having known that taking over such movements would not be feasible as well as viable in the long run, it tried to relate itself by initiating an organization like BGVS where it could allure the leader of the movement with a chair and resources, of course with some freedom. This view stands vindicated when we observed the desperate efforts of the DST (GOI) to form an all India umbrella organization named the NCSTC where it tried to rope in many of these PSMOs. With its sustained efforts DST succeeded in forming NCSTC with the affiliation of dozens of PSMOs. Thus the government has been able to relate itself to these voluntary and leftist dominated PSMs and has not alienated itself.

With regard to the comparability of these movements with the science movements from other parts of the world, as discussed earlier, the Indian PSMs seem to be unique. Because the science movements from USA, Europe and Australia discussed earlier were pure types as these were truly science movements that emerged within the domain of professional science, involved only professional scientists and their conduct (with exceptions). Hence those science movements remained confined very much within the realm of science. Whereas the Indian science movements were that of the people, initiated by the people, led by the people formed their organizations and related to the domain of S&T (involving amateur as well as

professional scientists and engineers) through their own issues and in their own ways. Of course being people centric the Indian science movements have assumed definition of science/ technology (some what different from that of the western) which is more inclusive and not strictly professional. In this context the science/ technology movements of the former Soviet/ eastern block come much closer to that of the Indians (may be because both were guided by the same ideology and both emphasized science popularizations). However the science movements of the then Soviet/eastern block were guided and driven by the state and the Indian ones are guided and driven by the activist intellectuals (implying its voluntary nature) and poised against the state and its dominant S&T.

Besides the observation on renewal and expansion of the movement it is desirable that we note the subtle points of imprint made by this movements: (i) These PSMOs have worked as pressure groups to make S&T in India more people oriented; by saying Science for Equity (socialism) and for Social justice. (ii) These have worked as critiques of state S&T policy and hence have succeeded to some extent in linking state science to the people. The state science is not merely linked to the people as deliverable goods and services but through people's organizations like these PSMOs. There have developed strong institutional linkages between the state science and people through these voluntary people's organizations (not through state science organizations). (iii) These PSMOs have kept alive the bottom-up approach to policy making and governance in science/ knowledge in India. Along with the top down approach, concomitant is the bottom-up approach that is permissive of feedback as well as new ideas moving upward from the people through these civil society elements. Thus it had strengthened the Indian civil society vis-a-vis state. (iv) Further, these have succeeded in linking science of the state with the rise of people's science, i.e. indigenous knowledge systems that are traditional and culturally embedded. These have encouraged the embodiment and growth of the articulations of the notion concerning 'indigenous sciences and technologies' and the 'alternative sciences and technologies' (the latter being inclusive of the former as all the alternative sciences and technologies are not necessarily traditional). (v) These have also brought recognition to and provided legitimacy to the indigenous and alternative sciences and technologies in India. (vi) A low-cost method of campaigning like, street theatre has shown the necessary flexibility to articulate local issues and forge a more intimate relationship with the people and audiences. (vii) These have handsomely contributed towards the literacy and the environmental movement in the country. (viii) It is true that a robust Left movement gives the background for a wider response to the larger PSM and the two complement each other, and to the process of raising people's consciousness towards S&T.

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Appropriate Technology Movement in India: An Emphatic Drift

This paper offers a comprehensive understanding of the concept of Appropriate Technology (AT) and brings out its relevance today both from the standpoints of developing and developed countries. The paper also focuses on the evolution of AT movement in India and ideological contributions by various thinkers like M. K. Gandhi, E. F. Schumacher, and others to this movement. It also stresses that AT movement as a discursive one is not about mobilizing activities and people but is about academic discourses on AT. Lastly the paper presents three empirical case studies of AT promoting organizations emergent of the said movement that represent the original discourse and the later turning points of the discourse in the AT movement in India. Noteworthy, that these three case studies are analyzed from the vantage of the well known resource mobilization theory of social movements.

Keywords: Appropriate technology, Discursive movement, Resource mobilization theory, Sustainable technologies, Intellectual mobilizations, Institutionalization.

Introduction

Arrival of 20th century sounded a great optimism for mankind that technology and science would provide solutions to almost all human problems, particularly those associated with poverty. However, these optimistic expectations had already begun to be undermined in the mid-20th century due to the long term adverse effects of technological innovations — for example, the introduction of extensive and capital intensive agriculture causing soil degradation, water scarcity etc and indiscriminate industrialization causing ecological degradation and climate change, use of labour intensive technologies and use of steam engines causing environmental and pollutions etc. The technology which has benefited us with the marbles of economic development and comfort is being countered by its own misgivings, i. e. by unleashing serious ecological crisis, environmental degradation, value crisis and economic inequalities. Great technologies have failed to provide solutions to many of world's major problems in particular to mass poverty. The global attempts to alleviate poverty in the developing world, which houses 75 % of the global population, also facilitated a shift in the global thought process towards

emergence of appropriate technologies. It had been natural to suppose at the outset that the best way to bring economic development was to facilitate in developing countries the kind of technologies that had led to the development of the developed countries. But in due course of time owing to the inaccessibility to developed technologies by the developing countries and the built in depenedencies there as well as growing unemployment and income disparities in developing countries lead to the emergence of concepts like appropriate, intermediate, and alternative technologies to be taken with increasing seriousness to solve human problems in a more human manner. India like other developing countries has experienced the rise of this great intellectual debate in the context of its development.

Objectives of the Paper

The objectives of this paper are: First, to understand the conceptual framework, debates on AT both from the standpoint of developing and developed countries; Second, to study the intellectual heritage and historical antecedents of the AT movement in India; Third, to study empirically the functioning of AT organizations, i. e. case studies of three Appropriate Technology (AT) Centre's, e. g. Appropriate Technology Development Association (ATDA): Lucknow, Application of Science and Technology to Rural Areas (ASTRA) later turned into Centre for Sustainable Technologies (CST): at the Indian Institute of Science (IISc) Bangalore and the Honey Bee Network (HBN): Ahmedabad and to articulate their contributions to enrich the movement, if any and; Fourth, to portray the trajectory of the AT movement in India through its varying thrusts and traits at different points of time.

Methodology: The study is based on both (empirical) primary and secondary data. Apart from empirically studying the three AT organizations, the relevant information regarding the functioning of these organizations was collected through interviews among a few of their personnel. And secondary data were collected from various sources like their, annual reports, documents, and publications. From sampling view points, if ATDA is an older organization started by a Gandhian like M. M. Hoda to pursue ATs, the ASTRA cell is an example of a research organization started by a citizen scientist like A. K. N. Reddy who was inspired by the ideas of M. K. Gandhi and E. F. Schumacher to develop AT, but its thrusts have changed over decades towards the notion of sustainable technologies. Lastly, HBN is a more recent organization with nuance, where grassroots innovations are registered and at times developed into sustainable technologies, which are also some sorts of appropriate technologies, as these are often socially and culturally embedded and based on local resources & skills.

Appropriate Technology (AT): A Concept

AT is a concept that denotes a set of ideas or a frame-work within which we are to think and act for the development of society. The aim of this concept is to provide a basis and method for the choice of technology. It is intimately connected with the concept of development whereby development meant development of people. It has led sociologists, economists, philosophers, technologists, planners and environmentalists to contribute towards its definitive descriptions. It is directly linked to major developmental issues like unemployment, population growth, rising inequality in society, urbanization, environmental

pollution and ecological degradation etc in many ways. The concept of AT hence endeavors to eliminate the adverse effects of modern technology by devising the same to retain its organic link between man and nature and to sustain growth by making units as small as possible. It also tries to change the life-style of the world by bringing mankind back to a life of simplicity which is in harmony with nature. The concept of AT is also closer to the operation of small scale industries. It advocates for smaller technologies dispersed in various areas with a bias against sophisticated large scale capital-intensive technologies. The concept can be used in terms of engineering designs and consultancy groups that have the necessary socioeconomic-cum-engineering expertise and have familiarity with the situation in the country (Tandon, 1974: 75). The concept of AT reminds us that alternative technologies are available or could be developed for many tasks. AT as a concept, is a set of diverse and engaging explorations of the linkages between technological choices and social values (Long, 1980: 38). AT is a line of thought and action which is being increasingly accepted and diffused due to the fact that it offers solutions to a world facing serious problems of inequality, injustice through loss of livelihood and resource crises because of resource intensive character of modern industrial technologies as well as its capital intensive character (Bertha, 1979: 1). The best can be said that it is about the appropriateness of the technology which is the touchstone of the concept. And the appropriateness is defined in terms of environmental and climatic suitableness, capital or labour intensiveness, use of local resources, energy saving character and resource intensive character of the technology.

Once 'Appropriate technology' was on its way of becoming a household term also. The proponents of small, environmentally sound, human-centered technologies have found a Bible of sort in E. F. Schumacher's book 'small is Beautiful'. Common examples of such technologies are solar heat collectors, windmills, recycling of waste to produce methane and compost, composting toilets, urban greenhouses and rooftop hydroponics' gardens etc (Holden, 1977: 857–859).

In sum, AT is a technology which can satisfy the basic human needs starting from the needs of the neediest. It creates a sense of being endogenous and self-reliant through social participation and control. Further it promotes environmental soundness, labour maximal utilization, employment generation, capital prohibitive and cost effectiveness, reduced dependence on imported technology and foreign exchange savings etc. It is greatly resource saving and energy saving too. In addition to these of late it is found to be physically non-displacing as modern industrial technologies are.

Debate on Appropriate Technology

In the past, 'Appropriate technology' concept was generally used in the context of developing countries only. But of late, the concept of AT has gained currency in both developing and developed countries. Originally, the concept had emerged in response to employment creation and poverty elimination in developing countries. But large numbers of developing countries today rely on 'heavy' industrialization path to economic development and the technologies they chose do not necessarily reflect local factor endowments and their socio-economic relevance in these countries. On the contrary developed countries are now worried about green and energy saving technologies under the rubric of appropriate/ alternative technologies.

Appropriate technology for Developing countries: The major problem developing countries face even today is mass poverty. There is shortage of food and nutrition, little access

to medical care and education, no clean drinking water facilities and very poor housing. It is here with such problems, arise a question of choice for AT. The form of alternative technologies developed for use by, 'developing country family' is generally referred to as Intermediate or low-cost technologies. It is the technology which selects or develops methods which are compatible to local economies, and which are intermediate in cost and their sophistication being placed between simple and complex technologies. The concept 'Intermediate technology' which was coined by E. F. Schumacher concerned itself with technical solutions to certain of the development priorities of the developing countries, and has concentrated upon finding ways to combat high unemployment and poor community services on low budgets and low technical inputs. On the other hand, Alternative technology concept emerged in response to the issues related to developed nations. Both alternative technology and intermediate technology qualify as appropriate technologies, because both relate to the issues of socio-economic development. Both seek to work with the natural systems rather than against them. However, the indicators of AT in the context of developing countries continues to be its labour intensive character, suitability to local climate, dependence on local raw materials, self- reliance in matters of spare parts, technical services, R&D, etc and cultural relevance (embeddedness). Added to these are the indicators like, eco-friendliness and energy efficiency of the technology.

Appropriate technology for Developed countries: 'Industrialized country family' comprising the developed nations of the West started to develop AT in response to a growing concern for the protection of the environment and more recently to escape a mounting energy crisis. The industrialized country family' is currently using AT to assist itself in the search for new and renewable sources of energy and in developing programs for the reduction of environmental damage caused by industry. The form of AT developed in the ' industrialized country family' is generally referred to as Alternative or Soft technology; it is a technology which seeks alternative approaches to present methods which are considered by many to have pressed too hard on the limits of existing resources (financial, natural/material, and human) (Lewis, 1983: 2–3). Nevertheless, the two major concerns of AT in the developed countries are its eco-friendly and energy efficient character.

Exiting Literature on Appropriate Technology in Developed and Developing Countries:

Many groups and scholars in the last three decades have been critical of the modern technology, and have advocated changes in rather than forsaking it. Their diversities of interests and philosophies are reflected in the variety of labels they have chosen to describe their proposals: appropriate, intermediate, alternative, radical, self-help, democratic, people centric, progressive, low cost, autonomous, soft, utopian, liberatory, non-violent, convivial and the like. There were some whose prime concern was with the problems of developing countries, and others whose concerns were about the 'quality of life', environmental, energy and resource problems of developed nations.

Developing Countries: In developing countries, a few decades ago, there was a debate on the issue of AT. The kind of technology which Schumacher (1973: 153–156) coined was 'intermediate technology'. To him, 'it is a technology which is vastly superior to the primitive technology of bygone ages, but at the same time much simpler, cheaper and freer than the super-technologies of the rich'. Nicolas Jequier (1978, as cited in Hollick, 1982: 214) pointed out that inappropriateness or appropriateness is a quality which can be engineered into particular technology. He further claims that 'appropriateness lies less in specific design features of particular piece of hardware than in the broadness of the evaluation criteria which underlie its development and application. Ken Darrow and Pam

(1977, as cited in Hollick: 214) stated: 'AT is a term which represents a particular view of society and technology. It suggests that technology is neither neutral nor does it evolve along a single path. It recognizes that different cultural and geographical groups will have different technologies that are appropriate to their conditions; that technological self-determination is essential to cultural identity (and political independence). To him, the key element of appropriateness in the development context is generating innovation and self-reliance at the village level rather than importing mass producing gadgets. M. M. Hoda (1980: as cited in Hollick: 215), the head of the ATDA, Lucknow has noted: 'disaster may follow if multi-national organizations take up to produce small machines in stainless steel package for the rural areas of the developing countries. This would be an end of appropriate technologies'. This dispute is related to — but not identical with- the question that whether appropriate technology should be an end in itself or stepping stone to modern western technology. The concepts associated with the former view are essentially those of groups concerned with the ills of western industrial societies.

Developed countries: The term 'alternative technology' has been used mainly in the context of developed countries and implies a rejection of modern technology whereas 'appropriate technology' permits discrimination between desirable and undesirable aspects of it. Prominent among those who promoted the concept of AT in developed countries were: Harper (1976), Clarke (1972), Lovins (1977), Rybczynski (1980) McRobie (1981), and Illich (1973).

Harper (1976**)** has pointed out that 'alternative' has the connotation of a counterculture in the West: not controlled by dominant institutions, cheap, improvisatory, personalized, and accessible to amateurs. He talked of 'Radical technology' which has its origins in the alternative lifestyle movement and utopian socialism. The word 'radical' literally means 'going to the root', and accordingly 'radical technology' implies a fundamental reexamination of the role of technology in modern societies. It also implies a commitment to the ideals of the political left. Clarke (1972) contrasted 'hard' modern technology with 'soft technology' using 35 characteristics, many of which overlap. In essence, he espoused an environmentally benign technology that is frugal in its use of resources; relatively labour intensive, produces in small-scale, anchored on craft-based decentralized, village based industries. It is suitable to community life style that encourages cultural diversity and is based on participatory democracy; a steady state economy with a local system of exchange and trade; satisfying work and reducing the distinction between work and leisure; and demystifying modern science and technology.

To Lovins (1977), 'soft' energy technology uses renewable energy flows; involves many modest and diverse renewable energy sources matched in scale, quality, and geographic spread to end-user needs; and is flexible as well as easily understood. Rybczynski (1980) argued that the absolute nonviolent technology may not be achievable. Technologies do differ on their degree of disruptive effects. As McRobie (1981) puts it 'Non-violent technology refers to mode of production that respects ecological principles and strives to work with nature instead of attempting to force their way through natural systems'. The concept of 'convivial tools' was introduced by Illich (1973) who was careful to state that he was using 'convivial' as a technical term to designate a society of ' responsibly limited tools'. The meaning of the term 'tool' also covered more than just technology, and included its use in factories and social institutions involving education and health care. He has cited the telephone as an example of a convivial tool, since (provided he has the money) the user can call anybody for as long as he likes and communicate anything he chooses. Thus there are many differences in approaches and opinions, on AT but all these enable to build a sufficiently coherent view of society.

Appropriate Technology: A discursive Movement

The problem of inappropriateness of technologies has resulted in an international social movement operating under the rubric of 'appropriate technology' movement. AT movement places emphasis on 'appropriateness' as a key issue and acknowledges the positive value of technology. It is an approach to technology which may provide hope for the preeminence of human concerns in an increasingly technological world. 'Appropriate technology' is a useful concept of central importance to technology studies and technology policies. The AT movement has acted as the harbinger of technology choice as a policy matter in India and has provided the main source of literature on the subject (Willoughby, 1990: 6–9).

The 'AT' movement, while failing in some respects, has opened pathways for helping individuals to gain better lives through simple, effective designs, said Amy Smith. In particular, AT has a new focus on helping people earn money from savings or efficiencies, said Smith. The pot-in-a-pot, for example, allows farmers selling food at the market 'to earn money because they do not have to reduce the price of their crops at the end of the day because they will still be good the next day.' This is a fabulous example of AT where a little bit of science and physics ends up creating device that is very useful (Smith, 2007: 3).

The origins of the movement can be traced much further back into history and in particular to the industrial and technological experiences of three major countries: India, China and the United States. In India, the interest in AT, even if it was not defined in such terms goes back, as we shall see later, to the early mid-20th century. In China, the philosophy which underlines Mao Tse Tung's ideas about technology could be traced back not only to the civil war of the 1920s and the reaction against the big capitalism of the Kuomintang society, but also to the peasant rebellions which have always been one important element in China's history. As for the United States, its industrial history illustrates the problems of industrialization in an underdeveloped country and also the fact that all the modern large-scale technologies of today were originally small-scale, inexpensive and in certain respects appropriate technologies. To national policy makers and aid-giving organizations in the industrialized countries, AT was progressively entering into the mainstream of development aid. The transition from marginality to acceptance is most conspicuous in the United States, Canada, and the United Kingdom. The interest in AT was spreading to other aid-giving countries. AT is primarily an aspect of development aid. But the philosophy underlines that AT should first and foremost be an indigenous creation of the developing countries themselves and the central problem they have to face is that of building up an indigenous innovative capability and not that of importing more foreign technologies (Jequier, 1976: 135–155).

The Early Ideological Mobilizations for Appropriate technology movement in India

(a) M. K. Gandhi and his efforts for appropriate technology development in India: Gandhian workers and independent voluntary associations had taken the leading part in AT development in India. M. K. Gandhi made it a movement, because he believed that 'If villages perish, India perishes too'. He organized the All India Spinners' Association and All-India Village Industries Association. He made 'Charkha' (the Spinner's wheel) a symbol of new village technology and started a systematic study of all the village industries with a view to improving their technologies and to give them a new dignity. In fact Charkha and village industries were the means to realise the Gandhian Swaraj. Gandhi had appointed many experts to develop village technologies, which would help artisans and craftsmen to improve their productivity and efficiency. As a result of M. K Gandhi's efforts, there are at least

one thousand such units that were set up in various parts of the country. In fact, the village development program had become an article of faith for the Gandhian movement in India.

(b) Low-cost technology as a Post-modern technology: The meaning of intermediate or appropriate technology had been aptly summarized by M. K. Gandhi. Soon after independence of India, Prime Minister Nehru went to the small East Bengal village in the Noakhali District where M. K. Gandhi was trying to bring about communal harmony. Nehru went there to seek his advice and guidance on how to run the administration and the government. 'Just keep one small thing in mind', said Gandhi, 'when you are taking any action or making any decision, try to judge how this action or decision is going to affect the poorest of the people in the country'. In this context, Intermediate or appropriate technology could be the solution, which can serve the poorest of the people and its impact on the masses should determine the appropriateness of technology. For developing countries, in many cases it provides work and also dignity to work. One of the lowest untouchable castes in India was the 'Chamars' who were traditionally scavengers. They had to do the dirty works of removing dead bodies of the animals, disposing of the flesh, flaying and tanning their skins, and making various articles out of the skin, bones and horns. If some improved technology is provided to them, for instance pulley blocks for lifting and loading (instead of carrying the carcass on their shoulders), wheelbarrows for carrying, gloves and gun boots to deal with the dirt and filth, it would immensely raise their dignity in addition to making their difficult task easier. Similarly in every field, some simple technology should be provided to the poorest men of the developing countries. Intermediate technology represents a sort of converging point for rich and poor countries and also for a life of quality, peace and permanence in the whole world. In this sense we might view it as a post-modern technology as it came into the conception after the arrival of modernity (Jequier, 1976: 146–147).

Within a few years of independence, however, the ideas of Gandhi were ignored not only by our planners but also by our scientists and technologists. Alienation from the rural poor, the equating of modernity with westernization, the submission to western criteria of excellence, the development of vested interests in large scale technology — all these factors were perhaps responsible for putting in the Gandhian ideas in deep cold storage. Today it has become imperative to move along with many elements of the Gandhian approach, because alternative technologies are the only ones compatible with the Pro-poor programmes like *Garibi Hatao* of the then Congres government in 1970s (Krishnaswamy and Reddy, 2006: 118). However people like Jammlal Bajaj, Maganlal Gandhi, M. M. Hoda, Vinoba Bhave and Sarvodaya workers followed Gandhi's approach and contributed significantly for the AT development in India.

E. F. Schumacher and his efforts for appropriate technology development in India: In 1963, E. F. Schumacher, a British economist and former adviser to the British Coal Board, visited India at the initiation of the planning commission and Jayaprakash Narayan. He was deeply influenced by the Gandhian ideas of industrialization and technology, adapted them to modern needs and converted into the notion of intermediate technology which further turned into a worldwide movement. His books, *Small is Beautiful*, *A Guide for the Perplexed* and *Good Work* carrying the ideas of intermediate technology and principles of Buddhist economics made waves across the world. In 1966, he had set up with other like-minded people the Intermediate Technology Development Group (ITDG) in London to collect information on such technologies which would be really beneficial to the rural areas of the developing countries. This was the first organization of its kind in a developed country which advocated cheap, inexpensive and labour-intensive machines and equipments for the developing `countries,

instead of sophisticated, modern and highly capital-intensive machineries. The ITDG voiced its concerns and new ideas through its journal named *Appropriate Technology*.

Schumacher's movement of intermediate technology gave a new lease of life to the concept of village development. And the Gandhian movement, reinforced as expected by Schumacher's ideas, took a lead in giving a new meaning and a scientific backing to the rural development programmes in India. The Gandhian Institute of Studies, Varansai had taken an active interest in intermediate technology, organized many seminars on the subject. Later on, it decided to establish an Appropriate Technology Development Unit in the voluntary sector. This dream was eventually realized late in 1972 when such a unit was set up at Varanasi in co-operation with the ITDG of London (Jequier, 1976: 146).

(c) *J C Kumarappa and AT development:* The other influential protagonist of AT in India was J C Kumarappa who being influenced by M. K. Gandhi's philosophy has expanded the notion of AT. To him Gandhi was successful in propounding an alternative economic system and vision that would ensure permanence and harmony with nature by using smaller and softer technologies as opposed to economic principles and values that compelled the west into a consumerist and imperialistic technology culture. Kumarappa invented the most effective way of conveying the ideas of renewable and non-renewable resources. He expanded Gandhi's vision of Khadi to a wholesome framework of rural industry and thus became a profound practitioner of AT. Kumarappa's legacy lives on the AT movement unleashed by Schumacher, of course greatly by the virtue of his celebrated book *Economy of Permanence.*

Appropriate technology: Beyond Gandhi and Schumacher: Many scholarly writings on AT came after Gandhi and Schumacher and notable among those were the following: Russel (1952), Jequier (1976), Meadows et al (1972), Willoughby (1990), Kunwar (1991), Vittachi (1993), Jamison (1994), etc. Russel (1952: 11–16) noted that science and technology had made tremendous impact in modern society. The most obvious and inescapable effect of scientific technique is that it makes society more organic, in sense of increasing the interdependence of its varied parts. Technology and science definitely have a role to play in shaping up a society and by integrating modern technology in traditional systems, in certain cases at least, can radically change the resource use efficiency and minimize the ecological impacts. Jequier (1976: 31–32) noted that *swadeshi* movement lead by Gandhi and the revolution lead by Mao in China to 'walk by their own leg' were aimed at self -reliant development of these countries. And hence are also part of the AT movement. He had made it clear that AT is not merely some tools or artifacts (Hardware) but it can also be ideas, knowledge, management, practices (software) etc. Diwan and Dennis (1979: 93–95) held the view that AT is an integral part of the alternative development strategy. In most developing countries the conventional development strategy was in operation for the last 50 years. But no substantial results have been observed. They noted that it is because of the failure of the conventional development strategy that an alternative development strategy in congruence with AT was experimented in a number of countries. They conclude that alternative development strategies are more radical and basic. Kunwar (1991), Meadows (1972), Vittachi (1993) and Jamison (1994) have also discussed on the Issue of AT movement. Kunwar (1991) observed that the sophisticated technologies are very costly and they have created undesirable side-effects or externalities in the societies. Technology created within a particular socio-economic framework of a country may be irrelevant for another country or region. But AT is area specific and there cannot be an AT relevant for all countries or regions. Long (1980: 38) evaluated that AT was a movement to develop new tools and techniques and technologies suitable to the needs of the poor people (Olson, Franklin, 1980). Meadows et al (1972) in the report to the club of Rome on 'limits to growth'

established the fact that unlimited growth is impossible in a world with limited resources. High technology solutions for the resource problem are not a comprehensive and final solution to the problem but it will push off the problem to certain extent only. The gloomy picture of scarce resource base provided by the report, of course had an effect on the resource use pattern, and has accelerated the pace of thinking on AT.

According to Willoughby (1990: 6–9) AT has evoked mixed responses among different sections of scholars. He said that according to the majority of scholars AT designated the 'hardware'-solar collector, the oxharness, the windmill etc; where as to some others it is rather a process. A technology was appropriate only if it were designed, built and owned by the local producer. Yet some others take AT as a life style of living on less and recycling wastes. Some do believe that AT is an economic system. Further, Vittachi (1993) pointed out that the bigger the better trend would always make it difficult for the intermediate or AT to make headway. He held the view that appropriate structural changes should go hand in hand with AT introduction in a society. Otherwise the experiment may fail. Technological appropriateness is not only a matter of introducing a new gadget in a village, but of equity, of introducing new systems of land tenure, land use, banking, cooperative ownership, management, maintenance of equipment and eventually of the apportionment of produce for local use or sale.

Jamison (1994) argued that search for an alternative for western science and technology was common for all third world countries that were under foreign domination. Common feature of such a search was their indigenous tradition. He says that AT movement of 1970s was a worldwide alternative in which a creative combination of traditional as well as modern technologies had taken place. It had 'developed as a multifaceted movement. AT addressed or challenged the traditional dimension of western science and sought to break the link that had formed already in the early modern period between the development of science and development of practical techniques'. To him AT tends to be seen as a process of development from below, a non-scientific locally based technological activity that made better use of the available human and natural resources than a technology from above, directed by scientific experts with little awareness of local conditions and capabilities. He also traces the reason of marginalization of AT during 1980s. Of course, AT had difficulties in meeting the challenges of new advanced technologies of microelectronics and biotechnology that began to appear in the international market place in the late 1970s. These technologies were based on latest scientific understanding and they seem to imply a re-westernization. AT could not pace with these developments.

Appropriate technology Movement in India: From Mobilization to Institutionalization

Intellectual mobilization for AT movement started in India aiming at a discursive movement where intellectual activists started only with a discourse, not in the form of rallies, but in the form of expression of speech, scholarly writings that later on manifested in some form of research organizations. Gradually the organizations have acquired institutional character. There was a shift from mobilization to institutionalization. Centers and organizations were being set up with the aim of developing tools, techniques and processes for the local communities and institutions which are simple, direct, small-scale, inexpensive, eco-friendly and sustainable by nature.

Various efforts have been made by Government of India and the Planning Commission of India for the development of AT. It was for the first time that the essentials of a common

production programme were defined in the *First five year plan (1951–1956) of planning commission* in the context of the development of small scale cottage industries. It states that village industries should place central importance on the rural development programme. As far as village was concerned, the main aim was to process local raw materials for local markets with simpler techniques. The scope for such industries depends, in part, on their relation to the corresponding large-scale industry, in part, on the development of agriculture and the growth of rural amenities. As agriculture becomes more intensive, there will be greater demand for certain articles of consumption and tools /implements which could be met by village industries. Amenities in rural life such as supply of pure drinking water, street lighting, sanitation, hospitals, recreation grounds, community centers and roads would enhance the scope for village industries. The possibility of turning waste into wealth, for instance, by production of gas from cow dung and other refuse of the village through gas plants (so far as the operations prove economic), production of bone manure through bone digesters, soap making out of non-edible oils etc will further provide scope for the development of village industries. So long as villages worked largely as self-sufficient units, goods and services were mutually exchanged within a group and there was a great deal of inter-dependence and identity of interests within the village. As a result various institutions were set up to pull their skill and resources at village level such as the All-India Village Industries Association, the All-India Spinners Association and the Khadi Pratisthan, Sodepur, which have a long record of valuable work and considerable experience in the field of village industries. In addition to organizing industrial co-operatives, a useful method of developing village industries would be to give a measure of assistance to such associations so that, in turn, their workers can assist village artisans. A programme of village industries was supported through specific measures of assistance by appropriate State policy. In addition to the emphasis on technical improvements, research and other measures for improving efficiency, the primary objective of the state policy should be to provide a field within which each cottage industry may be able to organize itself. Various research and training programmes were then provided by government of India. Fiancés were also given in aid programmes. Various programmes were then given to rural artisans in consultation with State Governments and other organizations engaged in the field of village industries (Bhatt, 1980: 151–175). The *Fourth five year plan (1969–1974)* proposed to step up the tempo of activities to the extent compatible with maintaining stability and progress towards self-reliance. The plan proposed detailed action through regional and local planning to help the very large numbers of smaller and weaker producers and increase immediate employment and future employment potentials (*Planning Commission of India document, 1970*).

Further with a view to providing policy backing for the growth of indigenous technology in India, a Technology Policy Statement (TPS) was enunciated in 1983, with the basic objective of developing indigenous technologies and adapting imported technologies, as appropriate to national priorities and resources, thus paving the way to a self-reliant economy in the country. The aims were; first, to attain technological competence and self-reliance, by reducing vulnerabilities, particularly in strategic and critical areas of development, making the maximum use of indigenous resources; second, to provide the maximum gainful and satisfying employment to all strata of society, with emphasis on the employment of women and weaker sections of society; third, to make use of traditional skills and capabilities, making them commercially competitive. In technology development, special emphasis was focused on areas of food, health, housing, energy and industry. In particular, stress was laid on agriculture including dry-land farming, optimum use of water resources, increased production of pulses

and oilseeds, low-cost housing, development and use of renewable non-conventional sources of energy etc, which will lead for development of AT.

In view of the cost of technology development and the time necessary for successful marketing of a new or improved product, indigenously developed items are invariably at a disadvantageous position compared to the imported products or those based on imported technologies and brand names. Owing to the TPS 1983 support were provided through fiscal and other measures, for a limited period, in favor of products made through indigenously developed technologies, care being taken to ensure equality. Further, fiscal incentives were provided in particular to promote inventions, increase the use of indigenously developed technologies, enhance in house R&D in industry and efforts directed to absorb and adopt imported technologies.

And in, Govt. of India's Science and Technology Policy Statement (2003), the basic strategy was development of indigenous resources and traditional knowledge systems. Indigenous knowledge was enhanced for the purpose of wealth and employment generation. Innovative system to document, protest, evaluate, and to learn from India's rich heritage of traditional knowledge base, of the natural resource base of land, water and bio-diversity was enlarged and introduced.

It shows that through intellectual mobilizations for AT movement in India institutionalization took place in the form of emergence of Govt. policies and consequent Govt./(semi govt.) bodies. Number of institutions and organizations were set up with the aim of developing appropriate technologies. The central Government was persuaded to fund AT centers in various government bodies and academic institutions. IIT Bombay and IISc. Bangalore were the first to initiate work in technologies applicable to rural areas. These institutes engaged in activities of design and development of solar energy gadgets, wind mills, peddles, and hand operated machines etc. A cell for the Application of Science and Technology to Rural Areas (ASTRA), a voluntary research group was created by A. K. N. Reddy in the Indian Institute of Science (IISc), Bangalore in 1974 to initiate and promote work of rural relevance as a weapon (Ashtra in Sanskrit) against poverty. The objective was generation and diffusion of technologies appropriate for rural development (more later as a case study). And further, Centre for Technology Alternatives for Rural Areas (CTARA) was initiated by Anil Date at Indian Institute of Technology (IIT) Bombay in 1985 for the purpose of responding to the technological needs of rural areas. The center has been working on developing and disseminating technologies from diverse fields that are relevant to the rural areas. Centre for Rural Technology was set up at Indian Institute of Technology (IIT) Delhi in 1979. It had a vision to understand the technological requirements of the rural sector and to locate formal and informal production sectors in rural areas; where majority of India's population lives. Reflecting the same line of thinking the DSIR had founded its National Research and Development Corporation (NRDC) at the Zamroodpur community Centre Delhi in the year 1953 to support and finance small scale and indigenously developed technologies for marketing and commercialization.

Khadi and Village Industries Commission (KVIC), a largest government sponsored organization was set up in 1957 with Gandhian ideas. It is an industry specific organization and addresses technical problems particular to the rural artisans. With a series of research laboratories and workshops in its own, the commission has played a significant role in upgrading technology of traditional artisans. The operations of KVIC cover the following industries: cotton spinning, weaving, and carpentry and blacksmith etc.

Appropriate Technology Development Unit (ATDU) at Varanasi was established way back in 1973 with the aim to develop 'appropriate technologies' that will really solve some of the problems of the rural poor in India. The Unit proposed to become a 'Knowledge centre',

where information on such techniques and technologies could be pooled and farmed out to those who require them and R&D could be promoted. One of its first priorities was to motivate the scientists / the technologists, the students and the teachers of the universities/engineering institutions, I. I. Ts and other research and scientific institutions to carry out the research work for appropriate technologies to help the poorer sections and small communities in India (ATDA Progress Report, 1977-1979-3). ATDU Varanasi is now stagnating looking for fresh lease of life with a flush of fund and active scholars to infuse more relevant and creative thinking. Similarly the Appropriate Technology Development Association (ATDA) Lucknow founded by noted Gandhian scholar M. M. Hoda in the year 1976, after a brisk and vibrant life is now breathing the last phase of its life (More later as a case study).

Patriotic and People Oriented Science and Technology Foundation (PPST Foundation) at Madras, a trust came into existence to explore various aspects of indigenous/traditional sciences and technologies. It started as a movement of ideas in 1980 and it was registered as a trust in 1986. During the period 1980 to 1995 the PPST Foundation produced a magazine named, 'PPST Bulletin' which had undertaken detailed analysis of the various aspects of traditional Indian sciences and technologies. The PPST Foundation has also been holding a number of state level conventions on indigenous science and technologies. PPST Foundation was founded by some radical as well as nationalist scientists and technologists of the 1980s. A section of the intellectuals who mobilized for PPST Foundation were the campus breed of IIT Kanpur. As a nationlist voice these group of scholars were desirous of reviving the traditional Indian sciences and technologies lost in the history. However PPST Foundation is no more an active organization. M S Swaminathan Research Foundation (MSSRF) a similar non-profit research organization was established in 1988. MSSRF has all along been developing and promoting pro-nature, pro-poor, pro-women and pro-sustainable on-farm and non-farm livelihoods through development of appropriate, ecological technologies and knowledge for empowerment. Inspired by the same ideology, Honey Bee Network (HBN) was established at Ahmedabad during 1988–1989. It is the biggest network of grassroots level creative and experimenting farmers and artisans in the world (more, later on the case study section).

Some of the other AT promoting organizations which have come into existence as offshoot of the movement and have contributed significantly for AT development in India are: (a) Appropriate Technology Cell, Ministry of Industrial Development, Udyog Bhawan, New Delhi, (b) Kisan Krishi Yantra Udyog, Moti Bhawan, Collectorganj, Kanpur, (c) Vigyan Shiksha Kendra, Attara, Banda, U. P., (d) Asian Institute for Rural Development, Kanakpura Road, Basavanagudi, Bangalore, (e) Rural Agricultural Institute, Narayangaon, Pune, Maharashrtra, (f) Sarvodaya Ashram, Nawada, Bihar, and (g) Village Reconstruction Organization Brodipet, Guntur, A. P. etc. But, during 1990s, the AT movement in India declined due to the globalization of the economy and liberalization of Indian industrial and technological policies resulting in flow of foreign technologies and large scale technologies. The AT movement has been out of gear these days because of the preponderance of neo-liberal thoughts.

Studying Appropriate Technology organizations through Resource Mobilization Theory

Appropriate technology organizations can be studied empirically from a sociological perspective, i. e. Resource Mobilization Theory (RMT). This perspective emerged in the 1970s as a distinctively new approach to the study of social movements. It is today

a dominant perspective for understanding collective action. To this perspective the actors are engaged in instrumental action through formal organizations to secure resources and foster mobilization. The perspective has demonstrated considerable theoretical and empirical merit for understanding social movements (McCarthy, Zald, 1977: 1212–1238; Tilly, 1978). AT movement in India, with which we are concerned here, can be effectively studied within the resource mobilization framework. For instance, the actors or the scholars of AT movement are construed to be engaged in instrumental action by making use of resources and fostering mobilization for development of AT.

Second major feature of RMT is that it takes a distinct position on questions of recruitment, motivation and participation. Based on a rational actor model, individuals are viewed as weighing the relative costs and benefits of movement participation and opting for participation when the benefits outweigh the anticipated costs (McCarthy & Zald, 1977, as cited in Buechler, 1993: 218). Motivation, recruitment and participation aspects of the AT movement can be understood within the analytical framework of RMT.

The RMT also takes its starting point for analysis in organizations and not in the individual. It does not centre around the question of why individuals join social movements, the rationality or irrationality of their intentions or behavior as participants, but it centers around the effectiveness with which they participate in the movements, that is otherwise, making the movement organizations use effectively their resources in attempting to achieve their goals. AT has some characteristic features, where the major emphasis is on the organization playing a dominant role than a single individual member. RMT also helps us to understand the structure of AT organization and the role it plays to achieve certain goals and more specifically for the development of AT.

One of the most important features of the RMT is that it develops through the ongoing movements. The RMT emphasizes in the light of new evidences, the role of 'entrepreneurs, in the rise of social movement. Further RMT is not restricted to the direct beneficiaries of the social change pursued, but is inclusive of diverse kinds of individuals, groups and institutions which mobilize a 'conscience constituency' of adherents. These may come from different strata co-opted from institutional resources like, private foundations, media, social welfare institutions, non-government organizations, universities and even business corporations. Likewise, in AT movement, diverse kinds of individuals, groups from different sections of society come up with their ideas to put into action (McCarthy & Zald, 1977: 1212–1238).

Empirical Studies in AT

In India, some noteworthy efforts have been made to study the organizations involved in AT activities. Reddy (1979: 116–129) had made a study of AT groups spread in Asia, Africa and Latin America, through a detailed questionnaire, sent to 180 groups out of which only 75 responded. The major finding of the study was that, most of the groups had great deal of active interest in the concept. There was a vast difference between voluntary organizations on the one hand and the established institutions of education, as well as institutions of science and technology research on the other with regard to incentives for work on AT. Only about half of the groups and institutions have direct contact with the main target groups noted Reddy. Date (1981: 15–67) had examined the functioning

of about 27 voluntary groups involved in the field of appropriate technology in India. The objective was to locate the organization's role in transfer of technology to the rural areas. He had concluded that, those organizations were involved in one or other activities especially providing raw material, credits, and management to the rural poor and some were engaged in organizing people and bringing about their material development.

Ton de Wilde (1977: 160–177) had studied three research institutions named International Rice Research Institute (Philippines), Brace Research Institute (Canada) and Technology Consultancy Centre (Ghana). The aim was to understand the way technology was employed in the industrialized societies. Moulik and Purushotham (1986: 233–269) attempted to provide a comprehensive and analytical account of the technology transfer process in the Indian decentralized rural industry sector and further provided detailed case studies of a number of village enterprises and national R&D organizations in rural life situations. 20 such cases have been studied. Some of the states which were under consideration include Gujarat, Bihar, U. P., Tamil Nadu, Karnataka etc. Those R&D organizations studied were found to be poorly staffed and lacking motivation, running short of innovative approach in the identification of target beneficiaries. Askin (1976: 14–31) has conducted case studies at Philippines, Indonesia and Srilanka. The aim was to locate the less developed countries attitudes towards AT. The study reveals the fact that there is a very narrow base of AT research in the developing countries. And further those centers are understaffed and under-funded. There is lack of coordination in policy formulation and also decline in the center.

Further, in a study being conducted by Jequier and Blanc (1983: 9–17), a careful statistical analysis is being made on AT movement, which was published under the title, 'Appropriate Technology Directory'. There-in they gave an account of 277 organizations, which were working in the field of AT throughout world, particularly involved in one way or other in the development and promotion of ATs. Goodman (1976: 1–6) discussed the issue of intermediate technology and AT for less industrialized countries to make some recommendations. The study found that there existed indeed a relatively large number of R&D activities covering a wide cross section of ATs in many Asian countries. One of the major problems was lack of coordinated efforts to maximize available resources.

Pursell (1993: 629–637) noted the rise and fall of AT movement in the Unites States (1965–1985). His findings indicate that, there was a steady decline of those centers working on the development of AT due to rise of large private utilities, multinational constructions, and military-industrial complexes. In symbolic terms Pursell concluded that with the rise of Reaganomics (of Ronald Reagan) and cultural masculinity through Rambo (Hollywood marcho-man) there was a re-masculinization of American technologies in the late 1980s implying the decline of ATs that were symbolic of the softer feminine principles. In a similar study on alternative technology movement in UK based on the cognitive approach Smith (2005: 106–118) analyzed the advocacy of alternative technology in UK. Smith mainly explored two issues like, (i) the relation between conceptualization of environmental problems and the kinds of technology solutions promoted and (ii) the interplay and compromises environmentalist must make with other actors (social) important in technological development. Smith concluded reflecting upon how social actors advocate and construct technologies based on prioritization of their multiple values.

Operationalizing the Resource Mobilization Theory (RMT)

Before we analyze the five case studies from the view point of the RMT perspective, as per the theoretical requirements of McCarthy and Zald's (1977: 1212–1241), it becomes almost a necessity to explicate as to why these AT organizations (case studies) be treated as social movement organizations, Following are the reasons: (i) All these AT organizations have a set of specific goals to attain, (ii) All these AT organizations have their own strategies, tactics to mobilize resources be it material or immaterial, (iii) Leadership (both from inside as well as outside) played a major role in all these AT organizations, (iv) All these AT organizations also have small memberships and full time staff intending to speak for cause without involving the group itself (meaning end users and/or innovators/ entrepreneurs), and (v) All the sample organizations also possess sufficient resources to strengthen the movement and accomplish their goals. Further, the large number of AT organization operating in India (both in Government sector and voluntary sector, whether R&D or manufacturing etc) do make a strong 'social movement sector', in the true sense of McCarthy and Zald (ibid). And the vast domain of assertive social movements of various kinds prevalent in contemporary Indian society like, the cooperative movement, SHG and micro-finance movement, Forest protection movement etc make a perfect 'social movement industry' in the sense of McCarthy and Zald (ibid). Thus a perfect 'social movement industry' subsumes a true 'social movement sector' which in turn is inclusive of several 'social movement organizations', e. g. AT organizations. But it is need less to emphasize that the resource mobilization theory for analytical purposes concentrates on Social movement organizations only.

Case Study. 1:
Appropriate Technology Development Association (ATDA), Lucknow

1. Mobilization of intellectual Resources: Actors, Conception and Evolution of ATDA

India has one of the oldest traditions in rural industry. These industries based on economically viable craft based technologies like weaver's loom, potters' wheel; oilman's kolhoo (crusher), etc were the backbone of rural economy from times immemorial. They suffered a serious setback due to the introduction of large-scale modern technologies after the industrial revolution. No systematic work was done to improve the technologies of the rural areas in their own setting. M. K. Gandhi tried, in his own way, to revive and put a new life into them. It is only due to his sustained efforts and directions he gave to rural industry that made to improve the rural technology and enabled it to survive even now.

After the independence, Khadi and Village Industries Commission (KVIC) did a yeoman's service to rural technology and industrialization even though their efforts were more concentrated on Khadi (homespun textile). Other government institutions, research laboratories and voluntary agencies carried out research and experiment for impoving the methods, techniques and processes of small-scale manufacturing for rural as well as urban areas. The Planning Research & Action Division of U. P. State Planning Institute, Lucknow, was specially set up to give a new dimension to action-research on rural technology and it did a commendable service in this field. During first two decades, the research laboratories of CSIR, Government of India, have also laid considerable stress on the development of AT for generating employment in the rural areas and for increasing the income level of the rural populations (Hoda, 1977: i).

In this background, The Appropriate Technology Development Unit (ATDU) was set up at the Gandhian Institute of Studies, Varanasi in November 1972 as a result of decision taken by Shri Jayaprakash Narayan, Dr. E. F. Shcumacher. Shri M. M. Hoda then Project Officer of the Intermediate Technology Development Group, London, became the Head of this Unit which functioned upto 1976. Later, with the approval of late Dr. E. F. Schumacher and Shri Jayaprakash Narayan, this ATDU was recognized as Appropriate Technology Development Association (ATDA), registered under the societies Registration act, 1860 and started functioning from 10th August 1976 with its headquarters at Gandhi Bhawan, Lucknow, India (Hoda, 1979). Therefore, Jayprakash Narayan, E. F. Schumacher and M. M. Hoda truly are the 'Conscience Constituents' (McCarthy and Zald, 1977) of this SMO.

Shri Jayaprakash Narayan the noted nationalist and Sarvoday leader was the motivating force behind ATDA who had visualized a 'samagra Bikash' through AT. Because, developmental imbalances have created disparity between rural and urban folks in terms of employment and it had accelerated the rural urban migration. If the basic needs of life like, employment, shelter, sanitation, electricity etc are met with at village level then migration can be reduced. So, this organization aimed at basic needs of the rural poor and to improve their conditions of living, and its research was basically directed in that direction. And in this backdrop, a group of philanthropic people led by Mr. M. M. Hoda, Mr. T. N. Bajpai, Mr. K. M. Bajpai, Mr. Shiv Gopal Mishra, Mr. M. S. Hoda, Mr. K. M. Tiwari, Padma Shri A. K. Karan, Mr. V. S. Mathur and other likeminded people who were motivated to bring a change in the field of rural development to check migration to urban areas created this organization called ATDA. Thus this group of AT activists make the true 'Conscience Adherants' (McCarthy and Zald, 1977) of this SMO called ATDA.

The organization was set up with the spirit of an autonomous independent centre. Four people were employed during initial stage and almost like 300 people were employed at peak period (1993-1994). ATDA is not a purely research organization doing work in laboratory or at the headquarters, but it specializes in action research on the field level by establishing pilot projects. For this purpose, there was a core group of technologists at the headquarters and another at each project level. Each project had got its own technical and managerial staff. Besides this, they had technical collaborations with a number of foreign organizations which provided technical expertise by sending their technologists to ATDA.

They did have collaborations with the Government of India and sometimes drew on their technologists as well, in spite of the fact that some retired technologists worked on voluntary or part-time basis. They had also collaboration with other development organizations in India.

2. Organizational Resources: Objectives of ATDA

The objective of the organization was to create technological infrastructure for generation of employment and work places in rural areas with low capital investment and high labour usage. The idea was to create jobs where most people live, i. e. rural areas and not in urban areas where they tend to migrate. It was considered that this objective can be achieved by developing new processes and new products in rural industries and facilitate rural industrialization. This envisaged utilization of local skills and resources by promoting employment-generating technologies and by harnessing decentralized and renewable sources of energy and improving habitat, human settlements in the rural areas for improving quality of life. The AT movement in India believed in M. K. Gandhi's maxim of 'production by masses' instead of 'mass production'. The ATDA followed the Gandhian Principles and ideology (Hoda, 1979: iii).

Membership of ATDA: The Association, according to its constitution, consists of various classes of members, namely, Founder Members, Life Members, Ordinary Members and Institutional Members who also constitute its General Body. And any individual, institution, organization or government department, interested in the programme of Association can become its member by paying requisite fees. The General Body was to meet annually and elects the members of the Executive committee and office bearers. The executive committee was to meet quarterly. For day-to-day work, an Administrative and a Finance sub-committee had been constituted. In addition to that, a Technical sub-committee, a Publications sub-committee and a Policy-making sub-committee were also constituted to meet as and when required (ATDA Progress Report, 1981–1983: 3–4).

Activities of ATDA: Main activities of ATDA were to carry out R&D for AT development with a view to enhancing productivity of the rural poor. The domain of ATDA's R&D included areas like, non-conventional energy, cement technology and sugar cane. Its R&D works were published widely and circulated. In terms of regular publications, they did publish 'AP-Tech Newsletter'. It was in two languages. One was in English and other was in Hindi. The purpose was to update and inform rural masses about development of recent or latest technologies in the field of AT. Other occasional publications were about Solar Cooker, Cement and the like. It used to inform people about development through the use of AT. For imparting Education and training of personnel ATDA used to send staff to various training institutions of India and abroad. ATDA staff used to visit Singapore for imparting extension and training programme pertaining to ATDA technology. For Technology diffusion, ATDA staff used to give training to electricians in India.

ATDA Lucknow is also a consultancy organization to provide information to the grassroot level voluntary workers mostly with respect to AT and allied subjects. The technologies developed by ATDA includes solar cookers, fixed bio-gas plants, 12 spindle cotton spinning charkha, wool spinning Bageshwari Charkha and processing machine for cotton and wool have been taken up by a large number of voluntary agencies all over India and abroad for raising the income of the rural artisans and also providing employment to the rural unemployed.

Programmes: ATDA planned to achieve its objectives in the following systematized manner by:

• Up-grading basic village technologies like pottery, oil extraction, black smithy, carpentry, weaving, yarn spinning, food processing, tanning of hides and skins and leather work.

• De-scaling large-scale manufacturing processes for important consumers item like sugar, cement, paper and cotton spinning to create new employment opportunities in the rural areas.

• Improving physical amenities in the villages and other habitat and human settlements for better quality of life in rural areas like building material, smokeless mud stoves, solar cookers, rural sanitation, water supply, education etc.

• Harnessing renewable and unconventional sources of energy to provide for power to industries and other works, improving rural transport, making it pollution free and making it cheaper.

• Training for rural health management and making of a delivery system for rural areas.

3. Financial Resources: Funding Agencies

The funding sources for ATDA Lucknow had been the various Governments (central as well as state of U P) departments and agencies. Since the government has also set up a number of departments, councils, action groups for assessing the need of various voluntary organizations these have funded research as well as implementation and dissemination programmes

of ATDA. The more important among such organizations are the Council for Advancement of People's Action and Rural Technology 'CAPART', Department of Science and Technology New Delhi, the Department of Non-conventional Energy Sources (DNES), National wasteland board, Ministry of Human Resource Development (MHRD), Ministry of Environment and Forest (MOEF) all under the central govt. In addition, funds were also provided at local level through Integrated Rural Development Programme (IRDP), Development of Women and Children in Rural Areas (DWCRA), Training of Rural Youth for Self- Employment (TRYSEM) etc. The U P Council of Science and Technology of the state government has also funded ATDA several times. Besides these, oversea voluntary/private and semi-Govt. organizations like the European Commission, East West Centre Hawaii, India Development Group London, Community Funds UK, Intermediate Technology Group London, Overseas Development Authority London, ICCO Holland, K Delco of Molen Russia had been funding the ATDA. Further, Indian voluntary agencies like PRAD-ITIS, Gandhi Smarak Nidhi, KVIC Bombay etc have also funded ATDA (ATDA source).

4. External Linkages of ATDA:

ATDA's external resources were both from inside and outside the country as it had collaborations both in India and abroad. In India the collaborators (mostly for extension work) were; (i) Gandhi Smarak Nidhi in UP, (ii) KVIC Bombay, (iii) Planning Research and Action Institute in Lucknow etc. And the foreign collaborative agencies (mostly for consultancies) were; (i) ITDG London, (ii) Inter-church Coordination Committee for Development Projects (Netherlands), (iii) International Research Centre Siege Social (Canada), (iv) Overseas Development Authority London, (v) ICCO Holand etc.

5. Intellectual Resources:

Pilot projects implemented 1976 onwards: The ATDA has done various projects for internationally and nationally known organizations. For research purpose it had taken up a Mini-cement Plant, based on appropriate technology by utilizing locally available raw material like Kankar and Marl to produce Portland cement. It was developed with a motive to produce or develop low cost rural housing facilities for the rural poor. This project was funded by Intermediate Technology Development Group (ITDG) London and U. P. Science and Technology Department. Second was, Wealth from Waste. This project was designed to use cow-dung for preparation of gas, which could be domestically used for preparation of food and at the same time generate electricity in the village. It was extension of bio-gas technology. This project was completed with the assistance of Overseas Development Administration (ODA), London. Then, there was a project named Regeneration of village eco systems through bio-gas technology. It was designed to enhance the productivity and income of village people who are mainly dependant on diary. This project was designed to improve eco-system through bio-gas technology. The partner of this project was ICCO, Holland. Wool Spinning pilot project was conceived for carding and weaving of raw wool. It was supported by U. P. Council of Science and Technology. There was a Mini Sugar Technology project which evolves the technology for production of liquid sugar. This project was with the partnership of U. P. Council of science and technology, PRAD & ITIS and Gandhi Smarak Nidhi (Source: ATDA Gen secretary, 2010).

ATDA has also done a project of HRD Ministry, Government of India for development of environmental and educational activities and models. This project was named as Area Intensive Environmental Educational Programme (AIEEP). Ministry of Environment,

Government of India also had given a project. It was a sort of organizing workshop for state level teachers training for their capacity building in organizing environmental education activities. Community Funds (U.K.) London has funded a project known as Integrated Women Rural Development project (IWRDP) with the aim to empower women involved in mint farming and processing at village level. It was done in Mohanlal Ganj area. ATDA also reclaimed parts of Wasteland through plantation of green fodder. The project was named Development of Waste Land. It was funded by Wasteland Development Board of Government of India, Institute of Technology, K. Delco of Molen, Russia. The project was to develop floating pump for irrigation by using water current. It was AT for water lifting. Then the other project was, four roller care crusher. This project was funded by U. P. Council of Science and Technology. It was developed with an objective of extracting juice from sugarcane. U. P. Council of Science and Technology also funded for the project named Solar Cooker. They aimed at introducing bulbs for cooking. ATDA had developed some experiments on rural technology to reduce drudgery of women. Then, the East West Centre, Hawaii, and Honolulu in collaboration with ATDA have done some foreign participatory management of forest. Next project was from K.V.I.C Bombay that funded the project of leather processing skills to develop among cobblers. The U.P. Council of Science and Technology also funded a project named 'Leaf cup making'. European commission and UK funded a project with ATDA on capacity building of rural youth through self employment under the project name Skill development of rural youth.

These are by and large projects, which were taken in the past. From 2003 onwards, there is no such project. Last year, 2010, they have got a project given by government of U. P. The project was from ICDS (Integrated Child Development Scheme) in Kanpur to run a training programme. This project was known as Kishori Shakti. The modest budget was around 96 thousand. It was 60 days training programme in which they trained rural girls for some tailoring skill development. Only 60 students joined in such programme (ibid).

Cases of Success: ATDA Lucknow has some achievements in reaching out to the rural needs. It has improved upon the rural technologies like manually-operated cotton spinning, wool spinning, and irrigation pipes. It has de-scaled the process of manufacturing of white crystal sugar, Portland cement, cotton spinning and brought them down to scale appropriate to rural areas. It has introduced a biogas technology of fixed dome type for the use of human excreta, and any sort of animal dung like that of elephant, horse, goat in addition to cows and buffaloes. It has developed new methods for making leaf cups and containers from dry leaves, which had great employment generation potentialities.

The ATDA also organized training and orientation programmes for AT practitioners from all over the world. The State Government was also deputing their trainee officers to ATDA for orientation course in AT. The Association was also undertaking survey of rural industries to determine their status and efficient methods for improvement with a view to improving the condition of the rural artisans through technological inputs. The Association in collaboration with India Development Group, UK and others had set up Schumacher Institute of Appropriate Technology for creating a cadre of rural artisans and imparting training in various rural and appropriate technologies for wider dissemination including environment, social forestry, and rural health.

Causes of Failure of ATDA: So long as ATDA was involved in research work, it was doing well. But later on NGOs stepped into picture. Commercialization took place. They started to commercialize cement. The organization faced problem in marketing of cement as it had no expertise in marketing. As the entire workforce was not trained for marketing purpose,

they failed to market the cement successfully and their money was blocked. They failed to recover the money from marketed cement and that resulted in stoppage of wages to the workers of cement plant and subsequent closer of the plant due to unavailability of funds to continue production. Their liability towards sale tax and electrical dues could not be cleared because of their failure to realize money from the market. The organization by then faced with the problem related to license. They cleared liability of labour by selling the plant. Thus, plant was shut down because of recurring losses.

Initially, the product was meant for research purposes only and it was not meant for marketing purposes. The organization committed this mistake. That is how, it became sick. The people who were employed in the cement factory asked for wages while doing no work. Money was not there ultimately even to clear their liabilities. Once there develops liability with an organization like ATDA, no funding agency came forward to fund its next projects. It was the root cause of decay of the organization. Thus, when a research organization shifts its activities from R&D to production and tries to behave like a commercialized firm, it would face serious problems. Of course for the obvious reason that they do not have the knowledge and staff of a manufacturing and commercial organization. There would be serious legal problems with regard to taxation, excise duty, auditing etc. Corruption was also a factor behind failure of ATDA in terms of project financing (ATDA source). The organization also lacked initiative and dynamism following the death of its founders like M. M. Hoda and M. S. Hoda sometimes around 2003. The organization could not develop further leadership and its direction (Ibid). Absence of dynamic and committed leadership was also a major factor for failure.

Present Scenario and future direction

Once ATDA was one of the reputed centers of AT in India. It was internationally recognized. It had a good track record of implementing the projects with various international partners. But, today ATDA has gone to oblivion. It had done many pioneering works in AT, but has gone without recognition from the Government.

Today this organization is merely alive, being on sleeping mode, lacks the spirit of the earlier decades. Now, it does not have any project and also no funding. It has a financial crisis too. The biggest challenge today before the team is growing corruption in the field of project financing by funding agencies and therefore even good projects of larger public benefit or interest are gathering dust in the selves of various government departments and ministries. And also they need a vision and bold leadership. "ATDA is waiting for someone who can come up with a vision to carry forward its unfulfilled dreams. It has a distinguished record in implementing its projects with various international partners. If the Government and right-minded NGOs recognize ATDA's outstanding contribution in the field of appropriate technology for enhancing the productivity level of rural poor in India, they must take over the responsibility to rehabilitate such a pioneering institution in national interests" (personal interview, General secretary, ATDA on 23rd Nov, 2010).

Case Study. 2: Application of Science and Technology to Rural Areas (ASTRA) Cell at the IISc, Bangalore

1. Intellectual Mobilizations: Actors, Conception and Foundation of ASTRA Cell

Prof. A. K. N. Reddy, the noted citizen scientists of IISc Bangalore was the mind behind the mobilization for the foundation of ASTRA Cell. Reddy had strong conviction on the necessity of developing an AT research centre like ASTRA Cell. Reddy was convinced

that modernization and industrialization which occurred over the years in post-independent India could not attend to the problems of rural areas. The most immediate result was mass unemployment, massive migration to cities, rural impoverishment, environmental degradation, decreasing social participation and declining control over surrounding resources, etc. One of the major reasons for this situation was the continued dependence on import and adaptation of inappropriate technologies of the industrialized countries. But these technologies were not suitable for the countries like India where these faced the critical shortage of capital, energy and skills amidst growing surplus manpower. In this context, there emerged a need for alternative or AT which had relevance to rural problems. But it is unfortunate that these technologies could not be viewed as glamorous enough to merit the attention of major scientific and technological institutions, felt Reddy (1974). These institutions were overwhelmingly manned by elites with a 'westernized' life-style and aspirations, often accentuated by foreign training. These elites were alienated from the rural poor, rural problems and from their traditional technologies. This alienation was amplified by the strong linkages with the corresponding 'western' institutions. Hence, indigenous institutions derived from western institutions the patterns of organizing science and technology, prioritizing areas of research, their approach to solve human problems, their criteria of excellence and the source of recognition, awards, kudos even their techniques of evaluation. However unlike their 'western counterparts, scientific and technological research institutions in developing countries were invariably insulated from indigenous industries and favoured the flow of industrial technologies from abroad.

The result was that educational, scientific and technological institutions in the developing countries tended to be elitists, alienated and related to the society without native roots. As a consequence, they tend to be pre-occupied with irrelevant work or with work which is only relevant to urban industries or problems of the 'west'. The relevance of native rural problems was completely forgotten. It is no wonder that no major scientific and educational institution was doing anything about rural development in fields other than agriculture (Jagadish et al., 1980: 123).

ASTRA research cell at IISc Bangalore, was established in the year of 1974 with an aim to deliver the fruits of science and technology to rural areas. Prof. A. K. N. Reddy was the founder and guiding philosopher of this centre. Besides A. K. N. Reddy, there were many researchers and actor intellectuals like Vinod Vyasulu, Sethu Rao, and C. V. Seshadri, K. S. Jagadish, D. K. Subramanian, Low Cross, Krishna Prashad, H. S. Mukunda, Gururaja etc all made fantastic strategy for getting the then Karnataka state support to the ASTRA Cell. Then the Director of the institute, Prof. Satish Dhawan also gave the group ample support in this pioneering effort. Therefore, these make the true 'Conscience Constituents' (McCarthy and Zald, 1977) of this SMO. In this context, the idea of founding the Karnataka State Council of Science and Technology (KSCST) evolved after detailed discussions with eminent researchers like Satish Dhawan, M Y Ghorpade, GVK Rao and others. Thus, the latter group of intellectuals could justifiably be treated as the 'Conscience Adherants' (McCarthy and Zald, 1977) of this SMO called ASTRA cell. When ASTRA cell concentrated on identifying and generating on appropriate rural technologies, KSCST took steps to diffuse ASTRA cell's proven technologies with the active involvement of the government of Karnataka. Hereafter, ASTRA cell pooled together the competencies existing in different departments of the Institute and channeled these engineering researchers towards problems of rural development. ASTRA cell therefore was born with well-defined objectives, viz., the generation and diffusion of appropriate technologies for rural development, and promotion of sciences underlying these technologies (Raghunandan & Chanakya, 2004: 3).

To quote S Dasappa of ASTRA Cell, *The kind of work we do here at ASTRA Cell is economically and environmentally viable, socially acceptable and these reinforce self-reliance. Their impact should be sustainable and visible. This approach will serve the purpose of development in the long run. That is our aim.* (Personal Interview / CGPL, 6th April 2011.)

Personal contribution of A. K. N. Reddy in shaping ASTRA as a Research centre:

A. K. N. Reddy was an electrochemist, energy analyst, rural energy and AT practitioner, spokesman for sustainable development and campaigner against the nuclear weapons and a cricketer by hobby. He has pioneered the entire field of research in policy analysis and action. He was instrumental in setting up the ASTRA Cell. He too was instrumental to the founding of the Karnataka State Council for Science and Technology (KSCST). He with his collaborators also had set up International Energy Initiative (IEI). As the founder president of IEI he edited its research journal *Energy for Sustainable Development.* With this experience, approach and perspective behind, ASTRA cell over the decades has worked in different areas like bio-energy, biogas, gasification, fuel efficient stoves and driers, water purification, renewable energy, climate change, forestry and alternate and low-cost buildings. Much of the experimental work in the areas of Pura and Ungra influenced many colleagues and students to work with commitment and excitement on developing rural technologies to suit the needs of the rural India. A. K. N. Reddy was essentially aiming at strengthening self-reliance, energy alleviation, poverty eradication, and typical problems of developing countries related to energy perspectives. He was engaged in the learning, questioning and challenging the dominant perspectives. His work on rural technology and development led him to question the existing paradigm of energy which was by passing the poor and ignoring environmental sustainability. His approach for energy was a consumption-oriented and supply driven approach.

Lessons on Energy and Environment by A. K. N. Reddy:

It was suggested by Reddy that, if we are really caring about the environment, we must care about the production and utilization of energy in society, because a major threat to the environment is from energy related activities. If we care about the environment being sustainable in the long run, we must care about how energy is produced, in particular whether from non-renewable or renewable sources. If we care about people, particularly the poor, we must care — not merely about energy supplies and consumption — but about the utility that energy provides to people and we must care about how energy is used. If we care about energy use, we must care, not merely about increasing energy generation and consumption, but also about improving the efficiency with which energy is utilized because 'energy saved is equivalent to energy produced'. If we care about promoting the efficient production and use of energy for sustainable development, we must as a body emphasize not only on information and training but also on analysis leading to advocacy and action.

ASTRA Cell's Experience of Technologies for Rural Development: A. K. N. Reddy's Message for his future followers:

A. K. N. Reddy had a vision of formulating and implementing ASTRA with a motto that science and technology should be a weapon (or Ashthra in Sanskrit) in the interests of the poor. During the initial nine years of his work at ASTRA cell, he worked as its Convener and the remaining years, he involved himself in various projects like community biogas, plant project at Pura Village, Kunigal Taluk, of Karnataka state. Many lessons came forth with his involvement with the villagers. These lessons were shared with a hope that coming

generation can make use of those for understanding the problems of the masses and can put forward with technology development initiative.

Some of the relevant lessons were: (1) Rural people may be poor and illiterate but they are not poor indeed, rather are rich with experiences and local wisdoms; (2) Technological choices of the people are rational; (3) Rural rationality should be taken into account in order to make technology policy suggestions and recommendations; (4) We must first be students if we want to be successful teachers. Information must flow in both ways- from the people to the rural technologies, and from the rural technologies to the people. There are several important steps in this information flow process like scientific study of the lives of the people, identification of felt needs, rather than perceived needs, presentation of the technology options to the people, subsequent technology selection, technology generation, technology testing, technology finalization and technology dissemination etc; (5) We should start with the people and end with the people; (6) Women are often the best agents for disseminating technologies for rural development; (7) People may be poor, we must not ignore their preferences and needs; (8) We must curb our market tendency toward developed technologies in response to imagined needs; identified in remote and alien settings; (9) Traditional technologies were optimal solutions for the challenges of the past and therefore they must not be ignored as sources of innovation, these have evolved through a long process of natural selection of innovations; (10) Although traditional technologies were optimal solutions in the past, almost all of them are suboptimal and inadequate today because of changed needs, resource availability and circumstances; (11) The So-called 'modern' technologies, which are only bad zerox copies of western technologies, are invariably inaccessible to the poor; (12) It is therefore a Hobson's choice for the poor — if traditional technologies are inadequate and modern technologies are inaccessible. To permit the poor to escape from this dilemma, scientists and technologists must generate new options, each more effective than the traditional and more accessible than the modern; (13) But the ultimate choice of technology must be made by the people, because technology choice is too important to be left to the technologists and other experts; (14) In generating technological options, three approaches must be taken into consideration like, making cost effective western technology, developing alternative technology and transforming traditional technology; (15) The transformation of traditional technologies is a rich source of, and promising route for, technologies appropriate for rural development; (16) Technology developed are likely to be region specific, location-specific and culture specific; (17) Any fool can make a thing complicated, it takes a genius to make it simple; (17) In case of most rural technologies, there is a first generation of unsuccessful device and second generation of successful device; (18) Thus, the penetration in the countryside of rural technologies involves a learning curve; the initial part of the curve shows a very slow penetration of the potential 'market', then a rapid catching up, and finally a saturation; (19) During the initial part of the learning process, there has to be intense back-and-forth interaction between the lab and field; (20) There are four main mechanisms for the dissemination of rural technologies such as , the market, the top-down approach, the bottom-up approach and the franchising approach; (21) The technologist must ensure that all the objectives in the rural users list are included in his or her design criteria; (22) If the designer can not meet all the user's objective simultaneously but only in stages, then it is imperative that the designer's sequence must be in same order of the user's priorities — otherwise the implementation may run into problems; (23) Irrespective of the successes in generation and dissemination, rural technologies alone can not remove poverty. Technology is only a subsystem of society, which acts as an instrument of development of

society. Thus, technology is a necessary condition for rural development, not a sufficient condition; (24) Technologist must approach rural work with empathy and affection for the people. And last but not the least, rural technology is a path to a new society and it is an instrument for development (Rajan, 2009: 171–182).

2. Organizational Resources

Organizational Resources: In terms of structure, ASTRA cell-CST has been an interdisciplinary group where specific teams work on well defined technologies. The departments/centres of IISc Bangalore which came forward to work then with ASTRA cell were Chemical Engg, Civil Engg, Computer Science and Automation, Center for Ecological Sciences, I.P.C., Mechanical Engg, Management, Aerospace Engg etc. Currently the cell has 06 regular faculty members and 05 associate faculty members, one technical officer and more than a dozen research scholars.

Programmes: ASTRA cell has certain major studies on rural technologies pertaining to, (a) Energy Studies (e.g. rural energy planning, alternate energy sources, energy devices and applications), (b) Building Materials and Technology (e. g. system studies, walls, roofs and construction), (c) Water (e. g. water harvesting and water lifting), (d) Wood burning devices (e.g. improved Jaggery stoves, ASTRA stove for domestic cooking), (e) Bio-Gas (e. g. optimization of biogas plants, solar heating of biogas plants), (f) Wind energy (e. g. study of wind energy potential, optimization of wind mill towers), (g) Solar energy (e. g. designs and development of solar collectors, solar ponds skytherm cooling of building using solar energy), (h) Rural Industries (e.g. Sisal leaf processing, rope making, recycling of chemicals from black liquor etc), (i) Agro processing (e. g. processing of agricultural products and residues) etc.

An extension centre of ASTRA cell was established at Ungra, 113 kms away from Bangalore on the outskirts in Tumkur district, Karnataka state, for actual field research study. Many of the technologies of ASTRA cell which go out on a pilot scale generally get tested there. In this environment, faculty members could monitor or do close interactions with end users and try to find out solutions to technology packages. For technology diffusion, ASTRA cell took the help of various voluntary groups and institutions like TIDE (Technology Informatics Design Endeavour). KSCST also supported ASTRA cell in matters of to technology diffusion. And second way to diffuse the technology was through arrangement of educational programmes for ASTRA cell technologies.

In the late 1980s and early 1990s in the development discourse in India, there came an emphasis on the theme of 'sustainable Development' which emphasized equitable, self-reliant and environmentally sound development. ASTRA cell had started with the objective of developing technologies which are economically efficient and environmentally sound ensuring self-reliance and long term viability. ASTRA cell renamed itself as the **Centre for Sustainable Technologies (CST)** in the year 2003 with a motive of promoting sustainable technologies that would maintain a sustainable environment. Its current area of research includes: (a) Low Carbon building materials & systems, (b) Biomethanation, anaerobic digestion & nutrient recovery, (c) Biomass gasification, (d) Water Treatment technology, (e) Fuel-efficient wood burning devices, stoves and agro-processing driers, (f) Sustainability evaluation and forecasting, (g) Sustainability in architecture, human settlements and design, (h) Green Buildings: energy efficient, climatic responsive and thermal-comfort, (i) Building Integrated Photovoltaic (BiPV), (j) Ecotoxicology, aquatic biodiversity & bioremediation of lakes, (k) Solid Waste management, (l) Climate Change;

green house gas inventory, mitigation, adaptation, vulnerability assessment and policy studies, (m) Environment quality assurance and impact studies, (n) Energy, environment and climate change policy analysis.

3. Financial Resources

Federal agencies like Department of Science and Technology (DST), Ministry of Non-Conventional Energy Sources (MNES), Council for Advancement of People's Action and Rural Technology (CAPART), state agencies like DST Karnataka, Karnataka State Council of Science and Technology (K.S.C.S.T) and a private agency like Tata Energy Research Institute (former TERI) have funded the ASTRA cell.

***4. Intellectual Resources- Successful dissemination of technologies from ASTRA Cell-CST*:**

ASTRA Cell-CST has successfully disseminated some of its technologies in India and other developing countries. There is providence of certain technologies which were implemented in field and have received enormous success. Some of the selected applications of ASTRA cell technologies are: (a) Dissemination of ASTRA stove (1983), (b) Biogas plant dissemination (1985 - 1989), (c) Open- top Wood Gasifiers (1987, 1990), (d) Large Scale Dissemination of Solar water heater (1990-1995), (e) Dissemination of Lead Litter-based biogas plants (2004), ASTRA cell's rural technology is well recognized in India because those technologies are of energy efficient, low cost and sustainable.

Regarding patents, ASTRA cell-CST has varieties of patents. Sometimes, they have open patents, where they allow users to acquire license on the technologies. Patent has a new technology otherwise it does not come under the theme of patent. Some of the patent details are: (1) A process of removing Hydrogen Sulfide from a Gas Mixture — India (August 1996), (2) Biomass Gasifier — Switzerland (October, 2000), (3) Improved Biomass Gasifier — Sri Lanka (February, 2001), (4) Improved Biomass Gasifier — Brazil (July, 2001), (5) Improved Biomass Gasifier — Thailand (February, 2002), (6) Improved Biomass gasifier European patent (November, 2000), (7) CN Technology for cleaning Tar and Dust Laden Gases for use in reciprocating Engines/Gas Turbines for Power Generation — India (September, 2001), (8) Improved Biomass Gasifier — Japan (March, 2002), (9) A Novel process and Apparatus for the manufacture of Precipitated Silica from Rice Husk Ash — India (February, 2003), (10) The same technology patented later on in several other countries like, Thailand, (in February, 2003), (11) Vietnam (in September, 2005), (12) Japan (in August, 2005), (13) China (in February, 2004), (14) and Indonesia (in August, 2005), (15) IISc Advanced Biomass Cook Stoves — India (in September 2005).

Commercialization of Improved technologies in rural areas: problems and promises:

The problem of commercialization of rural technologies is the biggest ever problem and efforts have also concentrated on disseminating many of these technologies. The efforts of dissemination have been over a number of sectors ranging from rural industry and agriculture through transport, energy to health and housing. There are different mechanisms for the commercialization of rural technologies, such as; (a) the facilitation mechanism (e. g., Venture capital, subsidy, equity/share, awareness building and extension works done by NGOs etc), (b) the centralized mechanism (e. g., technology marketing agencies like NRDC), (c) decentralized mechanism (at local level), and (d) the necessity of modified market mode/ non-market mode of technology commercialization (Krishnaswamy & Reddy, 2006: 244–261).

The efforts to disseminate those sustainable energy technologies (SETs) are the biggest of challenges in the field of renewable energy and energy efficiency. Commercialization of those technologies refers to the process of moving a technology from laboratory to market acceptance and use that takes it to mainstream economic activity. SETs in India are at a very low level of commercialization because of Government's apathy (e. g. partly because of the withdrawal of protectionism). Barring a few SETs like solar water heaters, wind energy, most of the SETs in India have fallen inside the valley of death, where the cost of the production is high and scale of production is low.

For example, ASTRA Cell-CST has developed and commercialized Bio-Energy technologies (BETs), e. g. biogas based technologies, too. But it too faces problems in diffusion. In terms of family biogas, the problems were high first cost and procedural delay for obtaining subsidy. In community biogas, the problems were of inadequate demand for electricity, large investment at village level, absence of institutions to plan, implement and manage community biogas systems and absence of strong community organizations at village level. But in Biomass gasifiers, the problems were basically the land availability, sustainable biomass supply etc. In diffusing the other BET, e. g. improved stoves, the bottlenecks were, short life of mud stoves, low performance of improved stoves, lack of user education etc.

As pointed out by the ASTRA Cell-CST research team (through personal interviews), for the dissemination of these technologies and for overcoming the related bottlenecks, the following recommendations are made: (a) Capacity building for the effective and efficient technology transfer process, (b) Financing for technology transfer, (c) Funding R&D for specific technologies, (d) Policy to find large-scale demonstration programmes, (e) Rational energy pricing policy, (f) Private sector participation like that of NGOs and international agencies, (g) Policies to promote participatory approach, (h) Periodic assessment and evaluation of technologies, policies and programmes, and (i) Bilateral and multilateral mechanism. ASTRA cell — CST as a programme of the institute has survived (not flourished) for more than 30 years now. Its most positive aspect is its being sufficiently funded. CST's programme at the IISc Bangalore has influenced other research units even at IITs. It has been able to place rural technology on the agenda of national institutes. The contribution of CST to the field of AT in India is well recognized.

Case Study. 3: The Honey Bee Network (HBN), Ahmedabad

1. Intellectual mobilization of Resources: Actors, Conceptions and Foundation of HBN

The importance of local traditional agricultural techniques, knowledge about medicinal and nutritional value of nearby plants etc can hardly be neglected. The issue of how local knowledge and innovations can be documented and recognized is of immense importance under a globalized technology regime. How can those who seek to document local inventions ensure reciprocity between the innovators and those who may seek to use and perhaps even commercialize those documented ideas? What mechanisms would help an inventor to further develop, share or commercialize their inventions? How could this work be accomplished without undermining the communities from which the knowledge originates? With answers to such questions in mind, Prof. Anil K. Gupta, presently a faculty member at the Indian Institute of Management (IIM) Ahmedabad established Honey Bee Network (HBN) as an informal network in 1988–1989 to address those very issues (Gupta, 2006: 49–66). The HBN aimed to recognize and encourage the creative potentials of ordinary

people and also to document the innovative ideas embedded in the folk/local traditions and traditional practices of communities.

***Anil K Gupta's Vision and establishment of HBN*:** In the year 1985, Anil Gupta was invited by the Research Council of Bangladesh to advice on how to help scientists work on the lands and fields of the poor people and how to develop research technologies which are based on marginality? While writing a paper in the context, he discovered tremendous creativity among the tenants and landless farmers of Bangladesh that he was completely overawed. He received messages of tens of thousands of people from the villages, who have solved problem by their own indigenous efforts without any outside input, a point that he had been raising from last 21 years. The point was that people may be economically poor, but they are not poor by their ideas. In other words, 'the minds on the margin are not the marginal minds'. That is the message with which he started 21 years ago. So, Anil Gupta & Colleagues started with a message: Minds of the margin are not the marginal minds; shall we join hands in learning from grassroots innovations. That is the message, where he got inspired to establish HBN. Along with Anil K Gupta, the other scholars who have made immense contribution toward the growth of HBN were: Prof. Vijay Sherry Chand (faculty member at IIM Ahmedabad), Jyoti Capoor (now Editorial Assistance: HBN Newsletter), Kirit K. Patel (now Associate Editor: HBN Newsletter), Kapil Shah (Active member of Gujarat Network), Hema Patel (now in SRISTI, Gujarat), T.N. Prakash (now Regional collaborator: HBN, Karnataka), P. Vivekanandan (now Executive Director, SEVA & Coordinator, HBN), Riya Sinha (now National Coordinator: Scouting & Documentation, National Innovation Foundation: Ahmedabad), Prof. Rakesh Basant (faculty member IIM Ahmedabad), Amrutbhai Agrawal, Chiman Parmar, Shailesh Shukla, Sudhirender Sharma etc. Hence this group of intellectuals make the 'Constituent Adherants' (McCarthy and Zald, 1977) of this SMO called the HBN.

2. Organizational Resources of HBN

The principal organizational components of HBN include the National Innovation Foundation (NIF), the Grassroots Innovation and Augmentation Network (GIAN) and the Society for Research and Initiative for Sustainable Technologies and Institutions (SRISTI). But the network is inclusive of many of the branches of these organizations spread all over India.

Objectives of Honey Bee Network: The objectives of HBN were:

(1) to project the intellectual property rights of the grassroots innovators, and generate models for recognizing, and rewarding their technological creativities;

(2) to add value on the products for making better commodities;

(3) to explicate the insights learned from such traditional technological and institutional innovations developed by individuals as well as communities;

(4) to help develop entrepreneurial abilities among those innovators to generate returns from this knowledge/innovations and to enrich these innovative people and their providers (scientists, engineers, leaders and administrators).

3. HBN and its Internal Linkages

A dream to encourage the creativity of grassroots is known as HBN. Gradually, HBN felt that an independent institutional structure is much needed which could help to sustain the Honey Bee Newsletter and its associated activities. On the day of 1st June 1993, The Society for Research and Initiative for Sustainable Technologies and Institutions (SRISTI) an

organization was formed as a supporting institute of HBN. Based at Ahmedabad, Gujarat, SRISTI is a registered charitable organization under Bombay Public Trust Act, 1950 and the organization was registered under Sec. 80 of Income Tax Act, 1961 and foreign contribution regulation act, 1976. It is a voluntary organization. Another organization named, Grassroots Innovation Augmentation Network (GIAN) was set up in 1997 to disseminate basically the mechanical innovations of HBN. The idea of GIAN was to link the three viz. innovations, investments and enterprises. And the National Innovation Foundation (NIF), another organization was formed in the year 2000, and was set up as a society by the DST (Govt. of India), as an outcome of the collection and documentation of work of the HBN in the last decade or so. It became the main institution of the HBN to maintain the national registrar of grassroots innovations. So, the main aim of NIF was to provide institutional platform to grassroots innovators from different parts of the country.

The IIM Ahmedabad has a major role to play in this as it provides institutional support to the network. IIM Ahmedabad also provides editorial and logistical support to Honey Bee Newsletter which is one of the major activities of HBN. Regarding IIM's role, Anil K. Gupta says: *IIMA is playing a vital role for HBN. It has given me a place to do what I wanted to do. It has given me time, space, opportunities and social capital too. IIMA makes lot of things easier.* (Personal Interview, 16th July 2011.)

HBN and its Initial Attempts: In order to expand the scope of local creativity and to accelerate the interaction of creative grassroots innovators with scientists, academics, policy makers and civil society, the network decided to publish Honey Bee Newsletter. It was published in English. HBN printed its first newsletter in May 1990, which had only 44 subscribers including scientists, public aid workers, financiers, farmers and craftsman. Anil Gupta along with his colleagues collected handful of information and presented those in the form of write-ups and articles in the newsletter. The second issue of the newsletter was published in 1991; it was published in English and Tamil. The work of those early years was encouraging for Honey Bee's core activities which included scouting, documenting grassroots innovations and traditional practices and sharing this knowledge in a larger scale among a wider audience. HBN is now spread in different states. It has published its reincarnated versions in regional languages (in collaboration with different magazines) like, in Kannad, Malyalam, Oriya, Tamil, as *Loksarvani* in Gujrati, and as '*suj Buj Aas pass ki'* in Hindi. Chief functions of the Network institutions are to collect, edit, promote, reward and campaign for the new innovations as well for the old traditional wisdom (SRISTI, unpublished document, 2011). HBN Newsletter is now sent to 75 countries around the world. The uniqueness behind Honey Bee philosophy is that 'they are trying to transform the resources through which poor people became rich. The resources are their knowledge, innovations and sustainable practices.'

During the last 21 years, since its foundation, HBN has documented 150,000 innovations and traditional knowledge based practices in areas like — energy, agriculture, transport, food processing, herbal drugs, human drugs, agricultural inputs, horticulture, and utilities. These innovations are either of contemporary origin or based on outstanding traditional knowledge/practices primarily from India and from other parts of the world. Many of these innovations are extremely simple and can improve efficacy of farm workers, small farmers, artisans and others to a great extent. A handful of inventions have resulted in patents. *We are building awareness on the potential value of indigenous innovations in India. The experience of HBN over the past decade and half has proved how critical it is to document the traditional knowledge as a first step towards realizing their values.* (Personal Interview, Anil K Gupta, 11th July, 2011.)

4. External Linkages of HBN / Collaborating Institutions

The external linkages of HBN are very wide spread. Some of its collaborating institutions could be identified as follows: Prithvi, SEVA Madurai, PEDES Kerala, Innovation Club Orissa, and the Network of Gram Veedya Piths like, at Sardar Krushinagar, Nootan Gram Vidyapith (Thava: Bharuch), Lok Bharati (Sanosara, Tal: Bhavnagar), J. C. Kumarappa Gram Vidyapith (Gadhada: Bhavnagar), Gram Vidyapith Shardagram (Junagadh district), Gram Bharti Gram Vidyapith (Amarapur, Tal: Mahesana), Mahila Gram Vidyapith (Nardipur: Mahesana), Shree Sarswati Gram Vidyapith (Samoda-Ganwada: Mahesana), Nootan Bharti (Madana-Gadh: Banaskantha), Sabar Gram Vidyapith (Sonasan: Sabarkantha), Lok Niketan Vidyapith (Ratanpur, Banaskantha), Gram Seva Mahavidhyala (Dumiyni: Rajkot) and the Gujarat Agricultural University. Mostly students from these Gram Vidyapiths help assist HBN in scouting and documenting the grassroots innovations. These could be treated as the 'Conscience Adherants' of HBN SMO.

Society for Research Initiatives for Sustainable Technologies and Institutions (SRISTI)

1. Origin and Organizational Resources of SRISTI

SRISTI grew out of the informal network (Honey Bee) of academics, farmers, scientists, and others who wanted to stem the erosion of traditional knowledge in India, and to document and share local innovations. As HBN sought to link formal with informal science and traditional knowledge, SRISTI was to carry forward this aim of HBN. Traditional knowledge has the potential to expand the frontiers of formal science, which could itself enhance or build upon local creativity. As the HBN grew, there was a need to — and thereby consolidate — its vision. SRISTI was established and registered as a formal organization in 1993. SRISTI is based at the IIM Ahmedabad, and this has helped to secure its reputation as a legitimate and leading NGO in the country.

SRISTI is less structured as an organization. It does not have any hierarchy and neither has it maintained any division. It follows the philosophy of HBN. It is a voluntary organization. Anil K. Gupta is the Chairman of this organization and who is also the guiding force and the initiator of SRISTI's activities. Vijay Sherry Chand is the Vice — President. Ramesh Patel is the Secretary. SRISTI also has a governing body. Currently 20 employees are working at SRISTI, involved in different activities ranging from scouting, editing, publishing, and lab work etc.

Activities of SRISTI: The various activities of SRISTI include: (1) *Documentation, Dissemination of innovations and Networking with other grassroots organizations*. (a) In order to process the documentation, SRISTI takes the help of students (who do summer courses at IIM Ahmedabad) to identify innovators. In the next step, it takes the help of government officers /Gram sevaks etc in finding the innovators. Students who have contributed significantly in this regard are awarded by the network. (b) Survey through innovators: It also happens that innovators come forward to locate other innovators of the same kind. This process has been very rewarding in identifying innovations in farm implements and soils/water conservation. (c) Competitions for 'Innovation Scouts': Competition has also been organized in Gujarat and Rajasthan among students of agricultural colleges and grassroots level government functionaries to scout innovations. Workshops were first organized in order to provide

some background about prior research and to illustrate many of the innovations that had been identified by village level workers. The entries sent by the participants were evaluated and the winners were awarded the prizes. (d) Biodiversity contests for documenting innovations: Biodiversity contests also were organized among school children and adults in order to scout 'little geniuses' among children, and make them aware of their collective ecological knowledge systems. These contests also help them in accelerating the knowledge transfer from older generation to younger generation. (e) Shodh Sankal: SRISTI also provides scope for lateral learning among those who solve problems and not those who merely articulate the problem. In order to strengthen the lateral learning among the grassroots innovators SRISTI has initiated the concept of Shodh Sankal — a chain of experimenting farmers. Such meetings or Kishan Gosti encouraged the several farmers from the host villages to show their own innovations and took a major responsibility for networking and diffusion of ideas. (f) Agricultural fairs: Agricultural fairs are one such vibrant traditional institution in rural India where a large mass of people assemble either for religious or cultural celebrations or for exchanging agricultural information. *Loksarvani* is a magazine of SRISTI in Gujarati language for sharing information with the farmers.

(2) *The Educational Initiative***:** SRISTI also has taken some initiative for educational development of the downtroddens of society, through its programmes on educational rehabilitation, setting up village libraries, distributing books among villagers etc.

(3) *Shodhyatra: A Study tour:* Shodh Yatra has been one of the major activities of SRISTI. Shodh yatra means a journey of explorations. The idea is to walk for 8 to 10 days in extreme summer or winter to explore innovations and share its own database. The aim of Shodh yatra is to meet the farmers, learn about their experimental techniques and note what is learned from them. Next, the aim is to get children interested in creative farming techniques and to educate the farmers about HBN activities and objectives. Shodh Yatra has become a tradition of HBN. So far SRISTI has conducted 27 Shodh yatra festivals in different parts of India in order to collect information regarding grassroots level innovators and innovations.

(4) *Sadbhav SRISTI Research Laboratory:* SRISTI has set up a R & D Laboratory in the year 2000, with the help of Sadbhav Foundation (Charitable Trust, Mumbai) to test all the information systems scientifically and bring traditional knowledge oriented products to the consumer market. Both have procured a fixed percentage of the royalty and the share of innovators upon the profit fetched by the use of their techniques. Laboratory works include: (a) preparation of herbal and animal medicines, (b) preparation of herbal solutions to the disease generating bacteria in the farm, and (c) study of micro bacteria of the soil. Profits on the products in the market are shared with the innovators. Distribution of profits is fixed by the discussions among the innovator, scientists and the members of the Governing body of SRISTI.

(5) *SATVIK traditional food festival:* SRISTI organizes traditional festival in order to publicize innovator's idea at public. Every year, December 3rd and 4th, they organize the food festival. Traditional recipe is being placed at festival. Through this kind of food festivals, they sell the recipe. From Ahmedabad city itself, almost like 50,000 people gather every time. Till now six such festivals have been organized.

(6) *Honour of SRISTI/SRISTI Sanman:* A function to reward various artisans of different fields, traditional doctors, and or the persons having special or unique contribution in traditional art and knowledge is organized every year on the day of the yearly meeting of HBN and SRISTI. For SRISTI Sanman, i. e. Sristi award, the best researchers' innovations,

experiments and new innovative ideas are selected from the entries received throughout the year. The public utilities of those innovations and their social contributions are also noted for the selection of the award. The innovations made by women are given special place in the quota of special series for the SRISTI award.

(7) *Compilation of the wisdom from Century old mothers:* In order to make the youth aware and sentimental towards the importance of culture and wisdom, SRISTI initiated to reward centurion mothers, since 24 April 2003. SRISTI has made survey of more than 200 such women.

(8) *Loksarvani:* A magazine named *Loksarvani* is devoted to the prevention and procurement of intellectual property rights by editing and compiling the experiments of any creative artists or farmers with organic farming systems. SRISTI through *Loksarvani* is trying to provide literature about less expensive and innovative techniques to the small and remote farmers at their homes with subscription fee of mere 100 rupees.

(9) *Tech Pedia:* SRISTI provides for a platform called Tech Pedia, where engineering college students from different parts of Gujarat, interact with HBN network. Whatever problem the network encountered, they put in Tech Pedia, for which, engineering students come forward to offer technical solutions.

(10) *Grassroots innovation as grassroots Technology/appropriate technology:* SRISTI works on eco-friendly technologies. To SRISTI, technology is a broader term, not only a scientific way of producing things. It may be layman's invention to make a product whatever the tools he may use. That may be poor but useful. Technology does not only mean scientific product or process being followed for development. Some grassroots innovative practices can be transformed into technologies too. If it could be commercialised, then, it is technology and if it is appropriate to particular circumstances, one can consider it as AT. SRISTI scouts, documents, registers and even helps in commercialization of such technologies by protecting the interest of the innovators (SRISTI unpublished source).

(11) *SRISTI Commercialization of grassroots technologies:* SRISTI has also made some value additions in grassroots technologies. Those value added products are transferred to industries for their better publicity. SRISTI has successfully transferred 8 technologies. Five agro products have been transferred to Matrix Biosciences Pvt. Ltd, Hyderabad, two vetnary products also have been transferred to Matrix Biosciences Pvt. Ltd, Hyderabad and one Herbavate product has been transferred to Troikaa Pharmaceuticals Pvt Ltd, Ahmedabad. Technology transfer is done by keeping in mind the local and international policies (SRISTI update: 2011).

2. Economic Resources: Funding Details / Facilitators of SRISTI

International Development Research Centre (IDRC), Canada has been working with SRISTI since the early 1990s, providing core support for institutional strengthening, and a range of activities related to the preservation and valuation of traditional knowledge and practices related to natural resource management. IDRC has been a core support to SRISTI, as it granted USD $ 150,000 to SRISTI and this transition was possible with the help of Pew Charitable Trust. R. A. Mashelkar former Director General (DG) of the Council of Scientific and Industrial Research (CSIR) has also been a vocal supporter of SRISTI's work. About SRISTI, Mashelkar noted that 'when most people speak of India's contributions to society and the economy they refer only to the educated minority — the tip of the iceberg in India. But SRISTI's pioneering work has been considering the rest of the iceberg, and that the major challenge now lies in linking the two — linking formal and informal

systems of innovation'. He was one of the initial mentors of SRISTI (IDRC Report, 2003). The persuasive personality, commitment and credibility of Anil Gupta have also been an enormous facilitating factor in this case. Gupta has been and continues to be the "policy entrepreneur" of this endeavour — he has relevant expertise; political, academic, and international connections; negotiating skill; and is truly dedicated to SRISTI's work. For its Lab, SRISTI took the help of Department of Science and Technology (DST) for value addition. Sadbhav Foundation (Charitable Trust) also helped SRISTI for providing Rs. 6.0 million for instrument project. Wagh Bakri (tea group) has also donated Rs. 2.5 million to SRISTI (Burton, 2003: 7–8).

3. The Internal and External Linkages of SRISTI

SRISTI has its internal linkages with NIF, and GIAN. Its strong external linkages are with, Indian Council of Medical Research (ICMR), Council of Scientific and Industrial Research (CSIR), Indian Council of Agricultural Research (ICAR) and Gujarat University, Centre for Research and Social Development (Gujarat), Innovative Orissa Initiative (Bhubaneswar), SEWA Tamil Nadu, Centre for Interdisciplinary Studies (West Bengal), Development Research Communication and services centre (West Bengal), Sadbhav Foundation Mumbai, and the several engineering colleges of Gujarat (for scouting by students). All these organizations extend their cooperation to SRISTI in scouting, documenting and processing of innovations.

Grassroots Innovations Augmentation Network (GIAN)

1. Origin and the organizational Resources of GIAN

SRISTI's research and action programmes have triggered an institutional form of innovation, i. e. GIAN (Grassroots Innovations Augmentation Network). GIAN (Gujarat) was established at Ahmedabad and developed as an autonomous body. It was registered as a trust and society, supported by the Government of Gujarat, SRISTI and IIM Ahmedabad with a view to linking innovations, investment and enterprise. The need of a micro venture for promoting and financing the needs of grassroots green innovations was recognized during an International Conference on Creativity and Innovations at Grassroots (ICCIG), which was held at IIM Ahmedabad in the year 1997. Thereafter, it has been given the status of a Scientific and Industrial Research Organization (SIRO) by the DSIR, Government of India. It plays an active role within HBN by coordinating activities with NIF. GIAN has more than one campuses, e. g. GIAN West/Gujarat and GIAN North/Jaipur.

Members of Governing Body of GIAN: The Governing Body of GIAN (Gujarat) consists of its Executive Vice Chairman, Principal Secretary, Secretary, and Faculties from IIM Ahmadabad, Director of International Centre for Entrepreneurship and Career Development (ICECD), Innovators and entrepreneurs, Chief Innovation Manager, Project Manager, Finance and Administrative officers. That apart, it includes representatives of Gujarat Government, IIM Ahmedabad, SEWA, SRISTI and Gram Swaraj Shiksha Kendra.

2. Financial Resources

National Micro Venture Innovation Fund (MVIF) has been the principal financial source for GIAN which was made available with the help of SIDBI in the year 2003. It too has other small sources of fund like from Gujarat Government and DSIR.

3. Intellectual Resources of GIAN

GIAN activities: The activities of GIAN are three fold. First, it helps the innovators in standardization and development of improved prototypes. Second, it protects the intellectual property rights of the innovators. Third, it extends business development support to the entrepreneur through venture finance, technology transfer and enterprise development.

GIAN and value addition: GIAN is busy doing value addition particularly in mechanical engineering technology. For this purpose, GIAN has reputed technocrats and faculty members from engineering colleges as its advisors. At Ahmedabad, they have only the office. They do all their fabrication and prototype development outside their office. For that they involve local fabricators. Around Ahmedabad, there are industrial areas in Naroda, Chammur etc, where they do fabrication and prototype development. Sometimes, value is also added by the fabricators third party designers/entrepreneurs/ or by innovators. There are cases where innovator becomes the entrepreneur by himself.

Intellectual Property Right: GIAN extends its helping hand to protect the IP rights of individual innovators. It also helps in filling-in patent forms for those who are ignorant about the procedure. Patent Assistance Cell at GIAN performs various activities like providing basic patent education to the innovators and general masses by disseminating information at various events and workshops. It also tries to understand the novelty in innovation by conducting prior art search. GIAN also acts as a bridge between innovators and entrepreneurs by means of giving proper IPR protection with the help of patent attorneys and law firms like Anand & Anand, Surana & Surana, Y. J. Trivdei in India and International law firms such as K & L Gates of Boston etc outside India. So far GIAN has facilitated filling 30 patents in India out of which 15 patents have been awarded. Further, it has filed seven patents in USA out of which 4 patents have been awarded (GIAN Update, 2011).

Technology transfer/technology commercialization: Out of these 150 000 traditional knowledge and practices documented, GIAN has selected 150 such cases of innovation based on its demand for market. GIAN has actually worked or done with 50 technologies. There are 19 such cases, where GIAN has successfully transferred the technologies to outside entrepreneurs through legal agreements, where, the innovators will get the priority. GIAN has also accomplished successful cases of technology transfer, e. g. (1) Technology for Natural water cooler developed by innovator Arvindbhai Patel, (2) Technology for low cost wind mills (funded by Alstom Foundation, France), (3) Technology for Non stick Clay Tawa, Mitticool Refrigerator and Clay Cooker developed by Mansukhbhai Prajapatoi, (4) Technology of Cotton Stripper machine developed by Mansukhbhai Patel, (5) Technology of Bullet driven Santi developed by Mansukhbha Jagani, (6) Technology of scooter mounted floor mill developed by Sheikh Jahangir etc.

New Initiatives taken up by GIAN: Some of the new initiatives taken by GIAN includes: (1) Establishment of innovator based incubator with the financial support from NIF. GIAN extended support of Rs. 15.83 lakh to six innovators of Gujarat under the program, (2) Tie up with Reuters for technology diffusion to farmers through mobile (SMS) phone**.** Each innovator received about 20 calls per day on an average, (3) GIAN West also carried out market research on some herbal formulations developed from the traditional knowledge of traditional healers viz. Herbaglow, Pain Relief, MosqHit, Herboheal and Zematic, (4) In order to provide market identity, GIAN has also developed brands for two innovative products and launched it in the SATVIK traditional food festival which is held end of every year, (5) GIAN also approached automobile manufactures Shri. Sunil Parekh, Shri. Rahul Bajaj, (Chairman, Bajaj Auto Ltd.) and Shri Sunil Munjal (Chairman, Hero Honda Ltd) to incite their interests in automobile

technologies developed by grassroots innovators, (6) In case of innovative tractor operated cotton picker machine, GIAN has extended financial support to the innovator for value addition and prototype development through NIF. It has also filed patent application to protect the IPR of the innovators, (7) Looking at the potential of Gas Iron in Gujarat, GIAN West carried out Market research and organized a demonstration with the help of SEWA (Self Employed Women's Association) Ahmedabad, (8) GIAN West has extended its help in terms of value addition and patent protection support to the innovator of Jhulla operated washing machine and for further development and commercialization of the machine, (9) In case of Mobile Groundnut Thresher, GIAN West is helping the innovator in value addition by involving formal experts from IIT Kharagpur (W.B), (10) GIAN also established the Grassroots Innovations Design Studio (GRIDS) at National Institute of Design, Ahmedabad to provide world class design inputs to the grassroots innovators supported by Gujarat Government (ibid).

Problems with commercialization: Some of the major problems faced by the HBN during commercialization of those traditional innovations are: (a) Locational disadvantage, (b) Formal promotional or advertising problems, (c) Questions on preliminary results of tests done by GIAN/NIF, (d) Presence of low cost substitutes or machines, (e) Delaying payment of license installments fees, (f) Difficulty in tracking the sales record, (g) Subsidy problems, (h) No follow up of innovations by entrepreneurs.

4. External Linkages of GIAN

GIAN has also linkages with Govt. of India Depts. like DST and DSIR for taking advantage of schemes such as Technopreneur Promotion Program (TEPP) of TIFAC and the like. Leading nationalized banks finance innovators for the purpose of developing product prototype, workshop establishment, holding conference, seminar etc. GIAN played an instrumental role as a knowledge partner in building Global GIAN as an international incubation platform being supported by SRISTI and *Asian and Pacific Centre for Transfer of Technology* (APCTT) network. GIAN West was also extending financial supports to the innovators under the MVIF a Venture support, Value Addition Research & Development (VARD) support and Workshop development support. Apart from these, GIAN maintains its external linkages with Gujarat Govt.'s dept. of Industry and organizations like SEWA and legal firms like Anand & Anand, Surana and Surana etc. And noteworthy that GIAN also maintains strong linkages with academic institutions like, IIT Bombay, IIM Ahmedabad, National Institute of Design (NID), and Institute of Rural Management Anand (IRMA) for consultations in technical matters.

National Innovation Foundation (NIF)

NIF as an autonomous scientific society was set up in February 2000 with a corpus of US 5 million dollars by DST Govt. of India under the chairmanship of Dr R A Mashelkar, President, Global Research Alliance and former Director General, CSIR to fulfill the long felt need for recognizing, respecting and rewarding innovations and outstanding traditional knowledges/practices at the grassroots.

1. Organizational Resources

NIF has 5 sections devoted to: (a) Scouting and Documentation, (b) Value addition and R & D (c) Business development and micro venture, (d) Intellectual property right

management and, (e) Dissemination and information technology. Each section is guided by a national coordinator. Head of the institution is Chief Innovation Officer. Above all, there is a governing board. The Chairman of the board is Dr. R. A. Mashelkar. Prof. Anil K. Gupta is the Executive Vice Chairperson. Below the National Coordinator, there are senior fellows, associate fellows, junior fellows and research associates at different levels. Full time staff at Ahmedabad (NIF) would be approximately 40. Their main strength is the voluntary network spread by the HBN which contributes the bulk of the entries received.

2. Intellectual Resources

Models developed by NIF to extend its helping hand to grassroots innovators

*(i) Idea Licensing***:** Idea Licensing is one of the models developed by NIF. In case of Food Sprayer, the product was conceptualized based on the idea of the innovator. GIAN and SRISTI licensed the technology to an international firm. Business model was International Technology Licensing, one time payment of licensing fee. The present status is that the firm is using the technology for manufacturing toys. And a patent is filed by the innovator in India and by the firm abroad.

(ii) Innovator needs support for proof of the concept: It does happen like innovation sometimes need support to prove the significance of the concept. In case of 'Aaruni' bullock cart, the idea was for developing multi-purpose, efficient and user friendly bullock cart. SRISTI scouted the innovation and provided initial support for developing proof of concept. GIAN provided further support for product development, IPR and commercialization. In terms of business model, the innovator turned into an entrepreneur and also licensed the technology to three other entrepreneurs in different regions. Final status now is that the innovator earned so far Rs. 1.5 million.

(iii) Innovator develops proof of concept, needs financial support for prototyping: In case of Pedal Operated washing machine, a school girl from Kerala got the idea of a Pedal operated washing machine. She explained her idea to a local mechanic and got it developed. After scouting, she shared her ideas with NIF about the areas where this machine needs improvement, e. g. Tap arrangement, improvement in makeshift arrangement, material of construction etc. So, for this, NIF extended financial assistance for improving the prototype. In terms of its potential for commercialization in market, it is found that the product could solve both the purposes like washing machine and also as an exercising machine, but it is yet to be commercialized.

(iv) Innovator comes up with prototype and entrepreneur gets involved in developing a commercially viable product: In case of Auto Air Kick Pump, the idea was easy and unique solution to a commonly found problem: Punctured tyres on roads. The innovator came up with initial prototype. GIAN scouted an entrepreneur for him who helped him in developing a refined product. The technology acquired by the entrepreneur with an upfront payment had a royalty arrangement for next ten years. The present status is like more than 1,000 units being sold in market. And its patent is also filed both in India and US.

(v) Innovator turns into an entrepreneur: It is also found that innovator becomes an entrepreneur with the help of HBN. In case of Cotton Stripper technology, the idea was, a machine removes cotton from the cotton shell in faster and efficient manner and reduces drudgery for women and child labour. SRISTI scouted the innovator and GIAN mobilized technical support for product development, IPR and commercialization. Business model was innovator turned into an entrepreneur. Status of the product is that 65 machines being

sold in market worth Rs. 20 million. A patent has been filed both in India & US. And it is the first Indian Grassroots Innovations which has been awarded a US patent.

(vi) Innovator develops technology, GIAN licenses entrepreneur: In case of Kushal Sprayer, a Hand operated hassle free sprayer, GIAN helped the innovator with the support of National Institute of Design (NID) that helped in product development, NIF helped in protecting IPR, and TIFAC helped in commercialization. The business model entails, GIAN facilitating in transfer of technology and existing manufacturing facilities to an entrepreneur. The final status is that the entrepreneur is about to launch the product in market after some design improvements.

In case of Auto Sprayer, the idea was like a dead weight propels the spraying function while walking. GIAN motivated an existing innovator to develop a unique sprayer which does not require any manual stroking. As a result of lateral learning, innovator came up with a concept which was refined at GRIDS-NID, subsequently; IIT engineering students worked with the innovator and developed a working model. Entire cost of development was supported by GIAN. The Battery operated sprayer develops as a fine quality mist but runs on battery. And the Hand driven sprayer, does the spraying by manual pulling of the sprayer mounted on a pair of wheels. The business model involved in this category was the technology acquired by the entrepreneur. The final status is that entrepreneur is about to launch the product in market. And the patent is being filed in India.

(vii) Innovator develops prototype and commercializes through the SHG: This Tile making machine, was highly cost efficient and also easy to make machine for cement roof-tiles. It was scouted during Shodhyatra in Uttarnchal, GIAN financed the second prototype development. The business model was, GIAN identified an NGO which agreed to adopt this technology to manufacture low cost cement tiles for small medium houses with the help of women SHG's. Apart from being a cheap and stronger solution to roofing in houses, the technology is also being used as an instrument to generate employment for women in the region. Final status is that the innovator is about to start training of women who are going to undertake this activity as an occupation. Its Patent is also filed in India.

(viii) Joint Venture: Innovator and Entrepreneur: The case of Power saving technical Pump is a highly efficient double cylinder reciprocating pumping technology that saves about 60 % energy. IIT Kanpur tested and validated the data for the first prototype. The first prototype of the pump was developed by the innovator with the help of GIAN. Two entrepreneurs joined hand with him and started a JV firm with 33 % equity holding of each partner. Besides, the innovator gets employment in the same firm and earns a good salary for his technical inputs. The business model was joint venture with two entrepreneurs. The final status is the firm refining the technology, e. g. trying to make parts made of strong, heat resistant plastic with glass to improve the performance. And a patent is also filed in India.

(ix) Corporate House acquiring technology: In the case of Unique coupling device technology, the idea was to save upto 12–15 % energy losses in transmission. Lever principle applied in circumferential manner on two wheels of a coupler. IIT Guwahati validated the claims for the first prototype in pumps. GIAN North East (NE) scouted the innovator who developed this device for bicycle, cars and buses. With IIT Guwahati inputs, GIAN helped in refining the technology. Kirloskar Industries groups showed interest and invited GIAN team to demonstrate the technology. The business model was, on successful validation, the company would enter into an MOU for ToT with royalty arrangement. The final status is like, tests at the factory are on and efforts are being made to improve the performance of final applications.

In case of Bamboo fan, which is of double layer, multi-bladed design, throws high volume of air in the first plane of about 6 feet. In this case, GIAN NE scouted the innovator who was using the technology for paddy cleaning. GIAN NE and Jadavpur University tested the results. Presentation was made to Crompton Greaves Ltd (CGL) by NIF team. CGL promised to acquire the technology after validation. The business model was that the technology took a lot of inputs from CGL, creating a possibility of joint patent of modified technology and design. The final status of it was that validation was due in September 2003.

(x) Platform for technology with great promises: In the case of bicycle with rider-induced and terrain — induced forces for transmission, GIAN NE scouted the innovator and supported the prototype development. The Innovator developed several prototypes and reached upto a stage of E-BIKE, which is battery driven and is highly energy efficient as it gets propelling energy from the rider-weight and terrain induced jerks. The business model was technology transfer and licensing. Such kind of device has various applications like in automobiles, two wheelers, cycle rickshaws (where it can reduce drudgery for the puller). And the final status was product development and business development in process.

Projects supported directly by NIF so far

Sakun has innovated a multi-cylinder reciprocating pump. A prototype of the pump has been developed with the help of IIT Delhi. R. Jayaseelan has developed a coconut dehusker, with Industrial Design Centre, IIT Bombay. Tamarind Cultivation and processing techniques of A. I. Nadakattin has been developed through the linkage of IIT Delhi. All the above innovations have been supported by NIF for prototype development or familiar purposes. Mr. C. V. Pathak's pedal bore and other innovations have been supported by NIF for prototype development. A proptotype has been developed and tested by the innovator. A windmill developed by Mr. N. V. Satyanarayan has been given product development support. The Innovator will be provided with further support after NIF receives a report of detailed work done by him.

SEVA, Madurai along with NIF has supported several innovations in various ways. Such was the case of Sugarcane Off bearer cum Trash mulcher. Innovations in Power Tiller by the innovator Mr. Ansari, Tilting Bullock Cart by Mr. Amruthbhai Agrawal, Coconut Harvesting Machine by Mr. P. Karuppiah, and Improved Air-Energised Stove by Shri. Bharatbhai Agrawal etc are glaring cases of innovations supported by NIF for conversion into sustainable technologies (NIF Update, 2011).

*IGNITE Award***:** In 2007, they had started a campaign for Children's innovations, called IGNITE, for which NIF arrange award giving ceremony on each year October 15, the birthday of former President Dr. Abdul P. J. Kalam.

The Mode of Dissemination at NIF

The ways of technology dissemination includes, (i) presenting paper by the organizations at various National and International Seminars to promote advocacy for the usage of these sustainable and low cost technologies often based on traditional knowledge. (ii) Widespread decentralized demonstrations of technologies and large scale on-firm trials of promising agriculture related innovations are another model of diffusion. (iii) Various road shows to showcase promising technologies and to get feedback of potential users/customers is also a viable mode of diffusion. This feedback is used for identifying and improving features to find the best user fit for the technologies. Food and herbal festival programme is arranged by SRISTI regularly to create awareness among people. (iv) Diffusion also takes place through

women Self Help Groups (SHGs) in active collaboration with HBN partners' viz. SEVA: Madurai, PDS: Kerala, CCD: Tamil Nadu, Sristi Kendra: Orissa, Prithvi: Karnataka etc and through other diffusion clubs. (v) A subsidy scheme for percolation of technologies to marginal users, who could not otherwise afford the technology, but who can really benefit by usage of the technologies, is yet another mode of diffusion (NIF: web sources).

One of the other ways of disseminating those grassroots innovations is through electronics Media Interaction. Activities of NIF received a big boost through the Internet use and transmission through premier National and International Television Channels. In the year 2006, Discovery Channel-India profiled a few innovations of NIF for its television programme 'Beyond Tomorrow'. NDTV India ran a regular series 'India Innovates' in English and 'Aavishkar India' in Hindi profiling innovators across the country for one year. In 2006, Eenadu newspaper, a premier daily published from Hyderabad carried an article every week on grassroots innovations, which got tremendous response. Outlook India, a leading weekly published an article on innovators. BBC London covered NIF & 2006 Shodhyatra in Northern India. Some of the other Indian TV channels which showed an interest in grassroots innovations include Aaj Tak, CNN IBN etc. Major newspapers like The Hindu, The Deccan Chronicle, The Times of India, The Statesman, The Telegraph, Wall Street Journal, The Daily Mail, and Magazine like Yojana also carried out stories about grassroots innovators of NIF. Another major mode of diffusion of those innovations is through a medium like 'All India Radio', which has got the widest coverage even in the remotest part of the country.

Grassroots to global (g 2G): Global GIAN means Building Global Value Chain for an augmentation of Green Grassroots Innovations. GIAN innovation value chain has reached out to China, Brazil and many more countries. Collaboration steered by SRISTI takes it from grassroots to global.

Technologies sold by HBN Abroad: (1) Coconut tree climber USA (Florida, Massachussets, Carlifornia, Hawai etc), Australia, Maldives, Srilanka, Brazil, Mexico, West Indies etc), (2) Pomegranate deseeded — Turkey, USA, (3) Garlic Peeling machine — Pakistan, (4) Arecanut husker — Singapore, (5) Milking Machine — Philippines, Uganda and Ethiopia, (6) Resin grading machine — Peru, (7) Cassava Peeling machine — Kenya, and (8) Herbal growth promoters — Ghana.

Following are the patent details of NIF:

Table 1

Lists of Patents filed by NIF and GIAN in the USA

Innovation Catalogue	Nos. of patents filed
Electronic gadgets	1
Agriculture machinery & farm implement	2
Auto components, accessories & garage equipments	1
Agro based food processing machinery	1
Transport	1
Energy conservation and generation technology	1
Herbal formulation	1
Consumer durable	1
Sub Total	9

Table 2

Patents Filed in India

Innovation catalogue	Nos. of Patents
Agri-Plant variety	2
Agricultural machinery and farm Implement	27
Agro based food processing machinery	30
AC/ventilation machinery & equipment	6
Auto components, accessories and garage equipment	29
Construction & building equipment	7
Consumer durables	26
Diary Machinery	3
Earth moving and excavator machine	2
General purpose machinery & equipment	29
Electronic gadgets	6
Energy conservation and generation technology	21
Environment management technology	9
Transport	7
Traditional Knowledge	10
Herbal formulation	159
Mixed return (social and commercial) technology	17
Any other	8
Sanitation	3
Open source technology: no license fee required	4
SubTotal	405

3. Economic Resources:

NIF has a fund of Rs. 40 million from SIDBI (Small Industries Development Bank of India) as Micro Venture Innovation Fund (MVIF) to support innovations which have market potentials and also support to those entrepreneurs and companies which are interested in commercializing these innovations. It was sanctioned in October 2003 and operationlized in January 2004. MVIF is not a grant, it is rather a loan. It helps in extending risk capital to many ventures which otherwise are too risky for financial institutions to fund in the beginning. It supports the innovations in various ways like, (i) Support for converting market ready prototype to manufacturing in a small quantity based on the orders received by the innovator, (ii) Support for certification by Regulatory authorities, field trials, Market Research and Benchmarking etc.

4. External Resources of NIF

Collaborators of NIF: NIF has collaborators across the country. Collaborator details include, Retd. Brig. Pogula Ganesham (VSM), Andra Pradesh, Dr. Egul Padung from Arunachal Pradesh, Dr. Ranjan Kumar Singh from Haryana, Mr Azhar Hussain Ansari from Bihar, Mr. Ramji Bhai Dabhi (Centre for Research and Social Development): Gujarat, Mr. Ramesh B. Patel (SRISTI): Ahmedabad, Dr. Arun Chandan: Himachal Pradesh, Mr. Mushtaq Ahmed Dar and Mr. Zahoor Ahmed Shah from Jammu Kashmir, Mr. Rajeev Ranjan Pandey (Social Upliftment Trust): Jharkhand, Dr. T. N. Prakash (PRITVI): Karnataka, Father Hubby Mathew

from Kerala, Mrs. Anita Mahajan (Vishwasewa Foundation): Maharashtra, Dr. Balaram Sahu (Innovative Orissa Initiative/Aama Aakhha Paakkha): Orissa, Mr. Ranjan Mahapatra (SHRISTI Orissa): Orissa, Mr. Janmeja Johi: Punjab, Mr. Sundaram Verma: Rajasthan, Mr. P. Vivekanandan (SEVA): Tamil Nadu, Dr. Debal Deb (Centre for Interdisciplinary Studies): West Bengal, Shri Kamaljeet (Sristi-Gyan Kendra): Haryana, Peermade Development Society (PEDES): Kerala, Development Research Comminication and Services Centre: West Bengal.

For Scouting, there are many who extend their helping hands to NIF. Some of them are Mr. Azhar Hussain Ansari: Bihar, Mushtaq Ahmad Dar (Innovator): Jammu & Kashmir, Zahoor Ahmad Shah: Jammu & Kashmir, Mr. Goutam Rana: West Bengal, Mr. Bibhuti Bhusan Chakraborty (Innovator): West Bengal, SF Ahmad: Jammu & Kashmir, Syed Ahmed: Jammu & Kashmir, Sabzar Ahmad Wani: Jammu & Kashmir, Syed Nadeem: Jammu & Kashmir, Mrs. Sonia Suryavanshi: Uttarakhand.

Regarding GIAN & NIF cells, the collaborators are: Piyush (Chief Innovation Manager): GIAN-North: Rajasthan, Mr. Mahesh Patel (Chief Innovation Manager): GIAN — West: Ahmedabad, Mr. V. Abhai Kumar: GIAN cell — Tamil Nadu, Gangadharaiah — Memorial Entrepreneurship Development and Incubation Center (G-MEDIC): GIAN Cell — Karnataka, Prof. G. Mohiuddin Bhat Chairman: GIAN cell and J. & K. Director, Mr. Kishore Kalita: Indian Institute of Technology (Guwahati): NIF Assam Cell, Sikkim Manipal Institute of Technology, Sikkim (NIF Sikkim Cell), Dr. Natabar Hemam: NIF Manipur Cell.

MOUS with other organizations: NIF has also signed several MoUs with various national and international organizations. The aim was to promote mutual cooperation for grassroots innovation systems. It has signed MoUs with Malaysian Innovation Foundation (MIF), referred to as YIM, Botanical Survey of India (BSI): Kolkata, GB Pant University for Agriculture and Technology: Uttaranchal, IITG: Guwahati, IL&FS Education and Technology Services Limited: Mumbai, National Botanical Research Institute: Lucknow, Gangadharaiah-Memorial Entrepreneurship Development and Incubation Center, (SSITSTEP): Tumkur, University of Agricultural Sciences: Dharwad (UASD), CSIR: New Delhi, ICMR: New Delhi, IITK: Kanpur, Thiagarajan College of Engineering (TCE): Madurai, and Tamil Nadu Agricultural University (TNAU): Coimbatore.

It has also linkages with various private consultants and voluntary professional organizations like Matrix Agri Sciences Pvt Ltd (Matrix): AP and Small Industries Development Bank of India (SIDBI): Lucknow. It has also linkage with Govt. funded institutes of technology like IIT Mumbai, IIT Delhi, IIT Kanpur and NIT, Jalandhar. It has also linkage with NID (National Institute of Design) Ahmedabad and Grassroots Innovation Design Studio (GRID) Ahmedabad. Lastly the external linkages of NIF are inclusive of its several partners which are voluntary organizations like: SEVA — Madurai, PDS — Kerala, CED-Tamil Nadu, Sristi Kendra — Orissa, Prithivi: Karnataka etc (NIF Presentation Slide, 2011). The HBN, a network of three organizations namely SIRSTI, GIAN and NIF plays a very significant role in the grassroots innovations of India today. HBN is now well recognized for its original ideas and efforts both in India and abroad.

Conclusion

The major finding of this empirical exercise and the principal outcome of the discourse on movement is that the AT movement in India has shown a shifting trend. It has transformed itself slowly into an alternate/sustainable technology movement as evident

from the transformation of ASTRA cell into CST. So is the case of innovations of HBN, of which are being construed as sustainable technologies as many have been converted into commercialized technologies and some have been patented. These are indigenous technologies which are people centric and often tradition based. The notion of AT is fast becoming obsolete in the context of developing countries, of course because, (i) the neoliberalism driven globalization of the less developed countries has rendered the Schumacherian notion of intermediate technology and the Nehruvian notion of self-reliance in S&T greatly irrelevant, (ii) the issue of appropriateness of imported technologies is no longer considered important as today the main emphasis is on technological efficiency and environmental friendly nature of technologies, (iii) with the growing maturity of industrialization in developing countries, labour intensiveness, adaptation to local conditions etc are no more important considerations, what matters is quality of the finished products and (iv) all the industrial technologies of the world today are global. Hence the concept of appropriate industrial technology in the earlier sense is now a misnomer. The notion of appropriateness today do not persists even in the context of small scale, agricultural and rural technologies. With the recognition of indigenous alternative sources that are popular and culturally embedded (those other than from laboratories) in the context of small scale, agricultural and rural technologies the issue of sustainability (in terms of resource utilization), environment friendliness, and cost effectiveness have taken over the issue of appropriateness. Of course these indicators do meet the requirements of appropriateness too. Thus as evident from the empirical explorations from ASTRA-CST and the HBN, there seems to be a shift in the search and focus of research from appropriateness to sustainability of the technologies. This is a definite turn in the movement that has of course renewed itself with an emphatic drift. The last issue emergent of this concluding observation pertains to this new notion of sustainable technologies. What makes these technologies essentially sustainable is their being embedded in people, their culture and their traditions. And this also makes the people's participation in these technologies easier as these are non-alienating. The other source of their sustainability is of course their being participatory. The evidences in favour of their being participatory are not far fetched. As in the ASTRA-CST the lessons of A K N Reddy are very categorical about the people's involvement with these technologies. Even if the ASTRA-CST model of technology development is from Laboratory to Field, Reddy had advised them that even in conceiving a solution the technologists have to keep the end-user in mind. Further in this model at field level there is a need of extensive use of extension works for the introduction of these technologies in rural areas and these extension works cannot be carried forward without involving the local voluntary organizations/NGOs who are in touch with the target population and reflect their interests. Similarly in case of the HBN, the model of technology development is from People (via Laboratory) to People and accordingly HBN documents the innovations from the people directly and often from the daily lives and culture embedded practices of people. Hence they carry out the Shodh Yatras to meet farmers, artisans of different regions/cultures, Food Festivals in different regions etc. And the HBN also engages lots of people for scouting the innovations from grassroots level. Even in formal ways HBN organizations involve the innovators in patenting, commercializing and even in cases of transferring technologies to entrepreneurs. HBN is emphatic about the grassroots nature of the innovations it scouts and documents. This participatory nature of the technologies provides the strong bases of their sustainability.

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Science Communications in India: Role of Public Funded Institutions

At the outset this paper discusses the very relevance of and need of science communication in India. The paper then points out the policy measures of the Government of India for the promotion of scientific temper through science communications. Subsequently having spelled out the various means and modes of science communications, the paper summarizes the role of various public funded organizations (and selectively voluntary organizations) in the context of science and technology communications in India.

Keywords: Science Communication, Modes of Science Communication, Science Communication Network, Scientific Temper, Science Popularization.

Introduction

India has a rich tradition of communication, especially when it comes to communicating to masses. Folk plays, like *Nautanki*, and religious plays like *Ramlila (Hindu mythology)*, folk songs and folk dances are immensely effective as the means of mass communication. *Ramlila* is one of the oldest of religious arts, possibly, which has communicated to millions of people over generations, the code of conduct and ideals of social life. More recently, M. K. Gandhi was possibly the greatest communicator of all times, who aroused people of India to participate in the freedom struggle with their might against the mightiest empire the world had ever seen, and all this was through his extraordinary communication skills, which was so natural to him. '...Every cultural pattern and every single act of social behaviors involve communication, in either an explicit or implicit sense'. The might of mass communication, can be underlined as the root cause of any social change, let alone development. This speaks volumes obout the impact of sustained science communication, on changing the way a society thinks and behaves; a change which we want India to undergo, sooner the better; to get transformed to a nation of scientifically thinking and scientifically aware people. So why not think of institutionalizing science communication activities in our socio-cultural system like, the traditional means of communication are. Arousal of people for developing scientific temper and scientific awareness is a must for national regeneration through mass action, as was the case in freedom movement; unmistakably the only perceivable panacea for numerous miseries of our people.

Historical Perspective

India has a tradition and a treasure of scientific heritage. Various classical scientific works were carried out in Indian subcontinent, in the fields of mathematics, astronomy,

medicine, material science etc, during ancient, medieval and modern periods, which still form a huge treasure of our scientific and cultural heritage (Patairiya, 2002: 08). However, a remarkable gap between scientific knowledge and the common man remained during the entire span of time and almost no effort was made to bridge this gap. These scientific texts were generally written in technical and classical forms and not in common man's language. With the passage of time, despite many political and social ups and downs, scientific knowledge and more precisely custodians of that knowledge mostly remained centered around the corridors of power. This was the time when such knowledgeable gems used to be the *Navratnas* (Nine learned scholars of ancient Gupta empire) of royal courts.

Medieval age, however, saw a remarkable phenomenon. Classically coded scientific literature was made comparatively simpler and written in the popular forms of commentaries and analyzes. One can observe a great tradition of such commentators in the Indian subcontinent, who contributed such secondary scientific literature for generations. Indian history is replete with such tradition. This was indeed an exceptional attempt towards presenting science in comparatively simpler form. Many of India's ancient works, be it '*Aryabhatiya*' of *Aryabhat* or '*Leelavati*' of *Bhaskar*, are available in these forms. This situation is continuing more or less even today and the gap between scientific knowledge and lay persons is still very wide. Scientific knowledge is still confined to the language of the elite and it is very difficult to access such information in common man's language especially in vernaculars.

There have been a few people in various parts of the country, always eager to take science to commoners through their uncommon efforts and with limited resources in recent past before Independence. The formation of Asiatic Society in Bengal has historical significance. *Vigyan Parishad* was established in the United Provinces (now Uttar Pradesh) at Allahabad in 1913, which brings out *Vigyan,* a monthly since 1915 without discontinuity. In Orissa, the *Orissa Bigyan Prachar Samiti* was formed on August, 7, 1949, which began science popularization in Oriya language. Several other voluntary organizations continued to follow. Apart from organizations, several enthusiastic individuals also joined the movement. Some of them were Sir Syeed Ahmed Khan in Aligarh, Ruchi Ram Sahni in Punjab, Swami Satyaprakash in Uttar Pradesh, Shivram Karanth in the south, Hargoo Lal at Ambala, and several others.

After Independence, a number of government organizations also came forward for science popularization. Publications and Information Directorate, New Delhi (now National Institute of Science Communication and Information Resources) began publication of *Vigyan Pragati,* a Hindi monthly in 1952. *Science Reporter* (English monthly) and *Science Ki Dunia* (Urdu quarterly) followed this. National Research and Development Corporation (NRDC) started *Awishkar,* a Hindi monthly and thereafter *Invention Intelligence,* English monthly (both are closed now due to changed policy). Besides that, institutions like National Council of Educational Research and Training (NCERT), Central Institute of Educational Technology (CIET), Consortium for Educational Communication (CEC), Directorate of Agricultural Information and Publication, Indian Council for Medical Research (ICMR), Developmental Education Communication Unit (SAC) etc also started spreading scientific knowledge concerning their areas of interest. Thus, science communication was being taken up at various levels, institutional as well as individual. Indian editions of *Popular Science* and *Scientific American* also stepped in adding to international perspectives to science communication movement.

In order to integrate, coordinate, catalyze and support the efforts of science communication and science popularization, at micro as well as macro levels in the country, the Government of India established the National Council for Science and Technology

Communications (NCSTC) in 1982 as an apex body. NCSTC began its activities in 1984. The prime objectives of NCSTC are — to communicate science and technology amongst all the sections of the society, to inculcate scientific and technological temper amongst masses and to promote, catalyze, support and orchestrate such efforts in the country. In the year 1989, the Department of Science and Technology, Govt. of India, established an autonomous organization named *Vigyan Prasar*, which undertook the task of mass scale development and dissemination of software for popularization of science and technology, such as TV programmes, audio cassettes, CD-ROMs, publications etc. The National Council of Science Museums under the Ministry of Culture is also contributing in this direction by setting up of science centers, science exhibitions, science fairs, science cities and science museums etc. Ministry of Environment and Forests has planned to create environmental awareness through Ecology Clubs in schools. All India Radio, Doordarshan, and other TV channels broadcast and telecast various science programmes. Central and state governments, Birla Group and Jawaharlal Nehru Memorial Fund have established several planetariums at various places in the country. Various other attempts towards science communication and science popularization are being made at governmental, non-governmental, private and individual levels.

Current State of Affair

Currently several approaches and mediums are being tried and utilized by various agencies in India, both government and non-government, for S&T popularization. As a result a lot of infrastructure, software and human resources are now available in the country. Various means and modes of communication have been utilized in India by the science communicators to reach out to the masses. Every form has its own significance and utility keeping in mind the vast diversities existing in the subcontinent. A summary of these communications tools employed for S&T popularization and inculcation of scientific temper is provided in the following paragraphs:

Science communication has drawn the attention of policy makers, planners, scientists, technocrats and media personnel during the past decade world over and so as in India. Over the years, there has been a remarkable increase in science coverage in different mediums of mass communication, be it print, electronic, folk or interactive media. Several national/regional dailies have started weekly science pages and magazines are covering science columns. *Vigyan Prasar* started a unique activity and was providing ready-to-print science page to medium scale newspapers periodically in Hindi and English. Some 21 newspapers were incorporating the same page in their editions.

A variety of programmes are now available on AIR, like Radioscope, Science Today, Science Magazine, Science News etc; the interest was triggered by two joint NCSTC-AIR radio serials 'Method of Science' and 'Human Evolution'. On TV, 'Turning Point' a science based programme was able to catch attention of viewers. Besides the University Grants Commission (UGC), the National Council for Educational Research and Training (NCERT), Indira Gandhi Open University (IGNOU), and NCSTC also had developed science programmes from time to time. Several voluntary agencies like Kerala *Shastra Sahitya Parishad* (KSSP), KRVP, *Eklavya* etc are actively involved in taking science to the people by way of folk forms, street plays, theater, puppetry, folk songs, skits etc. In fact, print and electronic

media have certain limits, but the illiterates or neo-literates can also be enlightened through the use of folk medium, as it has no limitation, and offers two way channel of communication, which was proved to be very effective during the *Jathas* (great congregations) *Bharat Jan Vigyan Jatha* (BJVJ) — 1987, *Bharat Gyan Vigyan Jatha* (BGVJ)-1990 and *Bharat Jan Gyan Vigyan Jatha* (BJGVJ) — 1992.

Other mediums of science communication, like exhibition, *Vigyan Mela*, slide shows, lectures, demonstration, and planetarium are also part of the ongoing science communication/popularization movements in the country. A variety of popular science softwares have been produced. A number of potential science communicators are being trained through full time academic courses in science and technology communication and short term science writing/journalism workshops to bridge the gap, who can in turn take up responsibilities of different science communication programmes/activities (Patairiya, 2001).

Several government and non government agencies such as NCSTC, NCSM, Council of Scientific and Industrial Research (CSIR), Indian council of Agricultural Research (ICAR), ICMR, NCERT, All India Radio (AIR), *Doordarshan* (Govt. TV Channel), NBT, CBT, UGC, KSSP etc are putting in effort towards dissemination of scientific information and inculcating a scientific temper among people. Although much has been achieved, the picture is not so rosy and there is an urgent need to work towards putting in every effort to make science communication activities more effective and sufficient both in terms of quality and quantity and a lot is still to be achieved.

It is, however, disappointing that Indian science magazines, like Science Today, Bulletin of Sciences, Times of Science & Technology have been closed and Indian editions of some foreign magazines, like La Recherche and Scientific American have ceased their publication, after bringing out a few issues. Whatever may be the reason, it is clear that science has no territorial boundaries, and so is true for the science communication activities. As far as coverage of science and technology in mass media is concerned, in developing countries, like India, it will increase in near future significantly, as very fast and rapid developments are taking place. On an average, the science coverage in India is around 3–4 %, which we intend to enhance up to 10–15 %, as per a resolution of the Indian Science Writers' Association. So far, 5 Indian science communicators have won UNESCO's Kalinga Prize for outstanding contribution in the area of science communication/popularization. In terms of international comparison, in India the efforts put in by NCSTC, KSSP, and other organizations/individuals, like *Vigyan Jatha*, Children's Science Congress, explanation of so called miracles etc, are widely acclaimed and have no match and are unique and first ever in the world. There is a wide scope of a broad spectrum of science communication activities in future to better serve the mankind.

Science Policy and Science Communication

Jawaharlal Nehru, the first Prime Minister of India, introduced the concept of 'scientific temper' in modern India. He dreamt of the children of the country acquiring scientific temper (Pattnaik, 1992: 7–8). Accordingly the Constitution of India has a special provision 'to develop the scientific temper, humanism and the spirit of enquiry and reform' as one of the 'Fundamental Duties' mentioned under Part IV A, Article 51 A (h).

(a) **Scientific Policy Resolution:** Prime Minister Nehru presented the Scientific Policy Resolution on March 4, 1958, which has been a guiding factor for development of science

and technology in the country. Special attention was given to the scientific approach in the resolution, which reads as follows:

> "It is only through the scientific approach and method and the use of scientific knowledge that reasonable material and cultural amenities and services can be provided for every member of the community, and it is out of recognition of this possibility that the idea of a welfare state has grown."

(b) **Technology Policy Statement:** To give direction to the technological development in the country the Government of India announced the Technology Policy Statement in January 1983. The spirit of innovation and awareness about balance in technological development and environment was given special importance, among other features in the statement.

(c) **The Sixth Plan:** The promotion of scientific temper and dissemination of scientific information among people was given due importance in the report of the working group on science and technology for the sixth plan (December 1980). Special provision was made for science popularization under science and technology chapter in the Sixth Five Year Plan, approved by the National Development Council. Consequently the NCSTC was formed in 1982. Thereafter, the NCSTC was given the mandate for formulation of policy, programmes for science communication in the country. The need for national science communication policy was emphasized in the first convention of the Indian Science Writers Association (ISWA). Efforts were under way in the NCSTC for formulating a science communication policy.

(d) **Reviews of NCSTC Activities and Programmes, 1989, 1996, 2002:** The Department of Science & Technology, Govt. of India has formed different review groups to review NCSTC activities and programmes and to suggest future strategies for science communication from time to time. The First Review Group formed under chairmanship of noted physicist and science fiction writer Dr. Jayant V. Naraliker had given its report in 1989. The Second Review Group had worked under chairmanship of Dr. S. Z. Qasim noted ocean scientist and member, Panning Commission (Science & Technology) and gave report in 1996. The Third Review Group had Prof. S. K. Joshi, noted physicist and former Director General, CSIR as its chairman, which gave its report in May 2002.

(e) **Science and Technology Policy 2003:** Govt. of India has announced a comprehensive 'science and Technology Policy 2003' that carries a section on "Public Awareness of Science and Technology" (Govt. of India, 2003: 25).

Modes of Science Communication

The process of science communication can be interwoven into five principles. Generally science communication incorporates efforts for popularization of science, promotion of scientific temper and technological temper and diffusion of technology/innovations. Let us go into the details of the mediums of science communication:

(a) **Print Media:** Such as newspapers, magazines, wallpaper, books, posters, folders, booklets etc.

(b) **Audio/Visual Media**: Mainly radio and TV, besides, films, slide shows, bioscope etc.

(c) **Folk Media:** It has been a common observation, that through folk media, it is possible to achieve penetration to the segments where other media have limitations. Puppet shows, street plays skits, stage performances, folk songs and folk dances like, *nautanki* and other traditional

means of communication belong to this category. This media is cost effective, entertaining and offers two-way communication.

(d) **Interactive Media:** Science exhibitions, science fairs, seminars, workshops, lectures, scientific tours, conferences, *vigyan jathas* etc. The advantage here is being man-to-man and two-way communication.

(e) **Digital Media:** information technology has given birth to comparatively a new media, known as digital media. It includes Internet, CD-ROM, multimedia, simulations etc. This is proving to be an effective medium and it can illustrate difficult concepts through text, audio, graphics, video, animation and simulation. It has also made science communication simpler to handicapped segments of the society. This new media has given birth to a more instant and global mode of communication in the form of 'social Media', involving social and individual networking sites.

That apart, we are popularizing science through our 22 regional languages, to penetrate into local populace effectively. Selection of target audience is highly significant. Our science communication efforts are aimed at various target groups, such as, common men/women, children, students, farmers, workers or specialists etc. Various forms for presentation are being used to make science communication more interesting and enjoyable, such as science news, report, article, feature, story, play, poem, interview, discussion, lecture, documentary, docu-drama, scientoon (science + cartoon), satire etc.

Following are some of the important modes and means of science communication in India:

1. Popular S&T literature (articles/features in daily newspapers, periodicals; newsletters and specialized S&T magazines: comic strips, picture-cum-story books, wall charts etc).
2. Exhibitions of S&T themes (temporary, permanent and mobile).
3. Science Train- Science Exhibition on Wheels.
4. S&T and Natural History Museums (with permanent galleries on basic topics, on country's heritage and on famous discoveries and inventions, among others).
5. Science Centres and Parks (participatory and interactive activities and demonstrations to learn about S&T principles, applications and to encourage development of a spirit of enquiry among children and adults).
6. Contests (quizzes, essays, scientific models, toy and kit making, public speaking, debates, seminars etc).
7. Popular lectures on S&T subjects (for general public, for children a students at schools, colleges, universities and other institutions).
8. Tours (guided tours around botanical, zoological gardens, museums, planetaria, bird sanctuaries etc).
9. Planetaria (including mobile ones; sky watching with naked eyes or telescope to learn about planets, stars and other celestial objects).
10. Radio broadcasts (for general as well as specific audiences).
11. Television telecasts (for general as well as specific audiences).
12. Audio/Video-Programmes (on tapes and cassettes for special or general audiences; slide shows, bioscopes.
13. Digital software, CD-ROMs etc (for special or general audiences).
14. Science Films (for general and specific audiences).
15. Folk forms (song, drama, street plays, puppet shows, march, festival, fairs, jathas etc).
16. Science Club activities etc.
17. Low cost kit/toys and other hands-on-activities (with specific training modules).

Non formal Science & Technology Education.

Role of Various Organizations

Various Government, non Government and voluntary organizations are playing significant role in science communication. Some of them are described here.

(a) **National Council for Science and Technology Communication:** The NCSTC is an apex body of the Government of India for promotion, coordination and orchestration of science and technology communication and popularization programmes in the country, with two major objectives like; popularization of science and technology and stimulation of scientific and technological temper among people. Programmes began in right earnest with the finalization of the VII Five Year Plan and the first meeting was held in early 1984.

It has ten major elements, viz., (i) training in science and technology communication, (ii) software development, (iii) information networks/ databases, (iv) field projects, (v) incentive schemes, (vi) research in science and technology communication, (vii) international cooperation, (viii) women component plan, (ix) environmental awareness, and (x) policy advices. A number of training programmes have already been organized and supported to train people/ resource persons in various tasks of science communication as well as in different media. A number of science communication software items for electronic as well as for non-electronic media have been developed and disseminated to the users. Information networks developed and a number of research projects have been undertaken.

Besides a number of projects/ programmes, a mega project on science and technology for promoting voluntary blood donation has been formulated by NCSTC. Preparation of an annotated bibliography of popular science publications in all major Indian languages was undertaken. A project to develop self sustaining science communicators, who can generate income by selling software, produced by and with support of NCSTC was formulated, besides a Software Jatha.

(b) **Vigyan Prasar (VP):** It was set up by the Department of Science and Technology, Government of India, as an autonomous registered society in 1989 for taking up large scale science popularization tasks. Its broad objectives may be summarized as follows: (i) to undertake, aid, promote, guide and coordinate efforts in popularization of science and inculcation of scientific temper among the people and to increase the knowledge, awareness and interest about science and technology among all segments of the society, (ii) to provide and promote effective linkages on a continuous basis among various scientific institutions, agencies, educational and academic bodies, laboratories, museums, industry, trade and other organizations for effective exchange and dissemination of scientific information, (iii) to undertake the development of software materials for different media, so as to enable the masses to better understand, appreciate and comprehend abstract scientific principles and practices, and (iv) to organize research projects, courses, workshops, seminars, symposia, training programmes, fairs, exhibitions, film shows, popular discussions, street plays, quizzes, song-dance-dramas etc, in furtherance of the objectives of the organization.

(c) **National Council of Science Museums (NCSM):** Having its headquarters in Kolkata, NCSM is an apex body of science museums and science centers in the country. It has a National Science Centre in New Delhi, and some 30 regional science centers, including Lucknow, Bhopal and Bhubaneswar etc. A Science City has been set up in Calcutta by NCSM. Several states have also setup science cities under collaboration with NCST, i. e. Gujarat Science City, Ahmedabad, Pushpa Gujral Science City, Kapurthala, Punjab etc.

(d) **National Institute of Science Communication and Information Resources (NISCAIR):** Formerly it was known as the Publications and Information Directorate (PID). It was renamed as National Institute of Science Communication (NISCOM) on September 26, 1996 and further transformed into NISCAIR, incorporating INSDOC. It brings out eleven professional scientific journals, besides three popular science journals, *Vigyan Pragati* (Hindi monthly), *Science Reporter* (English monthly) and *Science Ki Dunia* (Urdu Quarterly). It has also brought out an encyclopedic series, titled, The Wealth of India, a compendium of knowledge on the economic products and industrial resources of the country. The institute also undertakes the publication of popular science books in Indian languages. Monographs on different scientific subjects are also published from time to time.

(e) **Science Communication Networks:** An All India People's Science Network (AIPSN) was catalyzed in 1987–1988, with 27 constituent voluntary organizations, which organizes All India People's Science Congresses and is also known as All India People's Science Movement. The NCSTC Network was brought into existence in 1991 with the objective of taking popularization of science activities to all nooks and corners of the country. Presently it has over 70 organizations, including government, NGOs and voluntary organizations. It is now known as National Science and Technology Communication Network (NSTC-Network). There is the need of a Science Media Network.

(f) **Voluntary Organizations:** There are several voluntary organizations in India interested in science communication programmes. Some of them even existed when there were no efforts from the side of state to popularize science. *Kerala Shashtra Sahitya Parishad, Karnataka Rajya Vigyan Parishad*, *Vigyan Parishad* at Allahabad, Vikram A. Sarabhai Community Science Centre at Ahmedabad, Eklavya at Bhopal etc, are among important voluntary organizations involved in science popularization movement in the country. The Indian Science Writers' Association brings out a newsletter and organizes meetings with prominent scientists as well as media persons.

(g) **Indian Science Writers' Association (ISWA):** The ISWA was founded by a group of highly motivated and enlightened science writers and journalists in April 1985, some 26 years ago, with a view to develop and nurture science writing profession in the country. Now, ISWA has some 500 members from across the country comprising science writers, science journalists and science communicators from various Indian languages. In pursuit of its broad objectives, the ISWA undertakes a broad spectrum of activities on science writing, science journalism and science communication. ISWA is an active, vibrant and visible organization. The following para carry glimpses of its activities:

Since its inception, the ISWA has been publishing an occasional newsletter to have a channel of communication with members spread all over the country. It has initiated ISWA Chapters at various places in the country. Some 10 ISWA chapters have come up so far, which are undertaking various kinds of activities, like training in science writing and science journalism involving students, teachers, journalists and scientists. The ISWA had introduced a Millennium Lecture Series. A number of lectures have been organized so far on various frontline areas of science and technology. The ISWA confers ISWA Fellowships and ISWA Awards on distinguished persons for recognizing their efforts towards promotion of science popularization in the country. The ISWA organizes national seminar every year on some current topic, concerning science and technology. Some of them were; Post GATT India, What is Wrong with Indian Science, Patenting System and Intellectual Property Rights, Challenges in Public Appreciation of Science in Digital Age etc, with a view to discussing and addressing the issues and problems emerging in this field. An exhibition on

Popular Science Periodicals in Indian Languages is also part of these activities. It also publishes the directory of ISWA members from time to time. The Directory is sent to various scientific and media organizations in India and abroad.

ISWA has been working in collaboration with government and non government organizations and has linkages with various agencies interested in science popularization, such as, the CSIR, NCSTC, National Institute of Science Communication (NISC), ICAR, ICMR, Society for Information Science, Indian Science Communication Society (ISCS) etc. We have organized training programmes with the Department of Atomic Energy and other organizations. Efforts are being made to make joint programmes, with Indian Space Resarch Organization (ISRO), British Council Division and UNESCO etc, including visits of ISWA members to various scientific establishments for writing/reporting on various R&D activities in the country. We are looking forward for more such joint programmes in future and are planning to have many more activities to strengthen ISWA as well as the efforts towards the cause of popularization of science and inculcation of scientific temper among masses. ISWA is an active partner of India-Brazil programme on public communication of science, technology, culture and society.

Highlights

Following are the highlights, where major achievements were recorded in the area of science communication in India:

(a) **Human Evolution:** A 144-part radio serial *Manav Ka Vikas* jointly produced by NCSTC and AIR was broadcast on Sunday mornings simultaneously from nearly 84 stations all over the country in 18 Indian languages during June 1991 — February 1994. Among the listeners there were 100,000 children and some 10,000 schools registered as dedicated listeners. They were provided kits, posters etc as supplementary material. Two unique radio bridge programmes of 30 minutes duration each were broadcast live through the satellite on February 13th and 20th, 1994. Selected children, who had assembled at five different places in the country, participated in these programmes which included questions, answers and discussions.

(b) ***Bharat Ki Chhap*:** The NCSTC has produced a number of TV programmes on scientific subjects. A 13-part film serial on the history of science and technology in the Indian subcontinent and its impact on the world, titled *Bharat Ki Chhaap*, originally in Hindi was produced by NCSTC and telecast on Doordarshan in 1989. Regional language versions were subsequently produced in Tamil, Malyalam, Telugu, Gujarati, Marathi, Bengali and Kannada, along with an English subtitled version.

(c) ***Vigyan Jatha:*** *Bharat Jan Vigyan Jatha — 1987* and *Bharat Jan Gyan Vigyan Jatha — 1992* (BJGVJ-92) were catalyzed by NCSTC, could be considered as the biggest ever science and technology communication movements attempted anywhere. The main themes of BJGVJ-92 included health, water, environment, appropriate technology, superstitions, scientific thinking and literacy. Science and technology communication software, on the main themes of the *Jatha*, was developed and duplicated both at the central and state levels, which included brochures and posters for publicity, poster sets on water, environment and housing, booklets on topics such as the preparation of science posters and charts, puppet plays, low-cost exhibitions etc. Some 2,500 government/non-government organizations were actively involved. The *Jatha* covered nearly 40,000 locations in about 400 districts touching

almost a third of the country's population. During the course of *Jatha*, various modes of science communication, especially folk forms, publications, lecture-cum-demonstrations etc, were employed for science communication among people in far-flung areas. Subsequently, regional *Vigyan Jatha* was organized to cover a geographical region on a focused science theme relevant to the area.

(d) **Children's Science Congress:** The first National Children's Science Congress (NCSC), with the focal theme 'Know your Environment' was organized by the NCSTC Network in December, 1993. The children were selected on the basis of their presentations on their scientific projects at the district level Congresses, followed by state level presentations and finally for the National Congress. The main aim of the congress was to provide open laboratory of the nature for learning with joy and to adopt the method of learning-by-doing. The other objectives were to extend classroom learning to inculcate an understanding of the environment, its problems and prospects and to help find feasible solutions. Participation was open to children of the age group 10 to 17 years. Till now 18 such congresses have been organized at different places of the country; and it has become an annual feature like Indian Science Congress. Selected groups of children from NCSC present their project reports in the Indian Science Congress. Further selected children from National Children's Science Congress visited Germany in connection with Germany Festival in India and India Festival in Germany in 2001.

(e) **Scientific Explanation of so called Miracles:** This is a very popular programme implemented across the country, wherein various tricks and miracles are demonstrated and explained by trained science activists to make the gullible people aware of the scientific tricks/facts behind the so called miracles, so that they can be saved from cheating by the self styled god men. In the event of so called milk miracle, when religious deities started drinking milk in 1995, the author of this paper demonstrated the phenomenon on television news and the hoax was refuted.

(f) **Science Communication Courses:** In order to develop trained manpower in the area of science communication, training/educational programmes are being offered at various levels in our country, which are catalyzed and supported by NCSTC: i) Short term courses, which are of 3 to 7 day's duration; the participants are all science activists and enthusiasts, whether students of science at higher level or not; ii) Medium term courses, which are of two to four month's duration; usually for those wanting to improve their science communication skills; and iii) Long term courses, which are of 1 to 2 year's duration; run at different universities/institutions and offer post graduate degrees or diplomas in science communication. Besides, a correspondence course and an online course in science journalism of one year duration are also available. The main aim is to develop as many science communicators as possible to meet the present and future challenges and requirements. 30 universities/institutions are running these courses with NCSTC's initiative. Recently, UGC has also introduced science communication under its thrust areas of studies.

(g) **Centres for Science Communication:** Centres for Science Communication at Lucknow University (U. P.); Devi Ahilya University (M. P.); Cochin University of Science & Technology (Kerala), and Krishna Kant Handiq Open University, Guwahati (Assam) were established to promote higher studies and research in S&T communication/public understanding of science.

(h) **Science Communication Archives:** A Science Communication Archives at Madhavrao Sapre National Media Repository & Research Centre, Bhopal has been started to preserve and retrieve science manuscripts, publications and other information products to facilitate researchers in S&T communication.

(i) **Indian Journal of Science Communication:** An international peer reviewed research journal in science communication is being published since 2002, which has an International Advisory Board and peer review system and offers print, electronic and open access edition available at < *www.iscos.org* >.

(j) **Public Debates on Current S&T Issues:** Public debates on current affairs in S&T where public requires adequate awareness to take decisions in matters, like, Bt Cotton, Bt Brinjal, Nuclear Controversies, Iodized Salt etc, were initiated. A recent debate on "Public Awareness of Nuclear Energy Controversies" was able to attract a house full at 11th meet of Public Communications in Science and Technology (PCST-2010).

(k) **Technology Communication:** More often, we talk about science communication and scientific temper and less on technology communication and technological temper. A major initiative was taken by NCSTC on 'Technology Communication', including hands-on science, with the objectives: (i) to inculcate a technological temper; (ii) to develop and nurture the spirit of innovativeness, and (iii) to focus on technological approach to problem solving. The programme has 3 major elements: (i) orientation of artisans and techno-students towards innovativeness; (ii) identification of areas of innovation and developing innovative ideas; and (iii) technology awareness. The module was successfully tested and being implemented across the country.

(l) **Science Fiction:** The first ever National Discussion on 'science Fiction: Past, Present, Future' by Indian Science Fiction Writers' Association and Indian Association of Science Fiction Studies at Varanasi during November 10–14, 2008 to emphasize role of Science Fiction and S&T communication.

(m) **Science Communication through Digital Media / Blogs / Social Media:** A module on S&T Communication through Digital Media on various popular science topics were developed including science Webcast and Podcast. A series of training programmes on science communication through visual media was organized across the country.

(n) **Science Communication through Cultural Events:** The module includes: (i) Workshop for Developing Scripts and Exhibits; (ii) Demonstration of Exhibits at Religio-cultural Events, i. e. *Shiva Ratri, Durga Pooja, Ganpati Festival, Eid, Pongal* etc; and (iii) Road Show / Procession / Prabhat Feri.

(o) **Campaigns on Total Solar Eclipses:** Science popularization programmes built around the total solar eclipses on the belt of totality for viewing total solar eclipses in 1995, 1999 and 2009 have been hugely successful.

(p) **Year of Scientific Awareness (YSA 2004):** With an initiative taken by DST, the Year 2004 was observed as Year of Scientific Awareness across the country; followed by Year of Physics 2005, Year of Planet Earth 2008, and Year of Chemistry 2011.

(q) **Indian Science Communication Congress (ISCC):** With a view to providing a platform for encouraging scholarly interaction between science communication researchers and practitioners, scientists and communicators, science communication faculty members and students etc, for further advancement of science communication profession, the Indian National Science Communication Congress was started in 2001. Since then 10 annual congresses (2001–2010) have been organized so far involving over 2,000 researchers, scientists, journalists, including international delegates. A special session for young researchers from over 50 universities has been an attractive feature of the ISCC. The aim is to establish S&T communication as an independent discipline of scientific knowledge and expertise and promote research. The ISCC-2011 was organized in November 2011 at Pune (Maharashtra).

(r) **Science Communicators' Meet at Indian Science Congress:** The 1st Science Communicators' Meet was organized at Indian Science Congress, Visakhapatnam, 2008; followed by 2nd Science Communicators' Meet at Indian Science Congress, Shilong, 2009; 3rd Science Communicators' Meet at Indian Science Congress, Trivendrum, 2010; and 4th Science Communicators' Meet at Indian Science Congress, Chennai, 2011. The programme is being implemented through Indian Science Congress Association. The 5th Science Communicators Meet is being organized as part of Indian Science Congress at Bhubaneshwar in January 2012.

(s) **11th PCST-2010:** The 11th International Conference on Public Communication of Science & Technology (PCST-2010) was organized in India in December 2010 with International Network on Public Communication of S&T, Australia attracting 600 science communication experts from 51 countries.

(t) **6th HSCI-2009:** The 6th International Conference on Hands-on Science (HSIC-2009) was organized in India in October 2009 with International Network on Hands-on Science, Portugal attracting 350 delegates from 20 countries.

(u) **Online Science Communication Networks:** Online science networks are immensely beneficial for connecting science communication professionals and bringing them together in India and abroad:

i. *sciencefictionwriters@yahoogroups.com*
ii. *popularsciencewriters@yahoogroups.com*
iii. *iswaindia@yahoogroups.com*

Challenges

In spite of well planed and well structured efforts of science communication in India, there are certain challenges before us, to be met. In spite of repeated and multifold efforts of spreading scientific information and inculcation of a scientific temper among Indian people, even today there prevail lots of superstitions among people who are still ignorant about common scientific principles of day-to-day life. Hence illiteracy and ignorance are major challenges. India's literacy rate has increased as compared to earlier times, though it has not reached the desirable level. Scientific literacy is drastically low in the country. The science communication has still not succeeded in attracting the media to the extent that it could appear on the front page or become a lead story, like the politics, films or sports. The coverage of science in print as well as in the broadcast media has not arrived even up to a minimum desirable level (Patairiya, 2001). It is rather disappointing to note that leading science magazines are ceased to be published, like *Science Today, Science Age, Bulletin of Sciences, Research and Industry*, *Invention Intelligence, and Awishkar etc* and Indian editions of foreign science magazines, like *Vigyan* (Scientific American), *World Scientist* (La Recherche) etc, could not survive. Several in Hindi and other Indian languages' science magazines have faced the same fate. India has 22 recognized regional languages. Hence, communication in many languages is yet another great challenge. The quality of scientific translation could not achieve the level of excellence in most instances; of course due to lack of equal command and training in both the languages and non availability of appropriate terms in regional languages.

Mass media has its commercial compulsions, which superimpose all the science communication efforts and leave a negative impact in the minds of the audiences. Instead of including scientific information, they prefer to generate more revenue by including non scientific, meta-scientific or occult information etc (Bruce, 2005).

The science writing is still dry and boring. And interesting styles of writing, like fiction, poetry, satires, skits, discussions etc, have not found adequate space and time in the media. Even most of the science writers could not contribute sufficiently such an interesting science material to the newspapers/magazines. Merely occasional appearance of something in the name of science fiction cannot serve the purpose.

In view of the present pace of science communication programmes, their potential and impact towards shaping the lives of the people and making them more informed and rational, nobody would be able to afford not to have the scientific information confronting day-to-day life of the people, as it will be going to become essential and integral part of most of the human activities in the near future. That is why, even today, almost every parent is intending to provide modern scientific and technological knowledge to his or her child. There may be ample scope for unevenness, deprivations, limitations and lack of effectiveness of various science communication programmes and activities, but, despite various constraints and impediments, it may not be unrealistic to expect that science communication has a promising future in India and other developing countries.

Beyond the Boundaries

As obvious in the preceding paragraphs, India has been able to take initiatives in a number of newer programmes in the area of science communication, which were not tried out elsewhere and can take lead in these innovative areas. Similarly, we would also like to welcome other new ideas, methodologies, programmes available in other parts of the world and we can work together to better serve the mankind. Recently we have been able to develop cooperation at bilateral and multilateral levels with different countries. Of course there is ample scope for furthering such efforts in developing countries, especially in South Asian Countries in matters of science communications. We can take initiative in mobilizing like minded people in these countries to form Science Writers'/Journalists' Associations in their respective countries, with the help from international organizations, in order to enhance scientific literacy and scientific temper, which are considered to be the basic elements for development of any society in a more coherent manner.

A common science and technology news and features pool can be formed to facilitate writers/journalists to get/exchange information on scientific research and developments for further dissemination through mass media. There is a great shortage of properly trained science writers, journalists, communicators, illustrators in various parts of the world, though, a number of training programmes are conducted at various places. Therefore, more training programmes are needed, which may preferably be conducted jointly to give more opportunity to developing countries and their participation must be ensured. That apart many more joint collaborating programmes in the area of science communication can be worked out and implemented for further advancement of science communication to better serve the people.

Conclusion

Looking at the population, size and make up, variety of languages, urban-rural, digital divides, prevalent disparities, poverty, illiteracy, inadequate opportunities and services, poor reach of mass media, and so on, India is poised with many challenges, that offer opportunities and possibilities in S&T communication.

In developed countries, "the science museums, planetariums, exhibitions, lectures, audio-video media and high-end technological application" approach dominates the 'state-of-the-art' in this field, which is capital intensive and urban oriented. In India, same results are achieved through "folk forms, *Vigyan Jatha*, print and visual media, road-shows, and people's involvement" approach, which is cost effective and fits into our social milieu. However, India is not lagging behind in modern approach and has been able to make world records, especially in case of Science Express — Science Exhibition on Wheels. India was able to win international bids and organize international forums — 6th HSCI-2009, and 11th PCST-2010. Many developing countries are more or less following western approach but it is refreshing to note that after organizing these forums in India, not only developing but several developed cdountries are willing to try Indian models. Moreover, if scientific literacy implies disseminating knowledge of science, its wonders, its scope, its application etc, then perhaps in Indian context scientific and technological temper has more meaning and relevance. What we would like to see is that the Indian population at large, particularly the illiterate and backward rural community, develops a scientific outlook rather than being told about facets of science alone that allows informed and logical application of S&T and elimination of superstitions and ignorance. In India, therefore, a more organic approach has taken shape and is making inroads. Use of local languages, dealing with everyday S&T problems, using surroundings and environs at home, in field and outdoors, learning by doing, are some of the elements of this parallel approach of science communication and popularization movement in India.

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Communicating Science through Children's Science Congress: The biggest experiment on informal science education in India

The importance of engaging people at large with S&T is now well appreciated at the policy and implementation level in India. As per the pronouncements in the last S&T Policy of 2003 of Govt of India, a number of government agencies and voluntary organizations have come forward to take up the task of science popularization in general and complementing the formal science education through non-formal mode. The Children's Science Congress (CSC) is one of such non-formal science education programme, which has established itself not only as permanent activity in many schools, but, also assumed the status of a unique programme in the field of science communication and popularization. It has already taken the shape of a small movement proportion in India. This paper is an attempt to highlight the genesis, philosophy and the implementing method of the National Children's Science Congress (NCSC) in India.

Keywords: Children Science Congress, Science Popularization, Method of Science, Informal Science Education, Child-Scientists.

Introduction

It would not be an over statement to state that, Indian science as a whole has done well with a number of globally recognized laudable programmes, especially in space and nuclear sciences. The budget allocation for S&T in current plan is about Rs. 75 million, which is about 1,000 fold, the allocation in second Five Year Plan (1956). The expansion in the research sector is tremendous, the number of institutions has gone up and now India has infrastructure of global standard. But the other side of the coin is not very rosy. India's record on scientific paper publication is very dismal. There is a decline of interest in science education. The science education system has not yet been reformed to provide scope for innovation and creativity, which is one of the weakest areas of India S&T. Hence only 35,000 patents were filed from India during 2007–2008 which is abysmally low compared to and China's more than 2 million patents filed during the same period. One cannot deny this fact that the rate of innovation and creativity is directly proportional to the pool of scientists and unfortunately the same is very low in India (Deo and Pawar, 2011: 1538–1543). This pool of scientists can be strengthened only by reforming our formal education system in a way to promote original thinking, creativity and innovation.

One of the objectives of science education is to develop inventiveness and creativity along with competence. It is true that formal science education as at present, develops competence, but seldom encourages inventiveness and creativity and the practical application of scientific knowledge in daily life. Can the knowledge of Chemistry acquired at school be

used to test the quality of water which one drinks at home or detect the adulteration in the food stuff which one purchases from market? Certainly the answer is no. Paradoxically, the Indian students perform well in formal and scholastic tests, but few make it the grade of outstanding researchers or original thinkers. Children are naturally observant and curious, and love observing and exploring the world around them. In fact they are naturally scientists. But in the name of science education, science is presented to them as a mere collection of facts, laws and formulae — a system that encourages rote learning rather than encouraging them to learn the process, approach and the methodology of or towards addressing actual problems as one come across in day-to-day life. In other words, there is hardly any scope to encourage or promote curiosity, exploration and inventiveness or the practical application of scientific knowledge (Kamble, 2005: 2–22). Surely, teaching science in school should foster and nurture the natural curiosity. If India has to emerge as a hub of generator of new scientific knowledge at the world map, a total overhaul of the present system of teaching and learning science at school becomes a matter of utmost urgency.

In addition, the non-formal mode of education should also be given equal importance by the planners and the policy makers wherein children could undertake investigative projects develop innovative models/exhibits. To provide an environment for innovation, inventiveness and creativity, it would be imperative to provide a suitable forum like science clubs. Indeed, a variety of innovative software and teaching /learning packages and activity kits have been developed by several Government/non-government organizations in the country that could be made available through different forums. Teachers also need to be orientated to help the children to undertake such co-curricular activities. Further, the children could be encouraged to participate in programme like, Children Science Congress, National Science Exhibition and Innovation in Science Pursuit for Inspired Research (INSPIRE).

The successes and popularity of the programme like Children's Science Congress has already shown a way. The need of the hour is to develop more such programmes and their integration into formal science education. The government should provide more funds to such programmes and mechanisms need to be developed to make the reach of these programmes wider by keeping in mind the social, economic, cultural and linguistic diversities of India.

Objective: This paper is an attempt to highlight the genesis, philosophy and the implementing methodology of the National Children's Science Congress (NCSC) in India. It also tries to portray how over a period, this programme is fast becoming one of the biggest ever programmes of science popularization in India. Methodologically speaking this paper is a qualitative exercise based on primary (empirical) as well as secondary data collected by the author.

Science Popularization Efforts in India

The importance of engaging people at large with S&T is now well appreciated at the policy and implementation level in India. It is well evident from the latest S&T Policy of 2003. There has been increasing recognition that S&T popularization can pave the way to the growth of science and technology and overall growth of the country. At present a number of government agencies and voluntary organizations have come forward to take up the task of science popularization in general and complementing the formal science education through non-formal mode.

The National Council For Science and Technology Communications (NCSTC) (1984) and *Vigyan Prasar* (1987) were established to consolidate, coordinate, catalyse and support

the efforts of science popularization activities at micro and macro level. The science popularization movement has taken a national turn, and at the same time the pace of science popularization especially to supplement formal science education at school level has increased. A wide variety of software, training modules, films, books, booklets, interactive CDs and activity kits have been produced and disseminated through the country by organizing theme specific national campaign like "Total Solar Eclipse", "Transit of Venus", "Planet Earth 2008", "International Year of Biodiversity 2010 and International Year of Chemistry" etc. All these efforts have strengthened and complemented the formal science education in India in one way or the other.

If we took at the national efforts of science popularization undertaken in the last couple of decades, one event that readily comes to mind is Children's Science Congress (CSC), which not only has changed the way the science is to be looked at; but also has ignited the minds of Indian children. Over the years, the projects undertaken by the children on various themes have clearly shown that they have learnt to apply the scientific methods and develop the capability to translate their classroom knowledge to action for solving their problems. The best part of this movement is the involvement of the adults too; be it as motivators and guides, or organizers and facilitators. Such an amalgamation of diverse people and thoughts have truly made Children's Science Congress an extremely popular and desirable activity in the Indian scientific calendar (Pandey, 2004: 16–24).

Evolution of CSC

In 1987, after BJVJ 1987 *(Bharat Jan Vigyan Jatha)*, organized by the National Council for Science and Technology Communication, Department of Science and Technology, Govt. of India, the NCSTC-Network, a federation of 61 voluntary and Government agencies was formed. It was registered under the Societies of Registration Act 1960 in Delhi as an autonomous society in January 1991. Interestingly, majority of the NCSTC-Network organization were working for science education. In their own State/District, these organizations were organizing different programmes, training and activities to supplement the formal education. Each of the agencies was interested in bringing about desired change in science education system, specially the scenario, where there are no proper laboratories. Several member organizations of the NCSTC-Network were deeply involved in attempts to find out ways to give children opportunities to learn science as it should be learnt, and thus help them develop into rational individuals. Many innovative ideas were tried over the years. For example, in the town of Gwalior, Madhya Pradesh, the idea of children doing small scientific research of relevance to their immediate society, and using their environment as the laboratory, was called as Children's Science Congress. Similar things, with different names were tried by network members in West Bengal and Karnataka (Datta, 1995: 32–34).

In the year 1993, the Network members took a collective decision to organize — a national scale — science congress for children between the ages of 10–17 years. The basic idea behind a national level project was to demonstrate on a large enough scale that it is possible to transform the way science is taught and learnt in Indian schools. And also the purpose was to turn the learning of science into an enjoyable and creative pursuit that even within the frame work of the existing system of education — to begin with — children can be nurtured to become imaginative and creative little scientists.

Thus, was born the NCSC in 1993; once the preliminary planning was done, the Network got down to the enormous tasks like:

(i) Identifying organizations with some degree of capability to attempt this task in all the States/UT's of the Indian Union;

(ii) Getting a group of resource persons together to create an 'Activity guide book' on the focal theme, to be used by teachers and guides;

(iii) Training the organizers and master trainers from all the state level co-ordinating agencies identified;

(iv) Mobilizing some support from the concerned Ministries and Departments of the Government, viz, those of Science and Technology, Environment and forests, and Human Resource Development, not only in terms of extending grants, but also lending the preliminary 'permission' to interact with and intervene in the school pedagogy. This mobilization of support is required from the central Ministries as well as from the concerned states;

(v) Identifying and orienting a fairly large number of district level co-ordinating teachers;

(vi) Contacting and mobilizing a good number of schools in each district and motivating at least one science teacher in each school with some orientation imparted to help children for identifying as well as carrying out a focused projects of local relevance;

(vii) Organizing resource groups in states and districts for scientific inputs, (viii) Organizing district level (preceded by school level if required) presentation and screening of projects prepared by children–the District Children's Science Congress;

(ix) Organizing State level Children's Science Congress with selected children from all district of the State;

(x) Organization of National Children's Science Congress in a selected place each year;

(xi) Following up projects and trying to learn from the projects done by children all over the country.

Each of these tasks mentioned above had many elements within themselves, all of which required considerable inputs of time, expertise and efforts. Total accountings of the enormous energies were channelized, which had never been attempted before. The year 1993 was the first year of the National Children's Science Congress (NCSC). The experience of moving in the North-East from end to end to find out organizations to act as State Coordinators was an experience in itself.

Finally, first National Children's Science Congress was held at National Bal Bhawan, New Delhi, during December 20–23, 1993. This national congress was preceded by the District-and State-level Children Science Congress in 23 States of the Country. More than 200,000 children throughout the country participated in the congress by carrying out projects as per the themes and guidelines of the congress and prepared project reports. The entire mobilization was done by the members of NCSTC-Network. The state coordinators were selected from the members' organizations, who, in turn appointed district level coordinators. A series of training-camps, orientation workshops, meets etc were organized at State-and district level to train and mobilize resource persons, guide teachers, evaluators of the projects by each State coordinating agency. Over 300,000 selected children presented their projects at District-level Children's Science Congress in over 350 districts and more than 200,000 at State Level Children's Science Congress in 23 States. About 360 selected children from 23 States/UTs participated at the national level event at Delhi. In short the first NCSC was a great success in term of its reach, enthusiasm it generated among the participants and the agencies associated with its organization at the district, state and national level (NCSTC-Network, 1994: 17–21).

One remarkable feature of the national event was the amount of media attention. All form of media including the television and print media was agog with interests. They seemed to be ignited by the imagination and the enthusiasm of the hundreds of child-scientists

present. Interestingly, after the first NCSC, a good number of large-scale science popularization programmes were launched in India.

The success of first NCSC had owed much to the unique features of the organizing agency. It cannot be denied that the NCSTC-Network has some distinct advantages in conceiving and initiating such a nation-wide activity. The uniqueness of the network lies in the fact that both government and non-government organizations are its members. It has presence in almost all parts of the country. Many of its members, even before becoming the member of the network, were engaged in experimenting with various forms of science popularization activities. Moreover the formation of NCSTC-Network was catalysed by the National Council for Science and Technology Communication (NCSTC), Department of Science and Technology, Govt. of India, which itself had accumulated experiences over the years in this matter.

The progress of NCSC in 1994 was more in term of quantities which was again organized at Delhi during December 27–31, 2004. It was during the second national level event, a more ugly reality of the system of unimaginative competition among the child — scientists was realised. The competitive nature of the event at the national level, the system of giving coveted prizes to a selected few while not recognizing the diversities and beauties of the works of other children, turned them into fierce rivals. After some soul searching at the national event for more than two days, the competitive nature of CSC at the national level was done away with. It was a step forward with the spirit of CSC and evolving a new method of evaluation based on the philosophy of cooperative-learning. Since 1994, the CSC has not been competitive at the national level. Each project of child-scientists, done in group mode, having not more than five members, is evaluated as per new guidelines. Since 1994, the structure, methodology of CSC has remained the same, however based on the feedback of teachers and organizing agencies, the methodology is continuously reviewed and modified. Over the period, the basic philosophy, structure and methodology of the CSC have been consolidated and standardized. To make it more socially relevant it has involved more and more people from different walks of life besides children between the age group of 11–17, the target population (NCSTC, 1995).

The CSC, as a movement, by implication prompts children to ponder upon some significant societal problems, think over their causes and subsequently try and solve the same using the scientific process. This involves close and keen observation, raising pertinent questions, building models, predicting solutions on the basis of a model, trying out various possible alternatives and arriving at an optimum solution using experimentation, field work, research and innovative ideas in self discovery mode. It emboldens the participants to question many aspects of our progress and development and express their findings in vernacular. Today CSC is a common platform on which children from every nook and corner can come together and exchange their thoughts, thereby sowing the seeds of team-work, brotherhood and national intellectual regeneration.

The basic objectives of the NCSC are:

1. Providing a forum to the Children (Age group 10–17 years) both from formal and non-formal school system as well as from outside of school to exhibit their creativity and innovativeness and more particularly their ability to solve a societal problem.
2. Relating learning of science with the environment around.
3. Promoting the "methods of science" and applying the same for finding solutions.
4. Catalyzing curiosity, spirit of inquiry and inquisitiveness.
5. Inculcation of Scientific Temper, (*NCSTC Sources*).

The Genesis of NCSC:

The *Bharat Jan Vigyan Jatha* (BJVJ) in 1987 brought many voluntary organizations, non-governmental organizations and government agencies into a great melting pot of ideas and action, resulting in sincere desire to work together for science popularization and communication;

This new-found zeal and camaraderie was further boosted up by an activity similar to Children's Science Congress at Gwalior, Madhya Pradesh in the early nineties;

On January 02, 1991 the NCSTC-Network was born under the watchful eyes of the NCSTC, Department of Science & Technology, Government of India.

NCSC made its first appearance in 1993 by the initiative of NCSTC and is spread throughout the country by NCSTC-Network and its members.

The Philosophy of NCSC:

It is a unique program that motivates children to take-up specific topics of scientific research based on local issues of their choice under broad themes identified (instead of imposing topics on them);

It is a real experiment to promote methods of science with ample opportunities to encourage creativity, innovation and experiential learning;

It is an activity towards promoting congenial team work and co-operative learning, correlating science with everyday life situations;

It is a potentially strong and effective movement for influencing the impressionable minds to enhance community feelings and sensitivity towards societal needs;

It is an event not merely for the privileged and school-going children; but even for those who are not in the formal school set-up, drop-outs, or forced to be out of the conventional mode due to poverty and disabilities.

(*http://www.ncstc-network.org/objectives.htm*)

Features of the projects pursued under NCSC are:

Innovative, simple and practical;
Results of teamwork;
Based on exploration of everyday life-situations;
Involve field based data collection;
Have definite outputs, arrived through scientific methodology;
Related directly to community work in the local community; and
Have definite follow-up plans.

Eligibility Criteria for participation in the NCSC:

1. Children within the age group of 10 to 17 years can participate in the Congress,

2. 10 to 14 years constitutes the lower age group; while 14+ to 17 years is called the upper age group.

3. NCSC is not necessarily a school-based program; it is open to all non-formal systems of education besides out-of-school and disabled children.

4. Children in the past have joined this Congress from science centres, clubs and other forums that are, not necessarily part of formal school systems (NCSTC source).

Organizational Structure (Three Tires) of NCSC:

The congress is organized at three levels, first at district level followed by state and national level. The recommended projects from district level are again evaluated at the state

level and finally some selected projects are recommended to be presented at the national level as per the quota of each State. The methodology which is adopted to organize the district, state & national level congress is as follows:

District Level: In each and every district of India, NCSTC-Network in consultation with the state coordinating agency/state organizing committee, appoints a district coordinator for looking after the organizational aspects of the congress. Under his/her guidance a district organizing committee is constituted.

State Level: Similarly, the NCSTC-Network appoints a state coordinating agency in each and every state as per its guidelines laid down. The said agency then appoints its state coordinator for looking after the organizational aspects of congress. Under his/her guidance works a state organizing committee.

National Level: Likewise, for organizing the national level congress, the central office of NCSTC-Network invites proposals for hosting the National Children's Science Congress from its different members. The selected agency hosts national level CSC in its home State.

***Screening of projects*:** Screening of projects is done by the evaluators at district, state and national level congresses based on oral presentation and written report. A handbook outlining the criteria of evaluation for children from both, rural and urban areas has been developed which is made available to all of the evaluators. Even the orientation of the evaluator is being carried out at all levels of the congress. A child-scientist is free to make presentation in any of the scheduled languages. Promising and potential projects identified at national level are being pursued further.

(*http://www.dst.gov.in/scie_congrs/children/18th_national_children.pdf*)

Process of organizing the Children's Science Congress:

1. The national organizer, NCSTC-Network, in collaboration with all like-minded organizations and individuals, declares a Focal Theme, with relevant sub-themes, in every two years, for the purpose.

2. Necessary activity guide, leaflets, registration forms are circulated well on time through the state and district coordinating agencies.

3. District level organizing and academic committees are responsible for propagating the message and software to the children spread over the length and breadth of the country.

4. Children form groups of 2 to 5, and select a guide to steer them through their projects. They first identify a topic/ an issue/ a local problem under the given sub-themes and make quick assessment of the work schedule. Majority of the projects need to carry out survey work to proceed further; but not always as has been observed over the last 20 years. Some projects build up on models, prototypes or hypotheses which might be very refreshing and innovative.

5. Working through surveys, collection and collation of data, drawing results, presenting findings by suitable mathematical tools, suggesting solutions, testing results in the field, concluding with follow-up actions in that order, the groups prepare the project reports in a standard and uniform manner.

6. The report is presented first in the district level congress by the group leader and is assessed by a group of evaluators. All selected projects from this level are next presented in the state level congress in front of a wider audience and discussed threadbare by all concerned before they are sent for the national level congress, held during 27–31 December, every year.

(*http://www.dst.gov.in/scie_congrs/children/18th_national_children.pdf*)

Following are the Focal Themes of the past years:

1993 — Know your Environment;

1994 & 1995 — Clean up India;
1996 & 1997 — India of our dreams — Let's go for it;
1998 & 1999 — Nature — Let's conserve, share & Care;
2000 & 2001 — Indigenous scientific knowledge for a better tomorrow;
2002 & 2003 — Food systems towards nutrition for all;
2004 & 2005 — Harness water resources for better future;
2006 & 2007 — Biodiversity': Nurture the Nature for our future;
2008 & 2009 — Planet Earth: Let's Explore, Care & Share;
2010 & 2011 — Land Resources: use for Prosperity & Save for Posterity.
(http://ncsc.rajasthan.gov.in/intro.htm)

Extension of NCSC Activities:

Rashtriya Kishore Vaigyanik Sammelan (RKVS) *(National Adolescent Scientist Congress):* It is being organized every year along with the annual session of Indian Science Congress, in which selected child-scientists from the state-level NCSC participate. This provides a platform to interact with eminent scientists and exchange ideas.

International participants: Over a period of years, NCSC has attracted not just national but even international participations. Since last few years, students and teachers from SAARC and ASEAN countries are participating in this national event of Children's Science Congress.

The Noteworthy Features of NCSC:

1. Today the NCSC is not perceived as an annual, isolated event, but is a part of the process of an organized attempt to address some of the limitations of school education by encouraging children to imbibe and internalize the methods of science and the methodology of scientific research in such a way that they could relate their learning and education with real life situation.

2. Unlike the formal classroom teaching in school, the congress provided the children an opportunity to learn about their environment through hands-on activities. It brought a sense of discovery by bring children much closer to nature.

3. Among the children, it had provided a sense of belongingness to the society they live in. It emboldened them to question many aspects of our progress and development and thereby highlighted many locale-specific problems and indicated probable solutions.

4. It had mobilized children, parents, teachers etc, through voluntary actions by members of NCSTC — network and other resource persons, district coordinators etc.

5. The overwhelming response of the female child-scientist to the NCSC in all the districts of India has been major achievement of the congress.

6. The organizers always have put up a special emphasis on the participation of rural children.

7. Child-scientists are free to choose the language to make their presentation. Even some time the projects are presented in the local dialects by a child-scientist.

8. Over the years, the projects undertaken on various themes show that children have learnt to apply the scientific methods (that is, problem identification, hypothesis formulation, data collection, data analysis, drawing of inferences/conclusions and then writing a report).

9. In sharp contrast to current science education system, the congress has provided an opportunity to children to translate their knowledge to action and also thereby learn its relevance to daily life.

10. The NCSC has emerged as a big assembly of intellectuals and science communicators covering all disciplines of science & technology and is ready to play a bigger role in nation building process (Baruah, 2006: 19–21).

Some Milestones achieved by National Children's Science Congress:

1. A project by middle school students in Kerala, helped understand functioning of the lens in our eyes, formation of real image through a convex lens, rectification of vision spectacles and many other concepts of optics. Surveys followed by eye sight testing by the group of children in the school helped determine vision defects and corrective actions were catalyzed. The concepts were part of class science curriculum.

2. A child-scientist from Guwahati in Assam was the youngest person in India to have received a patent on the research work that he did for NCSC as a student of class VIII.

3. A female child-scientist from the year 1994 who is now doing her research at Chicago University on a full scholarship said that, NCSC was the platform that taught her to do research in a scientific manner.

4. Mr. Prabhan Chakraborty, a child scientist of the year 2000 and 2001, achieved the National Balshree Award for the year 2005.

5. In the year 2008, two child-scientists selected from NCSC went to Philippines to give their presentation during the ASEAN Youth Science Week.

6. A project by a child-scientist from rural Bengal on water shed management provided solutions to the problems faced the Panchayat administration.

7. Two students from Rajkot who have participated in NCSC were selected to represent India at the INTEL International Science Fair in 2008 and 2009.

(*http://epao.net/epPageExtractor.asp?src=education.National_Childrens_Science_ Congress.html.)*.

Table 1

State-Wise distribution of papers presented
at national level CSC in last three years

	State Name	Ahmedabad 2009	Chennai 2010	Jaipur 2011
1	Andaman & Nicobar Islands (U.T)	4	4	4
2	Andhra Pradesh	30	30	28
3	Arunachal Pradesh	9	10	10
4	Assam	25	24	25
5	Bihar	30	30	30
6	Chandigarh (U.T.)	4	4	4
7	Chattisgarh	15	16	16
8	Delhi	8	7	8
9	Goa	5	8	0
10	Gujarat	26	26	26
11	Haryana	26	16	16
12	Himachal Pradesh	16	15	16
13	Jammu and Kashmir	16	16	16
14	Jharkhand	14	16	16
15	Karnataka	30	30	30

	State Name	Ahmedabad 2009	Chennai 2010	Jaipur 2011
16	Kendriya Vidyalaya Sangathan*	0	13	42
17	Kerala	16	16	16
18	Lakshadweep (U.T)	0	4	4
19	Madhya Pradesh	28	28	30
20	Maharashtra	28	30	30
21	Manipur	10	10	10
22	Meghalaya	7	8	8
23	Mizoram	8	8	8
24	Nagaland	8	8	8
25	Odisha	26	26	26
26	Puducherry	6	5	6
27	Punjab	16	15	16
28	Rajasthan	28	28	30
29	Sikkim	4	4	4
30	Tamil Nadu	30	30	29
31	Tripura	10	10	10
32	Uttar Pradesh	41	42	42
33	Uttarakhand	15	16	16
34	West Bengal	30	27	30
	Grand Total	559	580	610

(*NCSTC Source*)

Table 2

Language Wise Distribution of Papers Presented at National Level CSC

	Language used	Ahmedabad 2009	Chennai 2010	Jaipur 2011
1	Assamese	19	13	14
2	Bengali	26	32	31
3	Bodo	0	1	1
4	English	292	297	338
5	Gujarati	16	17	21
6	Hindi	108	112	105
7	Kannada	19	22	18
8	Konkani	0	1	0
9	Malayalam	10	12	10
10	Marathi	14	13	18
11	Nepali	1	0	1
12	Odiya	11	15	14
13	Punjabi	7	5	3
14	Tamil	19	20	18
15	Telugu	18	20	18
	Grand Total	560	580	610

(*NCSTC Source*)

National Children's Science Congress — 2005, A Survey

Year by year CSC as a movement is gaining strength and growing in size. More and more children from different walks of life are becoming part of NCSC by associating themselves through the projects undertaken by child-scientists. As per the estimate, about 0.6 million children from the various part of India took part in the programmes in 2005. Almost an equal number of people which includes parents, teachers, social activists, science communicators, educationists, scientists, administrators, non-governmental organizations and other members of the community are also associated themselves for several months with this programme. When any child-scientist approaches any person/ authority for help or assistance, it is impossible for them to say no to them. This is evident from the fact that a number of authorities, departments, agencies (both Government and non-government) professionals and teachers extended the whole hearted support to children in their projects. The national event or the NCSC could be regarded as the culmination of the activities undertaken by children for six months, preceded by the district and state level congress. During the last couple of year, a survey on the utility and the importance of NCSC as perceived by the participating children was conducted. The basic idea of the survey is an attempt to see various aspects of congress through the eyes of child-scientists, as they are called. The survey also aimed at knowing the efforts put in by the participants in their respective projects vis-à-vis the system prevalent at their school. It is however, emphasized that the survey is not an evaluation *per se*, put only a qualitative study. The feedback received from the children during the national event is always was used by organizers to improve the programme, next time.

The Survey

Every year, a printed questionnaire is given to each participant at the time of the registration and who is asked to submit the duly filled in questionnaire on the last day of the congress. For the purpose of this paper, we have taken the data of 13th NCSC, which was held during 27–31 December 2005 at, Bhubaneswar, Odisha. During this year the participation of children was the maximum, crossing the figure of 0.6 million. Since then, this figure has not been crossed by any CSC. Out of 529 children registered at national level, only 383 responded. The questionnaire was similar to the previous years. The entire data collected through a questionnaire were processed and analyzed. Results have been compared with the findings of previous as well as the subsequent years. Interestingly there has been not much shift in the trends in all those years. However, where ever there is shift or variation from the earlier settled trends, an attempt has been made to find the possible reason for the same.

How did the participants get information about the CSC? Over the past 20 years, the implementation mechanism of this national programme has almost been standardized. Announcement of the theme of the next congress at the closing ceremony of the last congress, sending information like activity guide and other relevant information to state/district coordinators are now all settled procedures. A number of schools, science clubs and science activists involved with this programmes now also keep track of all the developments by keeping in touch with different agencies/organizations associated with the CSC in district, state and at national level.

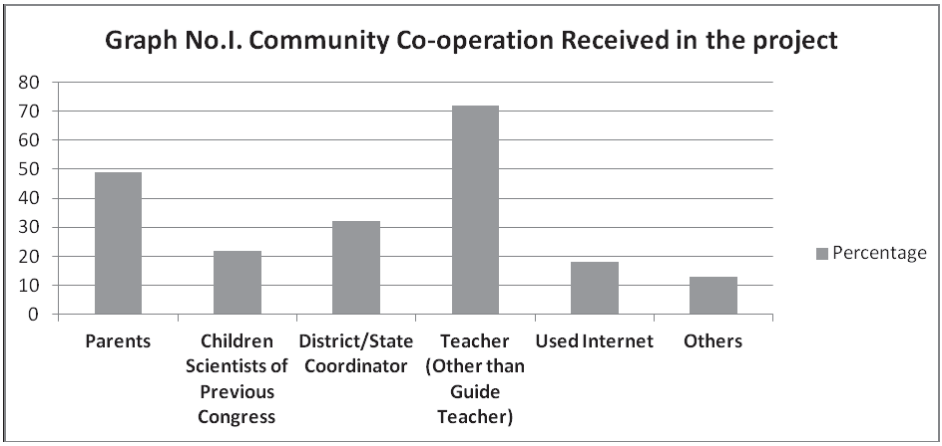
This development has considerably reduced the dependence of participants solely on state/district coordinator as used to be the case earlier. In 2005 only 31 % participants came to know about CSC from district and state coordinators. For most of the participants (66 %),

informal sources like school notice board, guide teacher, friends, relatives, neighbours, science clubs, municipality and previous child-scientists become the source of information. Among these the role of guide teacher and previous child-scientists was commendable. There is a little but steady increase in the role of media to sensitize the people in general and children in particular about CSC. About 11 % child-scientists came to know about the CSC through local newspaper and 5 % through radio and 3 % through TV including Cable-Network. Now a day's social networks, like face book is also being used by some children to pass on the information to their friends. But that percentage is meagre.

In majority of cases (71 %), the way the information was received was complete in all respects. For others (29 %) it was lacking in some vital details. In all such cases, majority of them contacted state/district coordinators (17 %) followed by their guide teacher and previous child-scientists. About 3 % child-scientists also hit the website of NCSTC-Network. All these trends are similar to the trends of previous years except hitting the website of NCSTC-Network.

What is different about this congress? The children's science congress has not only established itself as a 'national platform where children can speak about their ideas in a free atmosphere'. It also helps them 'to make friends from different parts of the country and expose them to a wide variety of cultures in a fun filled atmosphere, away from the four walls of the school'. These reasons are enough for children to like the programme. About 99% children endorsed the above points. Many of them gave their own specific reasons for liking this congress, like, 'it gives us enormous amount of knowledge and helps us create awareness among the students and people.' For few 'it encourages kids to get lot of confidence and knowledge by giving them an opportunity to show their work, creativity and talent to the whole lot of participants and experts'. To some others, 'it gives an opportunity to children to try their own approach in a field of their own interest which is different from their regular studies', 'it changes the mindset of the children'. To some 'it transcends culture and science in them and made them more punctual, disciplined and systematic by giving them joy'.

***The projects were community efforts*:** In 1995, the theme of the congress was the repeat theme of the previous year. Hence many child-scientists finalized their themes and other implementation strategies quite well in advance, without waiting for formal communication from the state/ district coordinators. Children started their works with the help of a number of people from diversified fields. In a way, this long period for project since June-July.



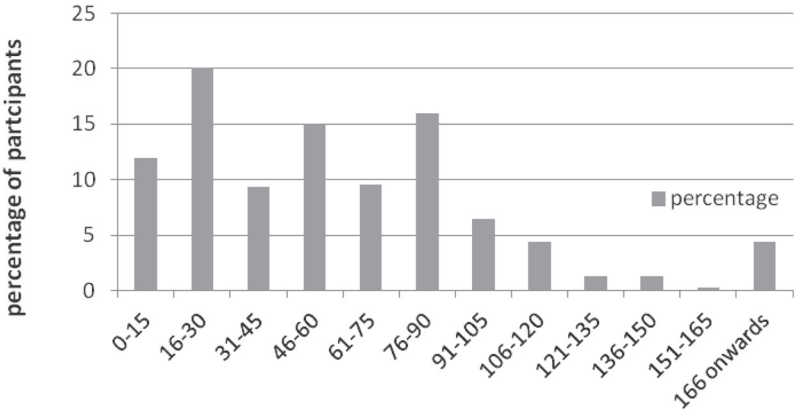
Onwards till September-November provided them more chance to do some original thinking before starting their projects. The scope of each project, in general is often very vast and difficult for an individual to work on his/her own. This makes it mandatory to seek assistance/ guidance from others to start with. This time they depended more (72 %) upon their guide teachers for guidance to give a proper shape to their project. They also took assistance from school teachers/ principal (78 %) besides their guide teachers. Support of state/ district coordinators was sought by (32 %) and 22 % took help from the previous child--scientists. The help of the parents was obvious and about 49 % of the projects had direct involvement of the parents in one way or the other.

In addition, this time the scope of the entire project was such that more and more information were gathered from different sources including Internet. About 18 % child — scientists also downloaded information from the internet for their projects. About 13 % also got information informally by meeting people from different walks of life like senior citizens, local craftsmen, engineers etc. For specific information and others inputs, assistance was sought from local universities, institutions/ agencies, science clubs, municipal corporations, panchayats etc. The elder siblings, parents, relatives, family members, class fellows, science activists, voluntary organizations were also not behind in extending a helping hands to these budding scientists.

The quantum of efforts in each project: The national event is the culmination of the programmes which started at the school or district level in the month of September-October. Before reaching to the national level each project has to go through the various level of scrutiny. This year, about 24 % projects were presented first at the school level. About 76 % projects were directly presented at the district level and there were still a few projects, which were presented directly at state level without any scrutiny at school or district level.

After the first screening at school level about 30 % participants further improved their projects to include the observations and suggestions made by the judges/ evaluators. After district level presentations, about 48 % participants further improved upon their projects to make those more presentable at state level by including more references and components from community interaction. About 50 % participants put special efforts to give final shape to their projects and for taking to the national level.

Graph No. II. Distribution of the work days spent on the projects



This year about 85 % projects were based on survey work of different types. Around 40% participants also consulted various scientific institutions and scientists and about 61 % collected reference material from various academic sources. This time a number of participants also used the Internet (16 %) to get information for their projects. A large number of participants (72 %) also prepared slides, charts etc as aids to their projects. To express their ideas for the benefit of the community about 18 % also made models. The uses of models in projects have shown a steep fall this year compared to previous years.

The component of community interaction constitutes an essential component of each project. For induction of this community component, to the projects various strategies and approaches were adopted by the participants. In a majority of cases child-scientists organized awareness campaigns to mobilize people (for the rational use of waters and its conservation-as per the theme of the congress) which included distribution of pamphlets, posters, organizing rallies, debates, seminars, quizzes, public meets, interviewing people, performing skits, plays and dramas and puppet shows etc. A number of good scripts for skits, drama and puppet shows were also developed and performed by the child-scientists even during the national event at Bhubaneswar.

The total time on a project shows a wide range of variation and most of the trends are similar to previous/ forwarding years. About 20 % participants spent 16 to 30 days on their project, while 16 % spend 76 to 90 days. The minimum number of days spend on a project was 7 days, while some spend about 730 days (Tyagi, 2007: 5–8). Some topics on which the next NCSC theme could be based are like Energy, Nano Technology and Robotics.

A few typical responses from Child-Scientists about NCSC:

"It is s very fine and innovative." "Good Job has been done." "It helps the student to invent new things." "It is very useful as it develops speaking skill, knowledge and mental ability." "It helps us to learn more and develop scientific temper among children." "It takes the children away from textbook and routine studies and they get to know more about science." "It is an opportunity to interact with many great people, I am so glad to get such a large member of friends from different schools of India."

"It has given me a new confidence and broadens my view about science & technology." "It has given us self confidence and provided us with a platform where we can express ourselves freely." "It is a personality development platform and a good step but more needs to be done." "I am happy and more enthusiastic after this experience." "It is very useful for us as well as for the society; it is a gift for children." "It is informative and creative and a great platform to show our talent, and has encouraged me to take up more projects in future." "It is a great platform for the success of children and the best method to make an all-round development." "It is a nursery of budding scientists." And "It is a platform which gives us a chance to do something big."

Conclusion

From the above stated empirical data, it is clear that the congress has been successful in achieving many of its objectives like, providing children an informal and alternative method of learning in a fun filled atmosphere which is away from the four walls of the school. The way the children prepared the projects has impressed the educationalists and scientists equally.

The CSC has demonstrated that the youngsters must not be perceived as passive recipients of delivered knowledge, but as capable of acquiring, creating and generating new knowledge. It has also proved that there could be alternative methods of science education which not only promote original thinking among children but also help them in internalizing the method of science in more practical way. This also led to conclusion that the present curriculum for science education in schools needs to be drastically re-modelled on the philosophy and methodology of CSC. Then only science education in India would infuse methodical and systematic approach among the recipients, irrespective of vocation they would pursue in future.

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Sketches of Science Popularization Movements in Pre and Post Independent India

The paper discusses about science popularization movements in pre and post independent India. Early efforts in pre-independent India were made by educators, teachers and science workers. Srirampur College established in Bengal in 1818 probably initiated first public demonstration of modern science in India through public lectures accompanied by experimental demonstrations by its teachers. Besides popular science lectures, initial science popularization efforts included translation of science books in the vernacular and writing of popular science articles. Father Eugene Lafont of St. Xavier's College played a pioneering role in the field of science popularization in the second part of the nineteenth century. The establishment of the Indian Association for the Cultivation of Science is an important step in the history of science popularization. Like it was in the then Bengal science popularization movements also took place on other parts of India like in Assamese, Oriya and Punjabi speaking regions. Mobilization for science popularization then took institutional forms as number of notable organizations came into existence as a result of the mobilizations for science popularization. The Dawn Society, Kolkata; the Punjab Science Institute, Lahore; and Vigyan Parishad Prayag, Allahabad; Orissa Bigyan Prachar Samiti, Cuttack; and later on Marathi Vidyan Parishad, Mumbai; etc are examples of such institutions. Indian Science Congress and the science academies played important roles in post-independent India. Jawaharlal Nehru, the first Prime Minister, had put lots of emphasis on spreading scientific temper in India. Science and technology policies of the government reflected Nehru's vision. Suitable institutional frameworks were created. Of late Non-governmental organizations (NGOs) in large scale are playing crucial role in taking science to the masses. People's Science Movements have emerged as an important dimension of science popularization movement in India.

Keywords: Science popularization, Rationalism, Scientific temper, Science Policy Resolution, People's Science Movements.

Introduction

Science popularization activities in India began even before modern science took roots in the country. The early efforts towards science popularization in India were initiated by educationists, science teachers in schools and colleges and professional scientists. The early science popularization in India started in 19th Century Bengal (then undivided). The Hindu College (which was later renamed as Presidency College in 1855) was established in 1817. Henry Louis Vivian Derozio (1809–1831) who taught at the Hindu College emancipated the minds of many Indian students and created an atmosphere of learning through discussion and debates. He criticized orthodox social practice and religious beliefs. He advocated the spirit of rationalism. His influence persisted long after his death and his followers came to be known as Young Bengal (Dasgupta, 1999: 22–23). He emancipated the minds of his Indian students and his role in inculcating the ways of rational critical inquiry was really profound. The first Indian

college for higher education including the study of European science was the Srirampur (also spelt as Serampore) College in Bengal. It was established in 1818 by three missionaries namely William Carey, Joshuah Marshman and William Ward. The College not only arranged lectures on scientific subjects but also published scientific books and articles in their periodical named *Dig-Durshan*. It built a laboratory, a museum and an observatory. The popular scientific lectures delivered by one of its most outstanding teachers John Mack (1797–1845) in Kolkata and Srirampur perhaps can be considered as the first public demonstration of modern science in India. The lectures accompanied by practical demonstrations used to be attended by students and other citizens (Biswas, 2001: 13–14).

Raja Rammohun Roy (1772–1833), a scholar and social reformer, advocated the spread of modern science in India and also advocated for narrowing the 'gap in attitude towards science and technology between India and Europe', noted Naralikar (2003: 88–104). In 1823, Raja Rammohun Roy wrote to Lord Amherst, the then Governor General of British India, advising him to provide modern scientific education to Indian masses. He further wrote that, 'the Sanskrit system of education would be best calculated to keep this country in darkness, if such had been the policy of the British legislature. But as the improvement of the native population is the object of the government, it will consequently promote a more liberal and enlightened system of education embracing mathematics, natural philosophy, chemistry and anatomy with other useful sciences' (Naralikar, 2003: 90). He also fought for removing unscientific beliefs prevailing in the society like caste division and *sati* system (the practice of widowed woman immolating herself on her husband's funeral pyre). In this sense Raja Rammohun Roy was one of the earliest exponents of scientific outlook (or scientific temper as Jawaharlal Nehru would call it later) in the India society.

Science popularization efforts in late-nineteenth century Bengal were carried out by a number of individuals. Ramendrasundar Trivedi (1864–1919) played a very important role (Chakraverti, 2000: 76–88). He began his popular science writing in 1884. The themes of his popular science articles included debates concerning the age of the Earth, the wave theory of radiation, atomic theory, the possibility of cosmic catastrophe, gravitation, light spectrum, the laws of thermodynamics. He also wrote on the scope, method and spirit of science. His articles appeared in literary Bengali magazines and they were later compiled in book forms, namely *Prakriti* (Nature) and *Jigmasa* (Enquiry). Santanu Chakraverti (Chakraverti, 2000: 82–83) while commenting on the significance of Ramendrasundar Trivedi's popular science writing wrote that, 'Ramendra's popular science writings acted as a source of inspiration for his younger contemporaries. It was evident from the famous science popularizer Jagadanada Ray's statement that he looked upon Ramendrasundar as a mentor and teacher in the sphere of science writing in Bengali. One must also refer to S. N. Bose's statement that Ramendra's staunch commitment to writing and reflecting on science in the vernacular served as an ideal and guideline for the *Bangiya Bigyan Parishad*. Indeed, generations had learned to delight in science from their reading of *Prakriti* and *Jigmasa*. These became for Bengali reader what the popular expositions of Helmholtz, Tait, Tyndall, Clifford and Mach had been for European readership.

Rajendralal Mitra (1822–1891), the well-known nineteenth century Bengali orientalist and intellectual played a pioneering role in popularization of science in Bengal (Ghosh, 2000: 66–75). There were attempts of popularizing science through translation of science books in the vernacular. Master Ramachandra (1821–1880) taught then in Delhi College (later renamed as Zakir Hussain College), did pioneering work in this respect. He was an Urdu journalist, mathematician and educationist. He translated mathematics and science books to Urdu (the *lingua franca* of northern India including Punjab) under the aegis of the Ver-

nacular Translation Society, which was established in 1843 (Habib, 2010: 281–292). Master Ramachandra also wrote articles on inventions, discoveries and research in modern science and on different aspects of mathematics. Master Ramachandra was himself an established mathematician. His work on mathematics entitled 'On the Problems of Maxima and Minima' was published in London and which included an introduction by Augustus de Morgan. The work started by Ramachandra was further expanded and taken to greater heights by his student Munshi Zakaullah (1832–1910) (Habib, 2000: 132–145). Zakaullah like his illustrious teacher undertook the tasks of translation of science books in Urdu and original writings on different aspects of science. Zakaullah was a strong supporter of teaching in the vernacular. He even argued for 'the constant use of English even from our childhood, so that we begin to express our thoughts in English instead of in our mother tongues. It may go far to denationalize us. But if we wish to remain as Eastern people, we must not neglect the language which we learnt at our mother's knee... To forget it, or to despise it, is to lose one of the strongest factors in the building up of national character' (Habib, 2000: 137). The tasks of translations and writing popular scientific articles were taken up in many other languages, in pre-independence India particularly in Hindi (also in Tamil, Malayalam, Assamese and Oriya).

In the Tamil speaking region then under Madras Province, the Madras School Book and Vernacular Literature Society established in 1870s by revamping the earlier Madras School Book Society (established in 1820s) took up the task of bringing out science books in Tamil and spreading the message of modern science (Venkateswaran, 2011). Little later in Madras Presidency many scientific and literary societies had emerged in pre-independence India e. g., Villapuram Literary Society (established in 1882) and Villapuram Educational Society (established in 1885) (Venkateswaran, 2011: 42). These societies created a much needed platform for discussing literature and scientific subjects with a view to bringing about educational and social reforms.

In Assamese speaking region, the first Assamese newspaper-cum-science magazine named *Orundoi* started in January 1846 at the Sibsagar Mission Press. It devoted among other things to religion, science and general intelligence which went a long way to widen the horizon of minds of Assamese speaking people. Later on the Cotton College established in 1890 in Guwahati, Assam, provided a platform to science popularization activities in the state of Assam through popular lectures, demonstrations and exhibitions (Phukan, 2000: 146–152). But in some other Indian languages science popularization efforts started only in post-independence India.

The efforts in science popularization in pre-independence India

The St Xavier's College Calcutta, which was established in 1860 by the Belgian Society of Jesuits, played an important role in creating public interest in science and promoting science education in schools and colleges. This had been possible because of Father Eugene Lafont (1837–1908), who joined the St Xavier's College on 7th December, 1865. Father Lafont gave his first popular scientific demonstration to the public of Kolkata on September 18, 1868. This was a great success. It was widely reported in the daily newspapers. According to some reports Father Lafont's demonstration 'clearly showed how attractive a really good course of popular scientific lectures abundantly illustrated with equipments, would be to the inhabitants of Calcutta' (Biswas, 2001: 24–44).

The establishment of the Indian Association for the Cultivation of Science (IACS) at Kolkata (then Calcutta) in 1876 can be regarded as a hallmark in the history of scientific research and science popularization in the country (IACS, 1976). Dr. Sircar in his article entitled "On

the desirability of a national institution for the cultivation of sciences by the natives of India" published in the *Calcutta Journal of Medicine* (Vol. 2, August 1869, p. 286–306) in 1869, first proposed the establishment of such an institution. He in fact desired a different institution altogether which shall be for the instruction of the masses, where lectures of scientific subjects will be systematically delivered not only through illustrative experiments performed by the lecturers, but also by inviting the audiences taught to perform themselves. He further wished that this Institution be entirely under native management and control. This was claimed not out of vanity but simply that the value of self-reliance may be learnt in matters of science without any serious risk' (Biswas, 2001: 175–176).

Further elaborating on the strategy to be adopted by the Association for disseminating a taste of science among the masses Sircar (Kumar, 1995: 198–199) further wrote that 'they shall be able to institute two series of lectures on each subject, one general for the general public, and the other a special one for the instruction of few who would like to form themselves into a class to learn the subject. There shall have in each section under the head worker, a few sub-workers as it were, who by virtue of the training they were to receive, would soon become workers in science themselves, and would be of help to the institution as well as to community in general. Thus a taste for science will soon be disseminated among the general community, and science would then have its votaries by hundreds of thousands' (ibid).

The IACS was the first scientific research institution started by Indians. The initial activity of the institute was to organize popular lectures on different topics of natural sciences. Father Eugene Lafont (1837–1908) started the first course of lectures in 1887 and continued till 1893. Father Lafont who taught physics at the St Xavier's College for 43 years was a great popularizer of science. Among his students was Jagadis Chandra Bose, the first scientist in modern India. Father Lafont was also the co-founder of the IACS (Biswas, 2001: 45–68). Commenting on his popular science lectures, Ruchi Ram Sahni (1863–1948) a pioneer of science popularization in pre-independence India wrote that, 'he will never forget the wonderful popular lectures of Father E. Lafont of the St Xavier's College. There were other lecturers also who appeared on the platform now and again, but in making a difficult point crystal clear and especially in creating popular interest in science, no one could match the Jesuit Professor' (Sehgal and Mahanti, 1994: 9). Among others who delivered popular science lectures at the Association were: Mahendra Lal Sircar (1833–1904), Asutosh Mookerjee (1864–1924), Jagadish Chandra Bose (1858–1937), Pramathanath Bose (1855–1934) and Nil Ratan Sarkar (1861–1943).

After the establishment of the IACS, efforts were made in other parts of the country to establish such kind of institutions for spreading the spirit of science.

The *Dawn Society* of Bengal was established in 1902. Its founder was Satishchandra Mukherjee, an eminent educationist. The *Dawn* magazine, started in 1897, became the mouthpiece of the Society was even older than the Society. The magazine served as an important vehicle in transmitting scientific ideas by publishing science articles. As Palit (2000: 90–91) notes that by 1912 the magazine published 40 articles illustrating the progress of science and its applications including "Material triumph of science," "Wireless telegraphy," "Right pursuit of physical sciences considered from the point of view of individual as well as national regeneration," "Is matter alive: some of the researches of Jagadish Chandra Bose," "New alchemy," "Chemical research in Bengal," "Indian metallurgical knowledge" etc. Eminent scientists and educationists like Jagadish Chandra Bose, Acharya P. C. Ray, Ramendrasundar Trivedi and Nilratan Sarkar were associated with the *Dawn Society*.

The Punjab Science Institute established in 1885 in Lahore, Punjab of the undivided India was directly influenced by the model of the Indian Association for the Cultivation of Science,

Calcutta. Though the idea of establishing such an organization for science popularization at Lahore was first conceived by Professor J. C. Oman of the Government College of Lahore it was Ruchi Ram Sahni who was instrumental in establishing the organization. The fact that Sahni was inspired by the example of the IACS Calcutta, was noted by Sahni himself in his *Memoirs* (Sehgal and Mahanti, 1994: 68). Sahni wrote that, 'the idea of the Institute originated with Professor J. C. Oman of the Government College; when he was then in M.A. classes at the College and before he had proceeded to Calcutta, he used to discuss with friends the need and scope of such an institution. But it was only in summer of 1885, (say, after Sahni returned from Calcutta and explained to Professor Oman what he had seen in the Sircar's Institution) that a Society under the name of the Punjab Science Institute was actually established.'

Sahni organized popular science lectures under the aegis of the Punjab Science Institute for laypersons on subjects like: "How does the telegraph wire speak," "The common flame," "The water Lahoris drank before 1880," "Pure and impure water," "The toys and their lessons," "Soap making," "Electroplating," "Electricity in the service of man," "Glass making", "The Punjab and its rivers". Lectures on the latest scientific discoveries namely "X-rays," "Edison's Phonograph" and "Wireless telegraphy" were also delivered. Sahni himself delivered most of the popular lectures arranged by the Punjab Science Institutes but he also persuaded many teachers in the colleges to come forward to share the activities of the Institute. According to some estimate Sahni himself delivered more than 500 popular science lectures in Punjab (Virk, 2000: 125–131). Popular science lectures organized by the Punjab Science Institute were not delivered in any special theatre or auditorium. They were delivered in open spaces. In Lahore Sahni used the compound of a Gurdwara (Baoli Sahib Gurdwara). The audience for these lectures in Lahore consisted mostly shopkeepers from the surrounding market and office workers mostly clerks. Lectures were organized in smaller towns and villages on the occasion of festivals and fairs. These lectures were often accompanied with experimental demonstrations. Sahni in 1880s was able to demonstrate that the local language, Punjabi could be successfully used as a vehicle of scientific ideas. Sahni admitted that there was no dearth of volunteers from the audience to provide suitable Punjabi work for a scientific term in English. In this way an unwritten dictionary of technical terms in Punjabi was created. Unfortunately even after 120 years of such successful demonstrations science communication in local languages including Punjabi is far from satisfactory. All the expenses for these lectures were covered by the fees charged for them. There was so much enthusiasm for such popular science lectures that Sahni received invitations for giving lectures from far flung areas. There was a direct impact of these popular lectures on science teaching in schools.

Similarly, the Orissa Science Association was established at Cuttack in November 1921 through the initiatives undertaken by professors of Ravenshaw College and Cuttack Medical College. The society did not survive long but it had initiated science popularization activities in the state. The Orissa Science Association was followed by the Bigyan Prachar Samiti. On August 7, 1949 Orissa's first society for popularizing science called as Orissa Bigyan Prachar Samiti (OBPS) was established at Cuttack for the Oriya speaking people (Pattnaik and Sahoo, 2006: 211–214). This society was formed with combined efforts of late Gopal Chandra Pattnaik and Gokulananda Mohapatra. In the first meeting of the Samiti the other members present were eminent economist Sadasiba Mishra, noted psychologist Radhanath Rath, plant scientist Shymananda Pattnaik, and professors of medicine like Mahendra Chandra Mishra and Raikrushna Mohanty. In all nine members were present in the first meeting and among them six were from Ravenshaw College and three others from medical college, Cuttack. To begin with, it was known as Utkal Bigyana Parishad but later it changed its name to Orissa Bigyan

Prachar Samiti. This society was registered as a formal organization in 1961. The Samiti during its inception had three objectives, such as; (i) Spread the messages of science through discussion forums and popular lectures in vernacular language, (ii) Publication of books based on science in vernacular language and finally (iii) Publication of a popular science magazines (Pattnaik and Sahoo, 2006: 211–214). Besides, the chief objective of the society was to provide a comprehensive language (terminology) and style suitable to students and common people to study science. Their sole aim was to make science simplified for the people and students in particular as it was so intricate. In 1944, Oriya was made the medium of instruction in schools. Exactly on that year science was introduced into the high school curriculum. But as there was not a single science text book in Oriya language the students were faced with a lot of difficulties. In view of this the OBPS desired to publish Oriya text books on science. Probably because of the absence of text books in vernacular medium students in the then Orissa showed a little interest in science. With a view to mitigating the plight of science education on Orissa then, Gokulananda Mohapatra along with Harihar Pattanaik published the first Oriya book on science for matriculation students which were frowned upon by some of the college teachers of the time. Those years in Ravenshaw College large number of students enrolled in Arts departments but a few in Sciences.

However, after the ten years of establishment of OBPS the government of Orissa recognized their contribution and recognized as an educational society. The OBPS did not deny funding offer made by the government on its own. As a result, a few education ministers have extended financial help to the OBPS. It is interesting to note that Orissa Bigyan Academy (OBA), now a government organization to propagate science originated from the OBPS. In the absence of a regular office usually the meetings of OBPS were held in the private quarters of its members. In one of its meeting OBPS gave birth to Orissa Bigyan Academy (OBA) not only for science propagation but also to perform many other activities that were not done by the OBPS *(*Pattnaik and Sahoo, 2006: 211–214).

The IACS Calcutta also influenced many individuals to engage in science popularization. Many well-known scientists not only took part in the activities of the IACS but they also made individual efforts in popularizing science. Jagadish Chandra Bose (1858–1937), besides being one of the pioneers of modern science in India, contributed to the field of science popularization. He wrote a popular science book in Bengali too. This book entitled *Abyakta* (Unexpressed) was a compilation of his popular articles and it dealt with life processes of plants. He also wrote one of the earliest science fiction stories in Bengali. The Institute started by him, now known as the Bose Institute, started the practice of popular science lectures since its inception.

Prafulla Chandra Ray (1861–1944), the founder of the school of modern Chemistry in India also wrote popular science articles. C. V. Raman (1888–1970), the only Indian Nobel Laureate in science, made significant contributions in the field of science popularization. He could hold his audience spellbound during his popular science lectures (or performances as he called them). His popular science lectures were always accompanied by lively demonstrations. Throughout his life Raman delivered lectures to diverse audiences. He was at his best when delivered popular science lectures. Raman also gave radio talks. The texts of his nineteen lectures were brought out in a book form. The book was entitled *The New Physics: Talks on Aspects of Science* and it was published by the Philosophical Library of New York. K. S. Krishnan (1898–1961), co-discoverer of the Raman Effect, wrote popular science articles in Tamil.

The Indian Science Congress was established in 1914 to advance the cause of science in India. It was founded by P. S. MacMahon of the Canning College, Lucknow and J. L. Simonsen of the Madras Presidency College (Visvesvarya, 2003). They were supported by the well-known scientists of India. The Asiatic Society played an important role in sustaining the Indian

Science in its formative years. The founders of the Indian Science congress recognized the need to spread the message and spirit of science amongst the general public. A special section called "Science and Society" was created for discussing issues interfacing science and society. Asutosh Mookerjee in his Presidential address to the first Session of the Indian Science Congress held at Kolkata in 1914 said that, 'it is now more than two years that Professor MacMahon of the Canning College at Lucknow, and Professor Simonsen of the Presidency College at Madras brought forward a proposal for the foundation of an Indian Association for the Advancement of Science. The objectives and scope of the proposed Institution were stated to be similar to those of the British Association for the Advancement of Science, namely, to give a stronger impulse and a more systematic direction to scientific enquiry, to promote the intercourse of societies and individuals interested in Science in different parts of the country' (Mookerjee, 2003: 1–2).

The General Presidents of the Indian Science Congress emphasized the need of creating scientific awareness in the society. Excerpts from the speeches of two early General Presidents of the Indian Science Congress reflect its initial concerns. W. B. Bannerman was the General President of the second Indian Science Congress held at Madras in 1915. In his Presidential address entitled "The importance of knowledge of biology to medical, sanitary and scientific men working in the tropics," he stressed the need of removing ignorance of the common people vis-a-vis recent developments in biological and medical sciences. He asked (Bannerman, 2003: 6) 'if these things are so, if the cause of all these scourges and the proper measures necessary to take to prevent them are known, how is that so many thousands still die of these diseases, and that certain parts of the country still remain barely habitable on account of their presence.' He answered it himself by saying that the cause is a very simple one that is; 'ignorance, gross ignorance.'

P. C. Ray in his Presidential Address in the 7th Indian Science Congress held at Nagpur (1920) said that, 'while the study of Science is essential for material advancement, it has a special need and significance for the culture of Indian youth. A long period of intellectual stagnation...had produced in us a habit of dependence on the authority of the *shastras*. Reason was bound to the wheel of faith and all reasoning proceeded on assumptions and premises that were open to public questioning or criticism. Intellectual progress was handicapped under these conditions and it is no wonder that India cannot point to any notable achievement in this line during the 1,000 years that preceded the advent of British rule. Reason had thus to be set free from the shackles. And the function of science in achieving this end is undisputable. Science takes nothing in trust but applies to them all the methods of investigation and criticism. One may look forward to the growth of this scientific spirit in this country to liberalize the sphere of intellects' (2003: 92).

Vigyan Parishad Prayag (VPP), a non-governmental organization, established in 1913 at Allahabad has played a pioneering role in popularization of science in Hindi (VPP, 2012; Sinha, Mahanti and Kapoor, 2011). The Parishad started a popular science magazine named *Vigyan* (Science) in Hindi in 1915 and it is being continuously published since then. It has published a large number of popular science books. It has organized public lectures and seminars on scientific subjects. Many of the well-known science communicators in Hindi were initiated in the field by the Parishad.

Three national science academies established before India's independence played an important role in popularizing science. These were; the National Academy of Sciences India, at Allahabad (1930), the Indian Academy of Sciences at Bangaluru (1934) and the Indian Academy of Sciences (1935), first established at Kolkata and later shifted to New Delhi. On the occasion of laying the foundation stone of the National Institute of Science of India (later

renamed as Indian National Science Academy) in New Delhi on April 19, 1948 Jawaharlal Nehru said that, 'the scientific method is the only right method of approach to life's problems; and in India today it is even more important than elsewhere, as India is backward in science... Indians should pursue science in the right way and try their utmost to foster it. There is no other way except the way of science does bring development to human life and institutions. This is the scientific approach to life's problems... The fundamental thing is scientific approach. Man cannot change legally. But by creating an atmosphere where his actions are governed by a scientific approach, science remains the only right method of approach' (as cited in Jain, Ahuja and Mahanti, 1989: 6). Nehru further said that he was glad that the scope of the Institute of Sciences is comprehensive. He was hopeful at the same time that it will not presume too much and become too exclusive and disdain people who do not belong to it' (ibid). From Nehru's remarks it becomes obvious that he wanted the Academy to work for creating an atmosphere where due importance is given to scientific approach.

There were many other scientific societies for example Indian Mathematical Society (1907), Institution of Engineers (1920), Indian Botanical Society (1921), Indian Chemical Society (1924), Indian Medical Association (1928), Indian Physical Society (1935), Entomological Society of India (1938) and Indian Anthropological Society (1941). There are many others. All these scientific societies contributed towards popularization of science.

Science popularization in post-independence India

Pt. Jawaharlal Nehru, the first Prime Minister of independent India, laid real emphasis on the development of science in India for societal development and also on spreading the spirit of science or scientific temper, as he called it, in the country. He explained the term scientific temper in his much acclaimed book *The Discovery of India* published in 1946. Nehru (Nehru, 1981: 514) wrote 'It is the scientific approach, the adventurous and yet critical temper of science, the search for truth and new knowledge, the refusal to accept anything without testing and trial, the capacity to change previous conclusions in the face of new evidence, the reliance on observed facts and not on pre-conceived traditions, the hard discipline of the mind etc — all this is necessary, not merely for the application of science but for life itself and the solution of its mundane problems.'

Nehru was hopeful that India would catch up with the developed countries in creating the real temper of science. In this context he wrote further that, 'science has dominated the western world and everyone here pays tribute to it, and yet the west is far from having developed the real temper of science. It has still to bring the spirit and the flesh into creative harmony. India in many obvious ways has a greater distance to travel in this direction. And yet there may be a few major obstructions in its way, for the essential basis of Indian thought for the past ages, though not its later manifestations, fits in with the scientific temper and approach' (Nehru, 1981: 514–515).

The strong commitment to science of the Government of India headed by Pandit Jawaharlal Nehru got expressed in the form of (SPR) Scientific Policy Resolution No.131/CF/57 adopted by the Indian Parliament on March 04, 1958. It stated, 'it is only through the scientific approach and method of science and the use of scientific knowledge that amenities (both material and cultural) and services can be provided to every member of the community'. The SPR asserted the government's commitment 'to foster, promote, and sustain, by all possible means, the cultivation of science and scientific research in all its aspects — pure, applied, and educational' (Government of India, 1958).

In 1976, the Government of India incorporated the development of scientific temper as one of the Fundamental Duties of every citizen through an amendment to the Constitution of India: 'to develop the scientific temper, humanism and the spirit of inquiry and reform' (Fundamental Duties of every Indian citizen vide Part IV-A, Article 51-A (h) — introduced as a part of 42nd Amendment to the Constitution of India in 1976).

The Sixth Five Year Plan document approved by the National Development Council stressed the need of science popularization for inculcating scientific temper amongst people. In fact the Report prepared by the Working Group on Science and Technology of the Planning Commission for the Sixth Five Year Plan had noted, 'the task of creating scientific temper is almost a necessity, as repeatedly stressed by Jawaharlal Nehru. It is important not only for the society but also for the very growth of science itself and its utilization in the development process.' It further stated that, 'it is time to give the idea of disseminating scientific temper an institutional mechanism with an appropriate design and framework. It may be necessary to consider the establishment of a National Council for Propagation of Scientific Temper; this should be examined further.' Accordingly the National Council for Science and Technology Communication (NCSTC) was established in 1982 by the Government of India as its nodal agency for conceptualizing, implementing and co-ordinating large-scale science popularization activities at the national level. Soon after its establishment the Council took up the task of creating much needed infrastructure for initiating science popularization activities in all the States and Union Territories of the country. In 1989, the Government of India established Vigyan Prasar as an autonomous organization for furthering the activities of the NCSTC. These organized efforts undertaken by the NCSTC, Vigyan Prasar and government organizations like the Council of Scientific and Industrial Research (CSIR) and the National Council of Science Museum led to the development of high-quality communication materials for disseminating science at popular level in the form of books, magazines including e-magazines, posters/charts, activity kits & demonstration experiments, audio-video programmes, street plays, dramas, puppetry, hands-on activities, origami, scientific toys, websites etc. National campaigns were organized. Efforts were made to train science communicators. These national campaigns have led to networking of different organizations including non-governmental organizations engaged in science popularization (Mahanti, 2010: 73–102 & Mahanti, 2011: 113–132).

The Science and Technology Policy of 2003 of the Government of India clearly highlighted the need to spread scientific awareness in the country. It stated, 'to ensure that the message of science reaches every citizen of India, man and woman, young and old, advance scientific temper among them, emerge as a progressive and enlightened society, and make it possible for all our people to participate fully in the development of science and technology and its application for human welfare. Indeed, science and technology will be fully integrated with all spheres of national activity' (Govt. of India, 2003).

In 1948 S. N. Bose entirely on his own initiative had established an organization with the following specific objectives; (i) to create a scientific awareness in the society, (ii) to foster scientific attitude among people and (iii) to make available information regarding recent developments in science (Chatterjee and Chatterjee, 1976: 73–74). The organization was named Bangiya Bigyan Parishad (Science Association of Bengal). A popular science magazine called *Gyan O Bigyan* (Knowledge and Science) had also started. Bose advocated strongly for the use of the mother tongue (in his case Bengali) in teaching and spreading science. Even in those days Bose went to the extent of proposing teaching of science in schools, colleges and universities in Bengali. Bose himself gave lectures in his MSc classes in Bengali.

The circular printed on the occasion of the inauguration of the Parishad noted that, 'despite the need of science at every step, the Indian system of education does not prepare Indians for it. ... The main obstacle so far had been the foreignness of the language through which education was being imparted. Today the tides have reversed. New hopes and aspirations are emerging. Now it is the duty and the responsibility of Indian scientists to popularize science through the vernacular medium and thus help create a healthy scientific attitude among the people. As a first step toward this effort it has been resolved to form a 'Bangiya Bigyan Parishad'. It happened mainly through the inspired leadership of Professor Satyendra Nath Bose' (Chatterjee and Chatterjee, 1976: 73–74).

Vikram A. Sarabhai, founder of India's space programme established a community science centre now known as Vikram A. Sarabhai Community Science Centre to improve the state of science education in the country and to make students well informed in science (Joshi, 1992). This institute has played an important role in institutionalizing science popularization activities in the state of Gujarat.

Another major science popularizing organization in India is the Marathi Vidyan Parishad (MVP) which was established in 1966. It was the offshoot of efforts of a number of scientists and engineers in Maharashtra who wanted to take science to the public, as they were worried that scientific information was inaccessible to the majority of the Marathi speaking people. After a decade of success in translating scientific books and articles into the local language and making them available to vernacular schools and citizens, MVP's efforts were to foment a scientific inquiry attitude among the population aiming at self-empowerment and social change (Pattnaik and Sahoo, 2011: 205–228).

A group of socially conscious science writers led by M. N. Gogte came together in the mid-60s to form a science popularizing organization. They felt that it was necessary to attempt to fill the lacuna that exists in the publication of Marathi literature for the masses. Being committed to the society and public on the one hand, and the development of the approach, on the other, this group of intellectuals were also acutely conscious of the fact that science today is locked in an 'ivory tower'. It cannot remain there if it is to develop into something worthwhile and meaningful for the larger sections of the society. Gogte argued that though in post-colonial India English language is widely used for business and higher education, English alone will not suffice. A large chunk of population does not know English either. Furthermore, he finds that since the language is foreign, the subject is steeped in esoteric jargon. He pointed out that local language is very effective to convey knowledge, invoke creativity, connect individuals, enrich culture and induce social reforms (Pattnaik & Sahoo, 2011).

As an organization, MVP was formed in 1966 and a constitution formulated specifying that the organization aims to: (i) popularize science through local language (i. e. Marathi) and enrich Marathi language for expressing science, (ii) explicate and enhance importance of science in human life and (iii) use science as a means of social criticism. However, the activities of the MVP have grown much beyond the scope of the objectives set. The initial actors of MVP unanimously felt that propagation of science does not require any ideological platform. Rather they argued for a common platform from which scientific knowledge aimed at bringing about rational thinking and attitudes (Pattnaik, and Sahoo, 2011).

MVP started initially with a group of 6–7 which consisted primarily of scientists and engineers. Today the membership has grown to over 1,500 and in addition to this; there are many non-members who participate in the activities which have been extended mainly through the establishment of personal contacts. It was observed that the individual life memberships of MVP have constantly increased in the last four decades. The number of individual life

members was 66 during 1966–1967 which arose to 1222 in 2007–2008. Though the institutional life members of MVP have increased, but in small number. During 1966–1971, MVP had branches. So, all the members of MVP branches were members of the main body. In 1972, MVP provided autonomy to branches and started calling them as local chapters. When these were branches, their income and expenses were also part of main body. However, once they became autonomous, they were free to have own incomes and expenditures. By doing so, MVP stopped including the branch members in the main body, hence the decline in number.

Most of the individual members of MVP are urban professionals, working at different scientific establishments of India such as Bhabha Atomic Research Centre (BARC), Council of Scientific and Industrial Research (CSIR), Department of Science and Technology (DST), Department of Atomic Energy (DAE), Inter-University Centre for Astronomy and Astrophysics (IUCAA), Tata Institute of Fundamental Research (TIFR) etc. The individual members of MVP range from scientists, engineers to teachers and academicians. It appears that MVP shares an affinity with the Maharashtra Government, as its members served in different capacities at various scientific and technological establishments. Among them, a group of elite scientific professionals like, B. M. Udgaonkar, J. V. Naralikar, Prabhakar Deodhar, Raja Ramanna and Vasant Gowarikar, were involved in the activities of MVP. They believed that their duties as scientists were not confined to their laboratories only but are spread also to science communications. They consider that Indian scientists should communicate their work to a wider audience to make them understand the value of their work. Even scientists have a lot to say about problems in Indian society, and they think that MVP provides a platform to communicate their views and opinions (Pattnaik and Sahoo, 2011).

Now, MVP operates through its 38 local chapters at the district and state levels. Of the 38 local chapters of MVP, 35 are working at the district levels and 3 are working at the state levels in Goa, Gujarat and Karnataka as these states have a significant number of Marathi-speaking population. The organizational activities are conducted through Marathi language.

In post-independent India a group of non-government organizations (NGOs) have played a very important role in popularizing science. Some of the important NGOs engaged in science popularization are: Kerala Sastra Sahitya Parishad (KSSP), Kerala; Srujanika at Bhubaneswar, Orissa; Pashimbanga Bigyan Manch, Kolkata in West Bengal; Science Centre, Gwalior, Madhya Pradesh; Eklavya, Bhopal, Madhya Pradesh; NCSTC Network, New Delhi; Assam Science Society, Guwahati; Marathi Vidyan Parishad, Mumbai; Tamilnadu Science Forum, Chennai; Pondicherry Science Forum, Puducherry; Haryana Vigyan Manch, Rohtak, Haryana; Tripura Science Teachers' Forum, Agartala; Madhya Pradesh Vigyan Sabha, Bhopal; Vikram A. Sarabhai Community Science Centre, Ahmedabad; and Jan Vigyan Vedika, Andhra Pradesh. These organizations are carrying out science popularization activities on continues basis in the respective states. The States Councils of Science and Technology established in almost all the states are also supporting science popularization activities in the states. Today a large number of individual science communicators are engaged in creating scientific awareness in the country. Science coverage in print and electronic media has substantially increased.

People's Science Movement (PSM) has emerged as an important dimension in the field of science popularization. The origin of PSM could be traced to the experiments and experiences of Kerala Sastra Sahitya Parishad (KSSP). It catalyzed the networking of many NGOs in the country which resulted in the formation of the All India People's Science Network (AIPSN). The first All India People's Science Congress was held in Cannanore in 1988. The main issues addresses by PSM are environment, health, development, education and self-reliance. PSMs have on many occasions have triggered mass mobilization for

questioning social development issues. It would not be completely wrong that the science popularization movement of India with its rationalistic overtone has gradually transformed itself into PSMs. It is a metamorphosis that too decades to take place.

Conclusion

Today in India a large number of science popularization activities are being carried out by government and non-government organizations. The major objectives of science popularization movements as perceived by the organizations and individual science communicators can be summarized as follows:

1. Making people aware of the recent developments in science and technology.
2. Enhancing the appreciation of the significance of science in their daily life.
3. Enabling people to take well informed and rational decisions as well as strengthen their decision making abilities.
4. Developing scientific temper in the society.
5. Making young people interested in science.
6. Enhancing the level of public understanding of science.

India is a vast and diverse country. It is necessary not only to improve and expand the activities of the existing organizations engaged in science popularization but also to establish new organizations. Mere incremental increase of the current level of science popularization efforts will not achieve the desired goals, the task of science popularization needs to be taken up on a mission mode. It should become an all pervasive movement. But the major challenges in the field of science popularization are creation of good resource material in local languages and networking of the organizations and individuals in the field.

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