SCIENCE AND TECHNOLOGY DEVELOPMENT IN THE INDIA

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Science, Technology & Social Stratification in India: A Critical Perspective

One of the most profound sociological problems that S&T in India face today is that of the role of S&T in relation to social inequalities. The paper analyzes (at macro level) the role of S&T particularly in relation to the system of social stratification and other forms of social inequalities both within and outside the system of S&T in India. As a socio-historical analysis based on secondary data and findings the paper articulates a few original formulations on the role of S&T in (post independent) India in the contexts of major trend developments (in different decades) like: (i) Modernization of S&T, (ii) Green Revolution induced by technology intensive agriculture, (iii) Development as triage benefiting, selective sections of the society, and (iv) the ICT revolution in India during the last two decades. This is essentially a critical non-western view, i. e. a view of the periphery from the periphery itself.

Keywords: S&T induced inequalities, Class formation, Modernization of S&T, Artificial elitism, Emergence of big S&T, Development as triage, Green revolution, ICT revolution, Cyber coolie, Techno coolie.

Science and Technology together have come to be known as the most dominant tradition of mankind today. It is difficult to imagine a discussion on the development of the modern world or on the potentialities of human life in the future which does not almost immediately focus on the role of science and technology (S&T) in the development process. Nor is an analysis of the problems we face at present likely to mean much, if it does not involve some attempt to understand the complex interaction of S&T with society. At many different levels S&T are intimately bound up with our hopes and our fears, as well as our quality of life. They have given us standards of comfort and technical marvels unthought of earlier, and they promise more; but they pose threats too, graver in many ways than those posed

in the past. Operating in the socio-economic order of unequals S&T have favoured the life chances of some and have dammed those of many. Hence in this paper I am attempting to articulate the very many complex ways in which S&T have marred the livings of the teeming millions of a developing country. It is only part of the truth, I intend to discuss, as S&T have enhanced the life chances of many although with varying degrees.

At the out set it almost becomes necessary for me to explicate my value premise that modern S&T are essentially value free enterprises (methodologically). Epistemologically it is modern science that originated in the west/Europe and through application gave rise to modern technologies (scienticized). These acquired universal character under the European rule of the world in the 18th and 19th Centuries. These have been the companion of European powers for expansion of colonialism and even the instrument of domination of the world in the post world war times. These have been claimed to be universal and value free as these have been the means of domination and means of legitimization of regimes both in democratic as well as socialistic worlds (in spite of the democratic ethos of modern science for which it has been said to be the companion of democratic polities, Merton, 1973: 254–266). Further modern science is said to be value free/neutral because of its applicability irrespective of the context like nationalism, ethnicity, religiosity, etc. Lastly, it has been claimed to be universal and value free as this could be used in all the societies of East and West or North and South (irrespective of its societal history). Modern S&T operate in a given political-economic frame work which usually has its ideological hues. As a subsystem S&T acquire the hues of its political-economic frame work in which it operates. Therefore, given the structure of inequality in a particular society S&T yield the result accordingly and benefit the people of various strata proportionately. Thus S&T today are mere instruments of development that help perpetuate the system (of stratification) unless used to challenge the latter (as in history this modern science also has been the means of enlightenment and liberation of the masses from colonialism and feudalism).

Therefore, I argue here to show how S&T have determined the social stratification within the Indian S&T in particular and Indian society in general, in the context of four major trend developments (in post-independent India) such as: (A) Modernization of S&T in India (B) Green Revolution induced technology intensive agriculture, (C) Development as triage causing massive displacement and loss of livelihoods, and (D) Information and communication technology (ICT) revolution. Although the four trend developments are post-independent phenomena but have their own time frames. Of the four, the first two trend developments although were parallel but being contemporary overlapped each other's time of reference (i. e. 1960s). Similarly the latter two trend developments although have been parallel (mid-1980s onward) but have overlapped each other's time of reference (i. e. 1990s) significantly. Although based on secondary data and findings these formulations and the arguments therein are the original formulations of the paper. Hence this analysis essentially is from the vantage of a non-western perspective, i. e. a view of the periphery from the periphery itself.

(A) Modernization of S and T in India (during 1950s–1970s):

In the non-western traditional societies, the fundamental and core values maintain certain autonomy in relation to the values of modern S&T that are usually instrumental in character. Hence it is very likely that when modern science and certain systems of technology acquire

universality their adaptation or 'mix' with the fundamental or core values of a traditional society would differ and result in the emergence of a 'culturally relative system' of S&T. But this merely is a logical possibility.

Modern S&T entered into India and similar non-western traditional societies in the company of imperialists. By that time S&T had already acquired the support of state power in Europe as these were conceived to be the principal instruments of the development for European societies and instrument of exploitation of the colonial societies. Hence, from the beginning, S&T as major instruments have been responsible for the development of the western societies and for the underdevelopment of the colonial societies. The colonial regimes on the one hand imposed modern S&T in the traditional societies and on the other eliminated the indigenous forms of S&T in these societies. In this process of imposition and elimination during the long colonial period the colonizers found the native bourgeoisie as its closest ally to implant and lead the western development model.

Of late when colonial societies acquired political freedom, their ruling classes continued to look at the West, their erstwhile rulers, for all round development, what we all know as 'westernization'. The western scientific education in these societies justified the western mode of development for these traditional societies. Having eliminated the competing forms of native S&T in traditional societies, modern S&T had acquired a universal character and had left no alternatives in terms of knowledge and thereby no other development models for the traditional societies except that of the West. Unfortunately the indigenous intelligentsia of the traditional societies was itself an offshoot of modern western S&T education, whose role was then indeed to formulate it's 'culturally relative system' of S&T and a corresponding mode of development for India.

S&T and development have always been inextricably linked. Like the concept of development, S&T have come to be treated as universal and evolutionary. But the conception of universal and evolutionary S&T is based on two fallacious assumptions, such as (1) societies could be arranged into a system of hierarchy in which the core values would be essentially derived from the dominant value orientations of technologically advanced societies. Here the cultural superiority is combined with political superiority. (2) S&T in traditional societies is identified primarily through their abstract principles, calculi of abstractions, and models and not with their concrete manifestations of realities. As a result, development of S&T in the traditional societies was compared with that of developed societies where the indicators were different and too lofty to be achieved. Thus it is a fallacy grounded on wrong models of comparison. Of the two assumptions, if the first one is based on the 'culturological fallacy', the second one is based on 'fallacy of over-abstraction' (Singh, 1977: 137). Therefore, S&T in the then traditional societies and in today's developing societies have not been able to contribute significantly, neither for the upliftment of the poor masses nor towards development of the S&T itself.

The structural form of present day scientific and technological revolution in the developing societies is characterized by two important features such as, *contemporaneity* and *contradiction*, says Yogendra Singh (1977: 141). Contemporaneity is more a cultural reality which refers to a new value orientation that corresponds to attitudinal modernity (present orientation dominates over past, belief in the possibility of transforming life chances over fatalism, etc). Whereas contradictions are the structural ones engendered by the S&T modernization in India.

***(i) Artificial Elitism in science*:** The structural contradiction of the scientific and technological revolution lies in the linking of S&T in developing societies to that in the highly developed ones. This contradiction in fact refers to the biggest form of inequality as S&T in developing countries remained to be dependent. Owing to the historical dependence of scientists and scientific institutions on their counterparts in the developed nations right from the colonial period the roles of scientists and scientific institutions in developing societies in improving the life chances of their people tend to be marginalized. Their goals and aspirations are alienated from the fundamental needs of production and innovation in their own societies. Their underdevelopment as well as their artificial linkage to the scientific institutions and scientific communities of the developed countries thwarted their capacity to invest in their indigenous R&D activities. These scientists being placed in the developing societies tend to do research in the areas of S&T that are of interest to the developed societies. The compelling reason to do so is to win grants/awards/prizes and recognitions from the developed countries that have attached rewards to those frontier areas of S&T that are relevant to them only.

This also resulted in artificial elitism among scientists in developing societies. Thus, far from playing a meaningful role in improving the life chances of the teeming millions of their societies, S&T in newly developing countries have alienated themselves from the needs of the masses. {However, S&T in India have been some what different in this regard, particularly in selected areas like, transportation, telecommunication, information technology and the like that have reached out to the poor too.} At the time of independence India's capacity for higher education was small and was catering to the needs of the middle and the upper middle classes only. Hence in a sense it was elitist. But with the growing democratic decentralization and socialist impetus of the policy, higher education became mass-based, of course at the expense of serious quality measures. This gave rise to proliferation of universities and institutes of higher education in India. The class of Indian scientists, which manned these universities/institutes of higher education, had its origin in colonial India, proliferated in post-colonial India as the higher education did. In the year 2006, there were 354 universities (including 62 deemed universities). Of these 172 were conventional and universities (including 33 institutions for specialized studies in disciplines), 37 institutions provided education in agriculture (including forestry, diary, fisheries and veterinary science), 16 in health sciences, 38 in engineering and technology, 6 in law and journalism and 10 are open universities (AIU, 2006: XI). The scientists working in these universities/institutes make the academic scientific community of India.

(ii) Emergence of Big S&T: Further, a structural aspect of the scientific and technological revolution in India refers to the emergence of 'Big S&T' in Nehruvian Era of post independent phase. The roots of Big S&T in India could be traced back to the Nehruvian regime and belief of Nehru in then Soviet Socialism. Being impressed by the performance of the then soviet model Nehru had adopted for India several features of Soviet model of economic development like, centralized 5yr plans, infrastructure building by the state, promotion of state capitalism through creation of large PSUs, Policy of self-reliance and import substitution in S&T etc. Emerged from these the Big S&T in India and flourished under the socialistic thrust of subsequent regime in the 1970s. A few broad features of Big S&T in India could be articulated as follows:

(i) Big budgetary provisions (mostly through Five year plans / master plans) and massive expenditures met by the federal government (including non-plan expenditures): A cursory look at the India's federal expenditures on S&T (DST data base) from the 1550s to mid 1970s reveals the preponderance of a few large S&T agencies in budget allocations, like

those of, Dept. of Atomic Energy (AEC), Defence Research and Development Organizations (DRDO), Council of Scientific and Industrial Research (CSIR), Indian Council of Agricultural Research (ICAR), Department of Space (ISRO).

(ii) Organizing S&T by founding big S&T organizations with large manpower and bureaucratic structures: e. g. ICAR, DAE/AEC, DOS/ISRO, DRDO, CSIR, ICMR etc. These are centrally funded and regulated S&T organizations and their agenda were politically determined.

(iii) S&T development through central plans of action: e. g. *Atom for peace*, *Green Revolution*, *Satellite programmes for education*, *Operation Flood* (revolution in milk production), Flood control measures (through Flood Commission of India), etc. Similarly the other feature was building big scientific and technological projects like, several large multi purpose river valley projects, e. g. DVC, Hirakud, Bhakra Nangal, Nagarjun Sagar, etc and large technological and industrial enterprises like, SAIL (consisting of five large Steel plants like those at, Durgapur, Bhilai, Rourkela, Bokaro and Burnpur), ONGC, HAL, NTPC, RCF, BHEL, BEL etc.

(iv) Big S&T were essentially dependent upon the state support: These could not grow without the state support (through funding) and protection (through policy measures). These grew under the protection umbrella of the state without competition both from within and outside the country.

(v) Being fully funded by the federal government, these Big S&T organizations were not open to evaluations from outside for their performances. These had set their own standards to evaluate themselves and the methods of evaluations were also devised by themselves. These could be possible alone under the then closed door political economy.

This may give rise to an epistemological question that probably unless organized in a very big scale the modern S&T could not have become cost effective and also could not have delivered the services/goods it was supposed to. And the other relevant question that emerges from the above articulations is that probably Big S&T is a feature of Socialism as Big science grew in the then USSR also and India had acquired some of the features of the then USSR. However the best example of big science was the then Soviet science and in today's context it is that of the Russian Academy of Sciences where fundamental research is carried out. In the context of Soviet science big science precisely meant a vast percentage of the budget used to be devoted to designing experiments and making experimentations. By nature it used to be fundamental, non-innovative and non-market oriented. This big science had been known for discoveries and theory building than for innovations and commercialization. The big science of USSR/ Russia is also over organized meaning very large in size and bureaucratic in structure. But my notion of Big S&T of India is fundamentally different from that of the USSR/Russia as these were never meant for fundamental research, rather were for innovations and commercialization or for attaining popular needs directly. Although created to do so but the big S&T in India under government funding and protection never became market oriented during the initial three decades (i. e. 1950s to 1970s).

However, in this context, the implications of the rise of big S&T in India was the loss of significance for academic S&T research. Because with the shifting attention and funds of the state to big S&T the academic S&T mostly based in the universities / academic institutes became redundant for national developmental purposes. Although Big S&T remained vastly unaccountable (e. g. the Light Combat Aircraft project of the HAL) but overshadowed the academic S&T research. Being kept away from the national purposes (developmental/ industrial) academic S&T research in India remained poorly funded and confined to their

academic interests only. Having survived as the poor cousin of Big S&T, academic S&T research in India of late has started interacting with industry for problem shooting and adaptive purposes only.

The logical corollary of the emergence of Big S&T and artificial elitism in science was the emergence of several Peoples' Science Movements (PSM) in India that aimed at taking science to people and forging the link between people and S&T directly. As an alternative to elite science, a group of enlightened and reformist (non-radical) scientists and engineers in Maharastra, in order to take science to people for enlightenment had launched a PSM organizations called *Marathi Vidnyan Parishad* way back in early 1960s. Even today *Marathi Vidnyan Parishad* pursues its goals in more organized manner even beyond Maharastra but among the *Marathi* speaking people. On the contrary, also in the early 1960s, with a view to demystifying science and linking people with S&T at grassroots level, there emerged a radical PSM in the southern state of Kerala spearheaded by the *Kerala Sashtra Sahitya Parishad* (KSSP). The PSM of KSSP was on its peak during the 1980s to 1990s and now in decline. Similarly, as the alternative to elite science, emerged the radical Science Teaching Programme of Hosangabad fame (HSTP) in the early 1970s by two voluntary organizations named *Kishore Bharati* and Friends Rural Centre. This programme was subsequently carried forward by *Eklavya* a radical PSM organization in Madhya Pradesh. And for an alternative to the Big S&T in India there emerged again a radical discursive movement of Appropriate Technology (based on E. F. Schumacher's *Small is Beautiful* thesis and Gandhian vision of small/alternate technologies like *Charkha*) resulting in the establishment of research centres like ASTRA at IISc Bangalore, CTARA at IIT Bombay, etc. Similarly another group of radical scientists and engineers consolidated their thinking and brought into existence the Peoples' Patriotic Science and Technology (PPST) Foundation at Madras and published a radical magazine named 'PPST Bulletin' to advocate for people centered/ ethno and indigenous S&T (local craft based technologies that once flourished in the history). This micro-movement virtually lasted for nearly two decades. In continuation with the radical thinking in S&T came into existence another PSM organization at Delhi known as the Delhi Science Forum (1978) which was again discursive in its activities, i. e. mainly to develop a viable criticism of S&T policy in India. Finally then emerged a more comprehensive all India PSM organization named the *Bharat Gyan Vigyan Samiti* (BGVS) in the late 1980s out of the *Bharat Jan Vigyan Jatha*. Although its leadership was rooted in KSSP and its radicalism, later was allured by the central government to lead its mass literacy mission. The BGVS leadership although maintains its popular-base and mobilization activities particularly for spreading literacy, has already lost its radical punch. Now it is a semi-government organization engaged in literacy and science popularization activities.

Lastly, another note worthy and natural corollary of the emergence of big S&T and elitism in S&T research in India was the emergence of an anti-science and anti-technology movement in India which was again discursive by nature. This movement involved only a handful of scholars and was a short lived one. The beginning of the anti-science movement in India could be traced back to the early 1980s. Because *'A Statement on Scientific Temper'* collectively issued by a good number of ruling scientists and intellectuals of the country lead by P. N. Haksar in the year 1981 provoked so much of criticisms and reactions for years that it became the most hotly pursued debate in independent India's public sphere. The scathing criticism of the statement came from Ashis Nandy (1981) as a 'Counter statement....' portraying the first statement as scientism devoid of humanism. Carrying forward the criticism of modern S&T thereafter came some books from Ashis Nandy (1988), Vandana Shiva (1988, 1991) Claude

Alvares (1994), and a few others that were essentially anti-science and anti-tech writings. Because along with the authors of his edited book, Nandy (1988) not only emphasized the violent and hegemonic nature of modern S&T but also argued for a pluralistic version of science making legitimate claims for alternative sciences (ethno) and small/appropriate technologies. And subsequently Shiva (1988 and 1991) and Alvares (1994) attacked the anti-developmental thrust and anti-ecological foundation of modern S&T to portray it as a patriarchal/male enterprise. However this fervor did not last long and died down by the mid 1990s.

(iii) The stratification within Academic S&T: But this vast body of Indian academic scientific community is not undifferentiated and not a homogenous one. As the reflection of the larger social order this community is also a stratified one. The stratification among the scientists exists in term of their research output and subsequent recognition that further earns them huge grants, students, infrastructure, etc, to strengthen their professional standing. Following the notable study of Diana Crane (1965: 699–714) among American scientists where she pointed out the existence of a system of stratification in terms of their productivity and recognition (i. e. major and minor university departments), Cole and Cole (1967: 377–390), Gaston (1970: 718–732), Cole (1979: 353–394), etc did acquire similar results in their respective samples. Pattnaik in his study among Indian academic scientists (2001: 62–95; 2003: 189–220) has also found the prevalence of a system of stratification in terms of productivity and recognition. His study not only verified the prevalence of "Mathew Effect" and the 'accumulative advantage hypothesis' in the Indian sample but also pointed out the prevalent 'Elitism in Indian Scientific Community'. His categorization of university departments into major and minor (like that of Diana Crane) was highly justified. Further, Pattnaik's findings (2001: 61–93) on highly skewed research output in terms of quality and creativity makes the prevalence of stratification among Indian academic scientists more obvious a phenomenon.

Based on the sampling and empirical findings of Pattnaik's study (2001 and 2003) the Indian academic scientists in major departments could be identified as those in elite national scientific and technological institutions like Tata Institute of Fundamental Research (TIFR), Indian Institute of Science Bangalore (IISc.), All India Institute of Medical Sciences (AIIMS), Post-Graduate Institutes in Medical Research (PGIs), Indian Institutes of Technology (IITs), Indian Statistical Institutes (ISIs), Harischandra Research Institute (HRI), Bose Institute of Physics, etc. These scientists in major departments are highly productive both in terms of quantity and quality research output and receive much more awards/honours and recognitions compared to their cousins in the poor state universities. Because one hardly requires any official data source backing to observe that the most prestigious scientific and technological research awards of India like the Swarn Jayanti Award, Shanti Swarup Bhatnagar Award, INSA Award, the Young Scientist Award, etc. are mostly cornered by scientists of these national institutes. The class differences in output maintained by the major departments are indicative of their similar class differences maintained in terms of their input variables like infrastructure, research environment, prestige of the graduate school (Alma Mater) of the scientist, motivation level among scientists, reward system in the organization, etc. against the minor departments in the universities.

(iv) Import substituted Industrialization and technological dependence: To explicate further the contradictions of the modernization of S&T, it may be worth noting that the rich world of the north has only a quarter of the world population, but it has not only nearly 90 per cent

of the world's scientists but also 90 per cent of the world's MNCs and it spends 95 per cent of the total funds devoted to R&D. It dominates trade and patent systems and hence technology of the world. Therefore, the contradiction also implies that the overwhelming proportions of industrial technologies in developing countries are imported from the developed countries. Such technologies in the beginning of the import regime did not help in producing commodities for the requirements of the masses and those of particular qualities which might improve the living standards of the masses. Imported technologies in most developing countries of South Asia, Africa, Latin and South America (otherwise known as the South) have been successfully used for the production of 'high quality' goods' to meet the needs of high income groups and the middle class. This contradiction basically emanated from the social structure of these countries. For, most of these countries were at some point of time colonies of one or the other developed countries of today. As the colonial situation led to the formation of the upper and middle classes in these countries, these classes continued to find their cultural role models in the western living style and mode of consumption. The preponderance of middle and upper class interests in the bureaucratic and policy-making bodies of developing countries has distorted the industrial and S&T policy in its favour to sustain their consumption pattern which is essentially western and thus developed. Hence, imported technology in developing countries met if not those of the masses, but the needs of the upper and middle classes and added to their better quality of living. Hence the policy of Import Substituted Industrialization (ISI) was pursued. This of course remained to be the trend till the 1970s. The policies of self-reliance and import substitutions remained in the peak during the 1960s and 1970s. India's policy of self-reliance in 1960s was the reflection of the nationalistic fervor / Swadeshi movement and later the socialistic inclinations of Indian political economy. The policy of ISI was partly caused by the above stated structural requirements of Indian society and partly caused by the adaptive lessons learnt from the then Latin American economic crisis.

However, the problem did not end here, with these disparities between classes. As part of the ongoing process, import of technologies to the developing world from the developed ones engenders a set of other but related problems of a serious nature for the developing countries, such as: capital crisis/balance of payment crisis on account of monopoly pricing of technology and raw materials, transfer of inappropriate technology in term of capital and labour intensity, transfer of obsolete technology which may not be economically viable and mostly environmentally hazardous, energy crisis and distortion of the priorities in production and investments in developing countries.

India in early 1950s had started industrializing with the policy of open door economy and MNC led industrialization but by mid-1960s India had switched over to closed door policy with MRTP and other restrictions with import substituted industrialization. Under world capitalism where the developed and developing countries are related in terms of centre and periphery, technology had not only become a mode of domination but also means of exploitation. Because technology transfer from developed to the developing countries took place within a political structure of dominance and compliance.

Indian industries like those in other the then third world countries were fleeced by the MNCs of the West, as huge volume of money flew back to their parent companies, because of: (1) high lump sum license fees, (2) high rate of royalty, (3) repetitive collaborations, (4) high spare parts cost, training and consultancy fees and (5) several prohibitive clauses imposed by the MNCs in the agreements. Very little or virtually no export of industrial products (mostly because of denial of export rights) did not allow Indian firms any industrial in-

novation and compensatory income in foreign currencies. In-house R&D existed for name sake in large industries but was vastly adaptative by nature and not innovative. Thus the net result of Indian industrialization then (till 1980s) was technological dependence (Stewart, 1977). But it is noteworthy that this dependent industrialization in the beginning had given rise to the new class of skilled industrial workers and the new class of industrial professionals/ managers for the first time in post independent India.

Much has been written about the problems associated with the transfer of technology to Indian firms from foreign ones and the inbuilt problems of in-house R&D. Noteworthy among those were by: M. Bell and Scott Kemmis (1985), Subramanium K. K. (1972), Balasubramanian (1973), Parthasarathy A. (1977 and 1979) Desai A. V. (1982, 1988) Katrak Homi (1985, 1989), Kumar Nagesh (1994), Pattnaik (1999) and Kher M. (2001). To counter the misgivings of this process for industrial development the panacea was to come from the policy of import-substitution. Indian in-house R&D took off as a reflection of this policy and consequently developed a pattern of being only highly adaptative and not innovative. Whatever be it, in-house R&D in Indian industry was mostly confined to large firms. Several studies have pointed out this phenomenon of Indian industry that there existed a positive correlation between 'firm-size' and 'R&D intensity', e. g. Sherer, (1980 and 1984), Sanjay Lall (1980), Siddhartha (1987), A. V. Desai (1980), Homi Katrak (1984), Mohan Pillai (1979), etc. Thus in terms of in-house R&D output, may it be adaptational or low-end technical innovation, it is the R&D scientists of large firms which stood a class apart compared to those in the other. Conspicuous among the large Indian firms were the in-house R&D of large PSUs like BHEL, BEL, ITI Ltd., HMT Ltd. and now in the post liberalized economy in-house R&D of the large private sector firms like, L&T Ltd, Titan Industries Ltd, TELCO, Reliance Industries Ltd, Dr Reddy's Lab, etc have been distinctly innovative (Bownder and Richardson, 2000). And still conspicuous in-house R&D were those of certain identified industrial sectors like, Drugs and pharmaceutical, Chemicals, Automobiles & Electronics. But the most conspicuous in this sense have been the Indian software sector during the last two decades.

Owing to the policy of self-reliance and import-substitution, industrialization in India during the Nehruvian regime had tried to counter the process of technological dependence and established a chain of more than 40 industrial research laboratories under the CSIR. But these laboratories in those years functioned more like government departments without any accountability and promises to deliver. These had virtually no productive research output to benefit the people. The commercialization rate of their technology was very low and in the subsequent stage, their rate of failure was also very high. And they continued to be fully government funded.

As part of the same process of modernization of S&T, this was also the time when in support of the policy of self-reliance and import-substitution India created several scientific departments like Department of Science and Technology (DST), Department of Atomic Energy (DAE), Department of Telecommunications (DOT), Department of Electronics (DOE), Department of Oceanography (DOO), Defense Research and Development Organization (DRDO) etc. under the central government and good number of large semi-autonomous R&D bodies like the Bhabha Atomic Research Centre (BARC), Atomic Energy Commission (AEC), Indian Space research Organization (ISRO), Indian Council of Agricultural Research (ICAR), Indian Council of Medical Research (ICMR), etc with central funding. The departments manned by highly qualified technical manpower only regulated government policies and funding. On the contrary, the latter as R&D organizations were

engaged in more of developmental works and less of research works. As these are all government funded bureaucratic organizations and bulk of their works are developmental and often strategic by nature, no study has yet successfully been conducted to point out any form of elitism/stratification that existed among their scientists.

Thus the process of modernization of S&T in India created a new sub-class, i. e. part of the great Indian middle class intelligentsia: the Indian scientific community consisting of (1) Academic scientists of universities/academic institutes, (2) Scientists in the Government departments/semi-autonomous S&T agencies and the CSIR labs, and (3) Industrial scientists and engineers in the R&D units (both in public and private sectors).

(B) Green Revolution induced by technology intensive agriculture (During 1960–1970s):

In this context I am to show how the Green Revolution (GR) was necessarily paradoxical. On one hand it offered technology as a substitute to both nature and politics, in the creation of abundance and peace. On the other hand, the modern technology itself (being resource intensive) demanded more intensive natural resource use along with intensive external inputs and involved a restructuring of the way power was distributed in society. While treating nature (organic farming) and politics (agrarian politics) as dispensable elements in agricultural transformation the GR created major changes in ecosystems and agrarian social structures. GR supposed not only new relationships between science and agriculture, but also introduced new links between the state and the cultivators, between international interests and local communities within the framework of the agrarian society.

While peasant movements in the then third world societies tried to restructure agrarian relationships through recovery of land rights, the GR tried to restructure social relationships by separating issues of agricultural productivity from issues of justice. GR technology comes to the 3rd world essentially to depoliticize the agrarian societies from Left-wing agrarian politics. As it was in Latin America, (e. g. Mexico) so was it in the East and the South East Asia. When the Chinese Communist Party came to power it encouraged peasants' associations to seize land, cancel debts and redistribute wealth. Peasant unrests in other Asian countries like India, Philippines, Indonesia, Vietnam, Malaysia, etc. flared up. The new political authorities in these Asian countries had to find means to control the agrarian unrest and stabilize rural political situations.

The Capitalism responded immediately. In order to arrest the expansion of Red Chinese influence and to defuse the communist appeal the new Asian Governments were invited to join the British American sponsored Colombo Plan in 1952. It explicitly set out to improve conditions of rural Asia by defusing growing left wing agrarian politics. Rural development associated by foreign capital was accepted by these countries to stabilize their country-sides. So American agencies like Rockefeller Foundation, Ford Foundation, US aid, the World Bank, etc. mobilized themselves for a new era of political intervention in the then third world countries. Hence while GR was clearly political in recognizing agricultural systems, the concern for political issues such as participation and equity were consciously by passed and were replaced by the political concern for stability. It was projected that the miracle seeds of GR were the seeds of plenty, will create material abundance and reduce agrarian conflicts in rural India.

Having said about the politics of GR, now we have to bring out the stark realities of GR what it gave rise to. As I noted in the beginning of this section, GR has been a paradoxical phenomenon. Although it aimed at depoliticizing the agrarian societies by reducing the agrarian conflicts of particular type in the long run it has given rise to new type of politics and conflicts e. g. the thirsty seeds of GR created demand for intensive irrigation. And the intensive irrigation of GR Technology consumed huge quantities of water for irrigation. This irrigation has consumed both surface water as well as ground water. As a result it created problems of water logging and salinity. Scarcity of canal water for irrigation has also created regional political tension, e. g. among states of Punjab, Haryana, and Rajasthan, among the states of Karnataka, Andhra Pradesh and Tamilnadu. This also encouraged creation of centralized use of water as well as power and there-by demand for the creation of large Dams. With increasing demand for water, as Dams grew old, the decreasing storage capacity caused intensive conflict for water.

To be more explicit about the kind of social inequality that the GR technology produced in India, one has to start looking at the social consequences of the 1950s India's Community Development Programme (CDP). The CDP was launched in India with the active financial, administrative and technical guidance of the Ford Foundation and the Technical Cooperation Mission of the US government. The CDP ran for more than a decade but failed to make any impact on production. As pointed out by A. R. Desai (1969: 611–622) and the Government of India's, own Programme Evaluation Organization Report (GOI 1957) unequivocally stated that whatever benefits accrued by the CDP, went to the rural elites to the exclusion of the lower-caste cultivators, landless and the backward castes. In addition it was found that the CDP gave an opportunity for the land owning elite to further strengthen its positions of authority as the programme was administered through them and expected to percolate to the masses.

In the second phase of this American aid programme, came the real technical inputs from the USA. The foundation of research in agricultural sciences in India was led in the pattern of Land Grant Institutions of USA. The total agriculture aid to India involved Ford and the Rockefeller Foundations and the US Agency for Industrial Development (USAID). The aid package was directed towards: (1) Establishment of agricultural universities in India, (2) Crop improvement through "miracle seeds", (3) Supply of Fertilizers and Pesticides, (4) Provisions for American technical expertise, (5) Training of Indians in American agricultural universities, and (6) Soil testing and other related programmes out of the PL.480 funds (Naik and Sankaram, 1972). In the early 1960 came the Integrated Agricultural Development Programme with heavy capital intensive and mechanized agriculture particularly in the areas of assured irrigation. By end of 1960s the productivity level had gone up dramatically. The Bumper crop of 1970–1972 was attributed to the blessings of the weather gods and not the 'miracle seeds'. The Green Revolution had arrived; India attained self sufficiency in food production. But finally the role of HYVs/miracle seeds was recognized in the context of wheat growing regions only.

A mid term review of the net outcomes of and impact of GR on Indian country side was attempted by Centre for the Study of Social Change 1974, and it was asserted that the GR technology had a rich peasant bias and hence had disproportionately benefited the rich peasantry. The second review was attempted in 1973 by the London based Halslemer Declaration Group (HDG) and it also assailed the rich peasant bias of the GR technology because the government facilitated institutionalized subsidies like, cheap irrigation, cheap credit and other facilities that were relatively more accessible to the big farmers.

Although based on the study of Bhalla and Chadha (1983), D. N. Dhanagare (2001, 330–352) tried to point out that the small and marginal farmers in Punjab did not lack motivation, dynamism, initiatives and entrepreneurial abilities by showing an equal rate of productivity to that of rich peasants then. He concluded that, these abilities neither did help them substantially nor did it reduce the growing inequalities.

Even in a micro level-longitudinal study of two villages from Mandya district of Karnataka (1955 and 1970) Scarlet Epstein (1978) has pointed out the growing agrarian disparities, as the upper caste based big farmers (Lingayats) were the largest beneficiaries of the GR technology and infrastructure. Epstein categorically pointed out how the rural cooperatives then were serving the wealthy farmers. Thus, as it looked then, the GR technology worked in a socio-economic framework which was already unequal or highly stratified. The GR technology introduced then could not benefit all sections of the rural society equally. Lastly a more decisive study came from Dandekar and Rath (1971: 70) concluding that the process of rural development during the decade of 1960s has benefited the upper-middle and the richest section than the lower-middle and the poorest sections of rural India. The broader constraints that came on the way of an equalitarian growth in rural India were the following:

1. Capital intensive character of the GR technology: The GR technology was not scale-neutral in terms of productivity. Hence its capital intensive nature made it favourable to that section of the peasantry which could afford and mobilize the resources.

2. A study conducted by the Reserve Bank of India in 1967–1968 among small farmers pointed out that institutional credit facilities were not adequately available to them as they were available to big farmers. Even the credit cooperatives were cornered by the big farmers. And the small farmers relied mostly on private money lenders who on the contrary were notorious for fleecing the small farmers.

3. The other major constrain which went against the interest of the small tenant farmers was the prevailing land tenurial system. Even the 4th five year plan document of Planning Commission of India noted the same that the insecurity of informal tenants and the prevalent share cropping practices not merely impeded the widespread adoption of GR technology but in some cases also led to social and agrarian tensions.

4. The other important constraint was the GOI's policy for food grain prices. This also went in favour of the big farmers. The Agricultural Prices Commission of India (1968: 10; 1972: 3) also have noted this. Since the new technology was expensive, the price offered by the government to buy wheats and cereals had to be high enough to make the adoption of the new technology profitable. So the high procurement prices of the government also benefited the big farmers.

5. An additional constraint in the way of the small and marginal farmers' acceptance of the new technology had been the eating habits of the rural masses of India. The eating habits favoured the traditional varieties and often for domestic consumption small and marginal farmer preferred to cultivate the traditional varieties in a traditional pattern of cultivation.

Even in a more recent study reported by Mohanty (1999: 56) based on the Satara district of Maharashtra, pointed out that owing to the growing capitalist agricultural practices in agriculture (sugarcane cultivation) there has been a steady decline of cultivators and steady rise of agricultural labourer in the district between 1961–1991. This is a strong indication of depeasantization caused by modernization of agriculture. The paper also pointed out that the modernization of agriculture here has immensely benefited the big farmers (1999: 59).

With the emergence of capitalist farmers and capital intensive agriculture there came into existence mechanization of farming. The modernization of farm technology might have

been beneficial to the rich peasantry but it becoming highly injurious for the agricultural workers of India. The effects of mechanization as reported by Dhanagare (2001: 341) were visible in the form of 5000 deaths in India resulting from machinery accidents by 1978. In early 1980s it was reported that every year more than 300 farm workers used to be incapacitated during wheat harvesting in Punjab alone. There were large number cases of loss of limb reported among farm workers during the harvesting season in north Indian states. Agricultural works in these areas have been rendered even more injurious by increasing use of poisonous sprays/pesticides for plant protection. Poisoning out of pesticide sprays is not confined to India alone; rather it is a noticeable phenomenon for all the Asian/Latin American countries who adopted the GR technology. Victims of such poisoning were invariably the agricultural labourers. But there seems to be an absence of any legal protection or compensation provision for farm labourers in case of such health hazards and accidents.

Added to these were the observations of Oommen (1975: 175) that owing to the growing penetration by capitalist agriculture into countryside, the process of depeasantization has been accelerated and consequently large numbers of small and marginal farmers or poor peasants have been pushed to the ranks of landless labourers. Further as reported by Bhalla (1976) when capitalist farming came into existence the average demand for labour dropped down to 25.6 mandays. In certain prosperous parts of Haryana, the GR resulted in the replacement of traditional paternalistic relationship between big farmers and their workers by formal contracts. But in most other parts of country the household attached labourers were simply thrown out of work or being converted into casual labourers noted Gough (1977). Further because of mechanization of agriculture the vast migrating labour force from Bihar, UP, Bengal lost their bargaining power.

Then came the IRDP, NREP, etc the poverty alleviation programmes carrying forward the GR technology in the 1970s and early 80s. Although Hanumantha Rao's observation (1985) based on the NSS data noted that these poverty alleviation programmes have succeeded in bringing about appreciable decline in the proportion of rural population below poverty line, their performance is far less impressive for the SCs and STs, the traditionally weaker sections. Similarly A. K. Bagchi in (1982: 77) noted that although for nearly two decades the GR measures have been experimented by the Indian states, in most parts, the GR has failed to raise the incomes of rural poor appreciably and to contribute substantially to their effective purchasing power. Even the ILO 1977 report says that the real earnings of agricultural labourers and poor peasants have been lower in early 1970s, compared to 1960–1961 in several Indian states like U.P., Punjab, Bihar and Tamil Nadu.

Thus, the GR technology along with other factors had handsomely contributed toward the class formation in rural India.

It would not be inappropriate here to make a reference to recent controversy involving the use of Biotechnology based seeds named Bt. Cotton for farming and the suicide of farmers in large numbers particularly in Andhra Pradesh and Maharastra, Gujarat, Karnataka. Anti-sci, anti-tech activists and scholars have been crying foul not only against Bt-Cotton but also against Monsanto the bio-tech MNC and biotechnology itself. Bt-Cotton project in India is said, to be a 'Scientific-Fraud' conducted by Monsanto Mahyco. Some said 'Bt-Cotton technology Belies Promises'. The GM seeds and its MNC are directly blamed for the large number of suicides of small and marginal farmers committed in last couple of years. But the summary of several empirical studies conducted among the cotton farmers of AP, Maharastra and Karnataka revealed that the immediate causes of farmers' suicide were, (1) growing indebtedness to the money lender-cum-traders, (2) adverse

pricing, (3) competitive market situation, (4) low yields and (5) growing costs of cotton cultivation. But the antecedent causes of the suicide were consecutive crop failure/low yields and growing costs of cultivation. The antecedent causes are related to the promises of the Bt-Cotton and its MNC Monsanto Mahyco as it implies failure of the biotechnology based seeds. Apart from the large number of suicides by farmers, what is relevant for us here is the other implication of crop failure and peasant's indebtedness. This other implication is equally serious. Because apart from the large number of farmers who killed themselves there is good number of small and marginal cotton farmers who because of crop failure and indebtedness have now lost their lands as well as livelihood leading to their depeasantization and conversion into daily wage labourers (Kameswara Rao, 2006, Sharma A. B., 2002; ISIS press Release, 2005).

Of course attributing very low yields, high costs of seeds, high costs of pesticides and other technical inputs to failure of the biotechnology is in fact heavily contested by the MNC and it is not conclusively established by the experts either. As the same technology works fine as per its promise in USA and other western countries it should be working fine in India too provided its specification are met. Even if we agree with the antecedent cause of peasants' suicide and their loss of land holdings, there are other complex factors that have come into light too, i. e. (i) the promises made were not that of Monsanto but that of the marketing company of Indonesia named Mahyco, (ii) only around 9 % of the GM cotton seeds sold in India were legal under Bt-Cotton name, the rests, particularly those sold as 'Navbharat Seeds', and others were illegal, (iii) that the Bt-Cotton seeds were hurriedly introduced to Indian market without sufficient step-by-step field trials before full scale commercialization.

Thus the Bt-Cotton fraud lies elsewhere not in the technology, may be in a rogue marketing agency like Mahyco which made false promises or may be in the illegal seeds sent to market that were adulterated and rendered spurious, etc. Therefore, state governments in India have not banned Monsanto seeds so far. On the contrary area under its coverage in the country has multiplied. Now Bt cotton in India has much more acres of land under its seeds than before.

(C) S&T based Development as Triage (during 1980s and onward):

The other way in which S&T affect the social structure directly is through the developmental process. As I have already stated, the modern notion of development is considered to be scientific as it is an offshoot of scientific planning. Thus it is legitimized by science. At the same time development involves extensive use of intensive scientific and technological know-how.

On the contrary, modern S&T have become more desirable today because they have made development possible. The two provide mutual reinforcement of each other. As S&T are responsible for the difference between traditional and the new status in human living that development promised to offer, S&T encouraged a specific development strategy. And modern S&T essentially refer to a particular kind of resource utilization pattern and subsequently a kind of life style which is identified to be typical to modern development process. Thus development has come to be synonymous with better quality of life. Since development is assumed to be an universalization of western economics tradition, western style of consumption and living are considered necessarily to be better quality of life.

Development through industrialization or other scientific projects in an area will cause underdevelopment elsewhere as it happened in the case of Europe. Becoming developed involves the cost of others who are underdeveloped. There is a constant flow of resources from the traditional sector to the modern sector. The resource demands of the development process are often satisfied by diverting resources away from survival needs and life support functions. Therefore, the growth and productivity of the modern has to coexist with the poverty and backwardness of the traditional.

The effort to produce even a limited western style 'development' had to be executed against the survival capacities of millions who would insist on remaining outside the system. Such development would be premised on undermining both their life styles and rights to resource. Thus development inevitably became officially sponsored triage (Alvares, 1992; 7).

Also growth of one sector within a society would cause underdevelopment in other related sectors. Thus, with the growth of machine based industrialization not only crafts were lost or were eliminated in the colonies, but we also witnessed the transfer of all but the primitive jobs to the cities. Much of the rural resources/and products also were lost to the lust of the urban population. Examples of this kind are not in short supply. Development comes hand in hand with displacement. Some insightful examples would not be far fetched, such as: the replacement of mother's milk by baby food fed through bottles, replacement of Indian 'gur' (*jaggery*) by modern white sugar and the like, although value of food content in the former over the latter is much higher. The other meaning of displacement is much more important and lies very much in the context of development. It refers to the displacement of the tribals /natives from their natural habitats by the introduction of modern scientific developmental projects in the naturally rich interior areas. Some of the micro-protest movements that India witnessed during the last two decades are in fact protest against various types of development projects causing **large scale displacement** of rural/tribal populations. Many of these movements have been marred by violence. Some of these micro movements could be identified as, Save the *Gandhamardan* Hills (against the mining project of Balco in Orissa), the *Narmada Banchao Andolan* (against the river valley project on Narmada river spread in Madhya Pradesh, Gujarat, and Maharastra), Koel-Karo protest movement around Ranchi against the hydro- power project (in Jharkhand), Protest against Kaiga Nuclear plant in the Western Ghats, *Tehri Dam Andolan* (against a hydro-power project in Garhawal), *Chilika Banchao Andolan* (by fishermen against commercial Shrimp firming project of Tatas in the Chilika Lake of Orissa), *Baliapal Ghati Pratirodh Andolan* (against the National Missile Test Range in Orissa), *Kashipur and Lanjigarh* protest movement (against the mining projects of mining corporations like Utkal Alumina.../ Hindalco and Vedanta respectively in Orissa) and now the Nandigram Protest Movement (against the SEZ based Chemical industry hub) in West Bengal. The history of displacement in independent India starting from Damodar Valley Corporation (DVC), Hirakud dam, etc have been agonizing. A large section rural and forest dwelling communities have been economically sacrificed in the name of developmental projects (in the absence of an effective Rehabilitation and Resettlement policy).

Thus, 'development has meant nothing more or less that the displacement of one set of ideas, peoples, cultures, processes and realities and their substitution with another set designed by modern S&T' (Alvares, 1992: 69). Therefore a developing society within itself also remained divided as scientific and the non-scientific. This is a great divide indeed and S&T forms the basis of this dual society.

S&T as the active partners of development process have contributed largely towards the current environmental crisis which has two dimensions: one is the ecology destruction and the other is the environmental pollution. It hardly needs to be emphasized that in both the cases the poorer sections in developing countries are invariably adversely affected to the extent of loosing livelihoods and being vulnerable to hazards of pollution.

The colonial domination systematically transformed the common vital resources into commodities for generating profits and industrial growth in the West. The access of European industries to the natural resources of South Asia and other colonies, to a large extent, supported the first industrial revolution. But with the collapse of the international colonial structure and the emergence of sovereign countries, this international conflict over natural resources took a different turn but continued to prevail. Because the resource use pattern in the West continued as it is typical to the western type of development. Today the conflict over natural resources has given rise to social protests and tensions in the developing world.

Vandana Shiva (1998: 1991) has analyzed with clarity, how 'ecology destruction is an obvious cost for economic development, through the extensive use of modern technology, as it is the magic wand that transforms the natural resources into forms of luxurious consumer articles in the super market'. When S&T were used by contemporary societies to enhance men's access to natural resources these also allowed the utilization of natural resources at extremely high rates. Matched by the resource utilization tradition of development, modern technology is highly resource intensive and wasteful too. To prove the wastefulness of modern technology Shiva (1991: 38) explains how in the Solvay process for the production of soda ash, only 40 per cent of the raw material (that is sodium chloride and lime stone) is really utilized and 60 per cent of it goes as waste which pollute land and water resources. These resource intensive technologies operate from the industrial enclaves with enormous amounts of various natural resources extracted from diverse ecosystems that are usually far away. This long, indirect and spatially spread process of resource transfer made possible by energy intensive transportation, leaves invisible the real material demands of the technological processes of the development (Shiva, 1991: 33). The benefits of economic development do not percolate down to the poor, but the impact of development on the poor is the loss of their resource base meant for survival.

The unfortunate part of the development process is that it has given rise to a cult of consumerism which is highly destructive of the environment. Those who have access to all the fruits of S&T have been the conspicuous consumers. These are the consumers of the technologically developed societies of the West and the higher income groups of the developing societies. Imagine the situation of a western consumer, whose beef and fruits come from Latin America and Africa, peanuts from West Africa, coffee from East Africa, tea from India, prawns from the Asia-Pacific, timber from Asia, Africa and South America at throw away prices in hard currencies. Modern S&T are used by the rich and the powerful not only to dispossess the poor of his survival resource base, but also to undermine subtly the confidence of the poor in their own resources and resource use patterns. A classic example of this could be the hypocritical attitude of modern medical professionals towards herbal medicines, when majority of drugs in the U.S. market today are, derived from plants or plant based raw materials. Drug firms do take great care to screen the pharmacological properties of herbs. Pharmaceutical firms try to identify the active ingredient and the chemical analogue of every new found herb. This is manufactured, packaged, marketed and prescribed by the medical profession. Yet medical practitioners dismiss herbal medicine as outright

quackery when not packaged by pharmaceutical firms and even do not study the medical system based on it. Neither do drug companies make any effort to promote herbs directly.

Being resource intensive by nature and being the active partners of development process modern S&T have destroyed various ecosystems of the world by intervening in the processes of nature. Following Carolin Merchant, Vandana Shiva (1988: 22), and others have found the eco-destruction capacity of science to be inherent in its epistemology as modern science is said to be reductionist. It is reductionist because first, it reduces the capacity of nature to creatively regenerate and renew itself to its manipulable potentiality and secondly because it sees all systems as made up of some basic constituents that are discrete and atomistic. Further, it assumes that all basic processes are mechanical. Nature and society have been socially reconstituted by mechanistic metaphors, in contrast to the organistic metaphor in which concepts of natural order and power are based on inter-connectedness and reciprocity. The mechanistic metaphor of nature is based on the assumption of its separability from man and separability as well as manipulability of its parts. The epistemological assumption of reductionism is related to its ontological assumption 'that allows the knowledge of the parts of a system to be taken as knowledge of the whole and separability allows context free abstractions of knowledge to create criteria of validity on alienation and non-participation, then projected as objectivity (Shiva, 1988: 22).

Similarly, natural resources are treated as isolated, non-interacting collection of individual resources. They acquire value only in the context of the marketability not otherwise. Only those properties of a resource system are taken into account which generates profits through exploitation and extraction; properties which stabilize ecological processes but are commercially non-exploitative are ignored and eventually destroyed even though they are functional to the ecology at large. Hence the view that reduces the nature to its parts, and takes no account of the relationship between parts and structure and function of the whole system, is reductionist. Nature is to be understood as a cyclical process that renews itself and thereby functions as a life-generating mechanism. Further, it is to be recognized as a life-supporting system. Mankind has to benefit from the natural processes only in maintaining them, not in violating them. Nature is to be understood as a living ecological system and not as a mere embodiment of discrete facts, detached from their eco-systems, as resources in the context of market. Feminists scholars like Shiva (1988) have articulated how Indian women, who are still embedded in nature, are the worst affected lots in the ecological destruction. Modern science has a philosophical foundation which is anti-ecological too. The genealogy of modern science can be traced to the tracts of Francis Bacon, James Hobbes and Rene Descartes. Bacon is the father of industrial science who founded the experimental and utilitarian tradition of modern science. Bacon viewed science to be the means to acquire control over the environment. In Baconian philosophy nature almost appeared to be an awesome foe to be tamed and tortured to yield its secrets. Hence nature must be made a 'slave' and bound into service, 'put into constraints', or nature must be subjugated, 'coaxed, vexed, and tortured'. It has to be 'moulded' by the mechanical arts. This is a major attack directed against nature. Similarly Bacon's scientific knowledge and mechanical inventions do not merely 'exert a gentle pressure over nature's course; they have the power to conquer and subdue it and shake it to its foundations'.

But the mechanistic philosophy of Descartes (for details, see Merchant, 1982: 234) sounded the death knell of naturalistic philosophy. Apparently a proper understanding of nature particularly of eco-systems is hindered by the very nature of mechanistic world view and reductionist method. These also made possible the human manipulation and control of nature. And finally, Hobbes the individualist political philosopher forged the

link between science and political power and thereby clasped science to legitimate domination. Therefore, today in the given economic order of unequals, S&T have rendered the real owners of the natural resources, the non-owners, dependent and subordinate and have also molested nature through developmental projects.

We may go back to the initial issue of science, technology and environment crisis within the development process. The second dimension of the environmental crisis is environment pollution which is too obvious to be discussed at length. Within developing countries the developed sector, meaning the industrial sector, pollutes land, air and water indiscriminately by its fuel emissions as well as by the toxic industrial wastes. No less polluting are the modern means of transportion on land, air and water. S&T have extended the arms of the developed countries so far that even dangerous industrial wastes from these developed world are dumped in the territories of the developing world.

The tragedy caused by Bhopal-based Union Carbide's gas leak (that killed more than 10,000 and physically impaired 86,000 people) in 1984 is a familiar example of the violence inflicted by modern technology. The case of Bhopal gas tragedy can be pushed aside as a unique accident but such tragedies of lesser magnitude occur every now and then. Claude Alvares (1992: 19–29) has reported the cases of acute environmental hazard caused by modern industries in remote villages of India (such as: The Kabini Paper Mill in *Nanjangud* subdivision of Karnataka, the tanneries of North Arcot district in Tamil Nadu, the Orient Paper Mills at *Amlai* in Madhya Pradesh, the industries of Patanchurur and Bollaram industrial estates of Andhra Pradesh). Where the villagers are not only exposed to dangerous toxic industrial wastes but also many of their lands are rendered almost useless depriving the farmers of their livelihood (e. g. frequent ash pond leaks 1998 & 2001, from CPP of NALCO, Angul plant has degraded large tracks of cultivable land of farmers). However, examples of this kind are fast becoming everyday matters.

(D) Information and Communication Technology (ICT) Revolution in India (1990s onward):

In a recent study conducted by Deepak Kumar (2006: 90–96) in an MP village named Nagda about the social change a government funded IT project called *Gyandoot* has brought about. The author based on his empirical data points out the kinds of services the villagers get from this Gyandoot project. (Under which the village is provided with computers with LAN facility and an operator in an information centre called Soochanalay). The most beneficial and noteworthy services the villagers received from this project on payment of a token fee could be the following:

1. Information on Mandi prices of various agricultural products in all near by cities that enables the peasants escape the middle man and get more profit,
2. Information/documents about Land Records / Maps and ownership certificates to enable acquire loans/ have a sale,
3. Online registration of applications for obtaining income, caste, and domicile certificates including the loan passbook,
4. Public grievances redressal by lodging several complaints about teacher's absence, mid-day meal, pump disorder, disbursement of poor quality seeds / fertilizers and government employee related matters like, their PF sanction, pension, etc,

5. Getting school Board and Inter Board examination results on line right in the village itself by rural based pupils,

6. Getting online Transfer list and orders for state govt. employees,

7. Facility for auction (Gram Haat) of land, agricultural machinery / equipment, bullocks and other domestic commodities,

8. Access of villagers to a matrimonial alliance site, exclusively created for the villagers to help them find the right match for themselves or for their wards, and

9. Educational Queries *(Sawali Ram)* to promote inquisitiveness among children.

This impact of *Gyandoot* project articulated by the author seems to be like a fairy tale that Indian villagers have the world of information and the whole administration on their finger tips. Nevertheless, this may be an idealized and exaggerated state of affair but this could be the trend of state of things to come. This may not be the volume but the kind changes that are awaiting. This is empowerment of the masses through information. But these are not social structural changes to be called as social change. What structural implications these have are yet to be articulated.

Subsequently the author (2006, 133–160) analyzed the digital divide in the village in terms of use of the (*Soochanalay*) information centre for getting necessary information through the computer-LAN facility. The findings are as per the expected line, for, it was found that users are predominantly higher caste people, who have high school and to some extent college education and also these are the people who are the landed lot (comparatively). The dominant sections of these users are the rural based/rooted school teachers and state government employees. There are small evidences of village poor (SC and ST population) being benefited by the *Soochanalay* but this is too meager a number. Thus ICT in the village Nagda of MP strengthened and reinforced the existing social divisions and old social order, concludes Deepak Kumar (2006). These findings are very much in conformity with my general assertion that S&T are value neutral and by themselves do not create inequalities. But when used in an already existing stratified frame work it would proportionately benefit the different strata.

In continuation with my argument in the line of S&T and social stratification, I am to examine further some visible social impacts within the IT turned ICT revolution in India.

The rise of Indian IT and software industry during the 1990s has been the most spectacular achievement of Indian Industry. This industry grew at an incredible rate of 50 % per annum during the whole of the 1990s. Being export oriented it has earned 75 % of its revenue from exports alone. This industry in the year 2007 had nearly 1 630 000 and in the year 2008 had nearly 2 000 000 employees. The IT revolution in India has not only given rise to new class of transnational capitalist, but also, more significantly, a new class of workers/professionals that is fully knowledge-based.

Emergent New class of transnational Capitalists: It is now well known that a new class of entrepreneurs have emerged out of the IT revolution in India. As noted by Upadhya (2004, 5143–5145) in her study of Indian software industry, most of the founders of software firms (SMEs) in India had middle class origin who had built on their cultural capital of higher education (usually through engineering education) and acquired social capital (knowledge and business networks) through their professional careers. Their social capital enabled them to make use of the trust and cooperation of their professional networks, for making innovative business advancements, because their social capital could reduce the

transaction costs, bureaucratic procedures and even corruption. Thus the combined virtue of cultural and social capital engendered a class technological capitalist in Indian IT sector. This class of capitalists is not only driven by high need achievement orientation but also high level of technological innovations. They could ride innovation driven business that has flattened the technological world, at least in the IT sector to a great extent. This class of IT capitalist is also distinguished by its global linkages. Not only that many of them had studied / worked in the USA /abroad but also their business were, (i) greatly dependent upon foreign contracts (particularly US) and (ii) most of them acquired foreign funding either directly or through foreign Venture capitals (which were mostly from USA, particularly the Silicon valley). This class of entrepreneurs is distinct from the traditional Indian capitalist class (Seth Jis leading family business) and corporate houses like Ambanis, Bajaj, Birlas, Godrej, Goenkas Kirloskar, Singhanias, Tatas, etc.). These are also first generation entrepreneurs. As the offshoot of liberalization of the Indian policies and globalization of the economy this bourgeoisie is more adaptable to MNCs. Instead of being wary of the presence of the multinationals in the IT sector, this class could find a synergy with MNCs and have learnt to benefit from their presence. Therefore, this class, first being the offshoot and later being part of the transnational IT business is the strongest votary of globalization. By virtue of creating enormous employment and profit this industry has influenced Indian economic and industrial policies greatly during the last two decades. Upadhya (2004) calls them the 'icons of the resurgent India'.

Emergent New Class of elite Workforce: This transnational entrepreneurial class has emerged in tandem with a transnational labour regime which has generated a new class of IT workforce in India.

In this context of IT workforce extremely pertinent are the notions of '**techno-coolie'** and '**cyber-coolie'**. These derogatory terms refer to a new class of elite 'knowledge workers', emerging out of the global out-sourcing of services. Emergence of this workforce is not confined to India alone, rather is spread over several other developing and even developed countries like China, Singapore, Taiwan, Hong Kong, Philippines and Israel. Hence both the words refer to knowledge workers not merely that of India but to all such workers of countries who have become part of the international out-sourcing services. But India has a giant share in this.

Techno Coolie*:* Software engineers or other IT professionals otherwise known as techies, of developing countries are seen as a new knowledge workforce that caters to the global informational economy. The workforce is highly flexible and mobile. These IT professionals called as *Techno-coolie* are mostly employed in the US, UK and other European countries like Germany, Belgium, Netherland etc or even many of them who are employed in home countries travel abroad very frequently for 'onsite' delivery of their services. 'These are essentially immigrants may be Indians, Chinese, Philippinos or Hispanic, engaged in low-end technical jobs. *Techno coolies* are also a grossly under paid lot. The geographically dispersed nature of the software outsourcing business makes physical mobility as one aspect of the migration. The developed form of ICTs even enabled part of the services to be delivered 'virtually'. Software engineers even located in home countries, along with colleagues and mangers spread over distant geographical locations work as 'virtual teams' to communicate among themselves and deliver to the customer abroad through computer networks. In this connection they make short foreign visits too. Usually a techno coolies are hired through

a practice called as '*body shopping'* from the developing countries because of the international subcontracting practices followed by large corporations in these developed countries to keep their costs low

Migration of techies from India to Europe although started in late 1980, it became significant in late 1990s, particularly due to 'Y2K' crisis. The important routes of this migration from India by the techies were three. The first one was through an arrangement called 'Body Shopping' by which Indian techies were sent on short contracts to work on the customer's site abroad. (2) The other arrangement was through outsourcing by American/European firms through Indian software service providers who had a team of techies working on the project at home and another team working onsite at the customer's venue abroad. Earlier TCS, Infosys, HCL etc. large IT firms were engaged in Body shopping and had offices both in India and US/Europe. (3) The third arrangement was migration through the Indian subsidiaries of European MNCs like, Philips, R. Bosc, Siemens, etc.

1. Through Body shopping: This arrangement was not so encouraging for the Indian techies as they were engaged on the customer's site on low-end maintenance jobs with low salaries. Their employment conditions, compensations and nature of contract are determined by consultants (Indian agencies) and their works were managed by the customers. The techies were usually on a contract with the consultant company to be paid on hourly rate other than the travel accommodation and maintenance allowances. The duration of the stay abroad is specified in the contract. Usually the techie cannot break the contract with the consultant for greener pasture abroad as they had to pay back heavily. The Indian consultants were basically subcontractors suppose to provide mere 'bodies'/engineers with specifications to the MNCs.

2. Through Outsourcing companies: Those techies travelling abroad by outsourcing arrangements through Indian service providers like TCS, HCL etc. usually have their base jobs in India but are sent abroad to the client's site for a certain period. They are managed by their Indian service providing agency and not the client; mostly they get the Indian salary, with extra money for Europe/USA. The techies could make good money out of this but again carried onerous contracts or bonds with Indian agency not to join the job of the client or anybody in the client's country. Further on return they were bound to work with the Indian agency for a few years, and the like. Violation of the bond invites a hefty fine that may drive the techies bankrupt.

3. Through MNC subsidiaries: A good number of Indian engineers go abroad to work through their parent subsidiary companies of US/European MNCs like Oracle, Philips, Robert Bosc etc. These are employees of the MNC subsidiaries in India called software development centres and are in fact better placed compared to the earlier two mechanisms. They go on short/ long term assignments and are comfortably placed abroad, as employees of the subsidiaries they are provided with housing, good working conditions, allowances, etc. Even they have to make little or fewer adjustments in terms of work culture, etc. Often they are housed with employees of parent MNCs in block apartments abroad.

4. The other category of mechanism for the techies was to get employed directly by US/European companies leaving the Indian agencies' contractual arrangements behind. Although most of them had come under 'body shopping' arrangements for onsite delivery, but have shifted away. Their salary and employment conditions are better than first three types.

Apart from predicaments related to mode of recruitments, these Indian techies are marred by prohibitive immigration laws and regulations. It is well known that for Indian techies, obtaining visas, work permits and residence permits for European countries is much

harder than for the USA. Upadhya (2006) in her study among Indian techies in Netherlands, Germany and Belgium have tried to analyze their plight in terms of work culture differences, as victims of European stereotypes about Indian techies, culturally embedded communication patterns, poor time management, inability to adapt to multiculturalism of virtual teams and dim career prospects in Europe . These apart, these techies are to 'negotiate the quagmire of immigration laws and rules (which are often humiliating) to maintain themselves in Europe and have to chew the common images of immigrant workers, diluted with racism, held by local people. They too struggle for an identity of a professional/knowledge worker as different from unskilled working class immigrants (from other small poor countries). As if these were not enough the Indian techies have to withstand the anti-outsourcing sentiments in Europe and USA and a consequent fear of loss of job. Their isolation and social seclusion add to their owes.

Thus the Indian techie struggles hard not only to acquire the European work culture, multiculturalism, etc but also engages himself in a reconstruction of his identity and self to relate to a foreign society.

Cyber Coolie: Today the word *cyber coolie* refers to that growing workforce which comes under the IT Enabled Services (ITES) like, call centers, medical transcription and business process outsourcing. This workforce emerged out of the policy of 'off shore outsourcing' of services followed mainly by a few developed countries like the USA, UK and Japan. European powers like France and Germany do but their scales of outsourcing of services are very limited. And India being an English speaking country is favourably placed to be at the receiving end of this international outsourcing of services from USA and UK. Like the *Techno coolies* the *Cyber coolies* are also grossly under paid. When a 'cyber coolie' delivers his off-shore services through internet being present in his home country the 'techno coolie' delivers his services abroad right on the cite of the client being present there.

These low paid technical workers are hired from developing countries to do low-end, low intensity software jobs. They are employed on a contractual basis only. Even most of the BPO jobs are out sourced from developing countries as part of the policy of international subcontracting by large MNCs. If the large MNCs in the manufacturing sector outsourced their processed raw materials, components and even some times semi finished products from developing countries in the 1970s and 1980s, by shifting their manufacturing units from these leading industrial countries to developing countries, in the 1990s and 21st century the large corporations in the service sector in those industrial countries are outsourcing their services by low cost manpower from the developing countries. This is the consequence of the growing competition among MNCs in the developed countries and their efforts to reduce costs.

The word 'coolie' (whether *techno-coolie or cyber-coolie*) has certainly a contemptuous meaning and is used in a derogatory sense. Coolie, ***aka,*** a poor fellow, dressed in red, scurrying after us carrying our heavy luggage on his head as we board a train, all for a few pennies. It is indeed difficult to trace the exact origin of the word cyber-coolie/techno-coolie. But certainly the word was coined by the Indian left wing intellectuals who have been against free trade. It is also true that the leftist have been trying to trade unionize this growing work force which the work force itself has not entertained. Hence, this contemptuous attribution. The other source of the word 'cyber-coolie' is the British critics of the phenomenon who are yet to free themselves from the 'Raj' hangover. British economy today being more a service economy deals more with financing, banking and insurance than with

manufacturing. Hence it needs 'back up services' in these areas which they outsource from its ex-colony, India which is also English speaking. And this is also true that Unionists in Britain do consider these outsourced low-end jobs by Indians as job snatching. Therefore, this envious contempt.

These knowledge-workers emerging as a distinct occupational category in India is of very recent origin, may be a consequence of India's globalization. As a distinct occupational category it has certain characteristic features and it is fast developing a subculture for itself. Most of my formulations here are based on information/publications in the internet. I also borrow the findings of a study conducted by Babu P. Ramesh (2004, 492–493) on BPO workers of India. The empirical study was conducted among a sample of 277 customcare agents from six call centers of BPO companies in Noida, Delhi capital region. The BPO industry in India alone currently employs little more than 500000 так? according to NASSCOM (2007) (BPO industry includes the employees of the call centers who work over phones and business process offices who work over webs). (See, Appendix Table. II for data on India IT industry employees)

These knowledge workers are all young, educated and convented Indians who work in call centers and outsourced business processing offices to cater to American and British multinationals. They work through the nights, for good reasons that night in India is day time for their clients in USA. Since they work through the nights Harish Trivedi (2004: 1) even calls them a *"Chowkidar*" a derogatory word meaning night guard. They work through cyber phones and cyber webs to deal with their overseas clients. They speak in an American accent which they have painfully cultivated. As their Indian accent is neutralized, their personality, biological clock and identity also have been neutralized. Because they conceal their real names and country of residence while dealing with the clients. Often they have to introduce themselves as Pete/Greg/Jane from Atlanta/Ohio etc. Thus they are faceless workers with pretentious identities who deal with invisible customers/clients located on the other side of the globe.

Many of these BPO workers not only work for very long hours but also at odd hours. Many find that they have little social life left, as they work in nights when their families and friends are at homes. Some develop long term sleep disorders, some take so much verbal abuse, day after day, from irate and racist Americans that they actually need psychological help which now some call centers, have learnt to provide for (see appendix Table-II for Indian BPO Stress factor).

These young people are the scions of middle class urban parents, mostly graduates, computer savvy and educated in convents or public schools from where they have acquired a fluency in English and some times possess a technical or science degrees but all of them long for an exposure to western popular culture. This work force in spite of its long hours of work, even in odd hours, also works in the weekends. But this is a grossly under paid lot. This is why India is seen as an outsourcing threat. The cost of an Indian BPO employee is seven to ten times lesser than his American counter part in ITES business. True that, there exists a large pool of English speaking low-skilled manpower in India. And this makes India a western corporate attraction. The key is low wages.

The organizational structure of call centers is basically dualistic, consisting of a core/permanent set of employees and the periphery/temporary workers. All call centers agents are periphery workers, who are substitutable, while team leaders and managers make the core group. The long term career prospects there now are bleak or virtually non-existent. The dualistic work force model allows the firm to regulate the work force and nip in bud

any sign of trade unionism. Trade union is a strange word for this work force. The labour practices that call centers follow are even much older. Because work is monitored on the spot and even after working hours with the help of specially designed software, computer network and closed circuit cameras. All interactions of these employees in office are continuously recorded or taped and randomly checked by the manager. The most of surveillance recorded at work is even comparable with situations of 19th century prisons.

Mistakes at work lead to immediate warnings and those are recorded in 'warning cards' that form part of the daily ratings of agents. If an agent commits three errors in a day he/she gets a zero rating. Three consecutive zeros lead to counseling or even dismissal. Availing leave without prior notice/consent is considered unauthorized and could be reason for termination. So the call centers by and large practice a hire and fire policy. As it seems, there is no modicum of Labour Law in this sector. Thus the service conditions of this work force are very poor. But on the contrary its working conditions are extremely congenial and much superior to those in the manufacturing sector. Their office premises are very clean and fully air conditioned. They are provided with free meals, free transport (car pick-up and drop), regular staff entertainment, a concierge service that will book cinema tickets for them, an ambulance waiting at the bottom of the building if they are fallen ill, etc. Apart from less challenging jobs like telesales and customer services they do render more challenging services by providing value added 'back office' support in the area of banking and insurance too. The monotony of work and stringent service conditions are camouflaged by the projection of 'work as fun' — by introducing cafes, popcorn booths, Ping-Pong tables, internet kiosks, gym, clinic, etc into the office areas. In this comforting working environment, quotas for calls or emails are successfully attended. Besides, this particular working environment, a reasonably good salary (Rs. 10,000/ to 20,000/– 25,000/ per month), use of latest technologies, young and educated peers, all make these knowledge workers believe that the job they are doing is of an executive/professional.

That apart, this is a highly disciplined work force. And because of its education and predominantly middle class origin this turned out to be a docile work force with high level of efficiency. But unfortunately this highly productively docile work force is bereft of labour rights and job security. As a distinct and new occupational category this workforce is fast developing a sub-culture of itself. The English they write is of a different variety more of American spoken English type (with abbreviated forms of expressions) like the nature and the types of products they market or products they do value addition. They represent a subculture that emphasizes traits like, ***low cost***, ***instant satisfaction***, ***use and throw away, take it or forget it, minimum-quality assured, etc.*** Even they cherish the Mull Culture (Food, entertainment and shopping all in one building) because of their night duties.

It is precisely because of their perceptions of being professionals that holds back these elite knowledge workers from forming trade unions. Left wing politics in India has been desperately trying to penetrate its trade unionism into this sector for last several years. Another important reason why these workers are disinterested with trade unionism is that they do not intend to continue in this job for a long time, rather they consider this to be a stepping stone to migrate or shift the job. This kind of job perception by the ambitious young work force obviously finds the notion of unionism incompatible with itself.

A few internet based articles on 'cyber-coolie' by Harish Trivedi (2004), Prafulla Bidwai (2003), and Ranabir Ray Choudhury (2003) etc. have provoked strong reactions from among this work force. A frustrated Narayan Ram Hegde of Union Network International (a global alliance of 900 unions) when miserably failed in his effort to induct very few of the

knowledge workers into their trade union framework, noted that 'these young people have a negative image about unions. But they are more like cyber-coolies. Hopefully they will be convinced over time'. The debate has certainly created some hit in the net.

These young and educated workers claimed themselves to be 'cool professionals' against the attribution of being cyber-coolies. In the debate they too displayed their contempt for left wing trade unionists. Here are some of their responses:

> "Cyber-Coolies, the term trade unionists and leftist types use condescendingly to describe outsourcing professionals only reveal their contempt for the dignity of labour. And for those claiming to represent the cause of labour that is already a major disqualification".

> "The cyber-coolies argument is a load of crap, plain and simple. Working conditions as a rule are already better than what exists in other offices… Further most of the top software/BPO companies have a very good feedback system in place. Hence what is the need to go on strike, or have a bunch of gangsters speak on your behalf, when you can always just quit and join a competitor? At this point it is an employee's market, not employers and software companies are aware of it. The amount of begging my boss did in an attempt to prevent me from leaving to go do my MBA was almost shameful. There is no difference between unionists and a bunch of gangsters…" (TTG on Sept. 26th 05, at 13:09).

> "The left wing intellectuals who coined the term cyber-coolie were certainly not keen on free trade. But they do not mind selling their silly novels and social analysis of Indian society in western market but have an issue with people making a decent living while performing support work for MNCs. It is widely known what unions have done to slow down economic reforms keeping India in perpetual under performance mode for the past decades. This is just another step in trying to curb the fast growing BPO market" (Chandra Dulam on Sept. 27, 05 at 00:50 hrs.).

> "First of all a 'cyber-coolie' has a job and puts food on the table, so that ain't a bad thing. Secondly, he actually works (gasps!), something that the union idiots have never done their entire live…" (Guru on Oct. 2nd, 2005, at 14:50 hrs.) (The Acron, 2005)

In a website entitled 'Dancing with Dogs: Interesting debate' (Aug. 18. 2004) carrying this debate one finds some of these cool young professionals loosing their cool. Not only they did heavy left bashing but also literally lead a counter offensive against these left wing Indian intellectuals for their contemptuous writings.

Even a popular columnist like Gurucharan Das noted that 'Trivedi's depictions are truly bizarre. What he sees as exploitation by MNCs, the young people on the contrary see it as an exciting chance to make a career in global economy... The minds of these 'cyber-coolies' seem to be de-colonized whereas poor Trivedi is stuck in a post-colonial past'.

Thus there exists a perceptual difference between those of the left wing intellectuals and those of the elite knowledge workers. Of course there prevail an ambiguity with regard to the objective conditions of work of these knowledge workers. The objective conditions that are goading an intellectual to perceive the knowledge workers as 'coolies' are countered by another set of objective conditions that go in favour of the agents perception of themselves as 'Cool professionals'. May be it is a new class of elite technical workforce which by its objective conditions make a class in itself, but in order to make a class for itself it need to possess

a subjective consciousness of their being so. Thus an objective class is yet to be matched by a subjective consciousness or an objective class is yet to be converted into a subjective class. Therefore unless and until a class in itself becomes a class for itself, it would be difficult to treat them as cyber coolies. As in the early stage of industrialization the sociological problems of industrial workers were, inadequate wages, long hours of work (bringing surplus value), poor work environment, job insecurity, etc and in a later stage the same got changed to alienation (loss of skill and self), technologically deterministic human behavior, industrial accidents / health hazards, unionization, participatory management and the like, with the advent of post industrial society (part of the economy is knowledge based) the sociological perception of the problems of the knowledge based workers is bound to be different as the very nature of work has undergone change. This new sub-class of new technical work force is an off-shoot of the India's recent IT revolution which is still evolving fast. As slowly these new elite workers are coming under the fold of trade unions, their service conditions and salaries are improving. BPO as a phenomenon in India is going to stay, it is not a very transitory phenomenon. Rather it is fast expanding and once stabilized as a feature of Indian economy the career prospects in BPO industry are going to be brighter like that of their prosperous cousins in the software sector. It must be kept in mind that this Indian workforce is today envied in the USA and UK as job snatchers.

But the more enviable job snatchers are another new budding class of highly paid employees engaged in the knowledge based outsourcing industry of India. These are today known as KPO (Knowledge Process Outsourcing) professionals. These are true professionals like graduate engineers (in areas of CAD, Biotech./Pharma.), MBAs, Charted Accountants, Economists, etc. They are engaged in off-shoring knowledge intensive business processes that require specialized domain expertise. Their jobs involve high-end processes like, computer aided simulations, valuation research and analysis, data integration, investment research, patent filing, legal/insurance claims, and management consulting etc. KPO industry may be export oriented like the BPO. But unlike the BPO industry that mainly provides the IT enabled services, the KPO provides domain based processes and business expertise that are more challenging and requires professional as well as technical expertise on the part of employees. The KPO industry in India has slowly grown to reach an export value estimated to be $12 billion by the end of year 2010 (UNI, 2005). This industry is making use of the vast pool of highly qualified but un/under employed Indian manpower. This too is a new and growing sub-class of Indian professionals emergent of the IT revolution.

Conclusion

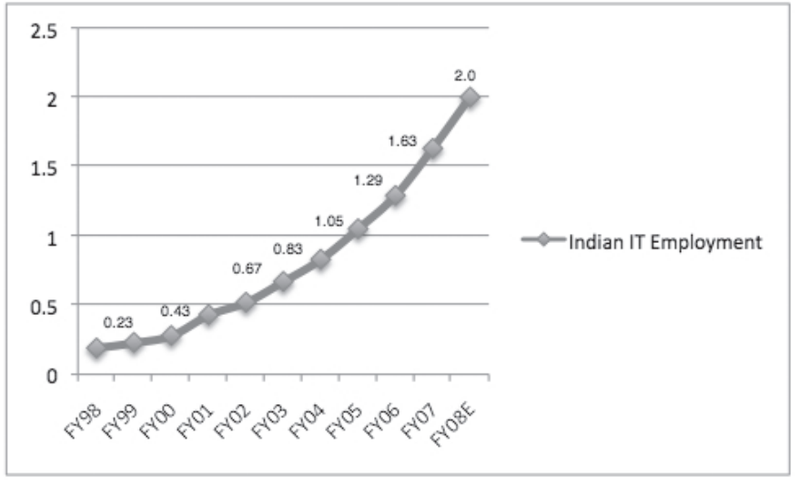
While talking about the class character of early science, eminent historian of science J. D. Bernal has noted that 'even 5000 years ago the identification of science with governing and exploiting classes had engendered deep suspicion about the role of science in the minds of peasants and the working of classes' (1969: 49). And Bernal had made it clear with examples (1969: 553) that it has been the operations of middle class interest that have again and again held up the advancement of science. On the contrary, it is the successful applications of S&T in war and the profitable applications in manufacturing business by bourgeoisie that have been the criteria for technical advances' (1969: 1246). 'The existence of class divided societies not only affect the material consequences of knowledge, it cuts deep into its roots...

It is in its basic philosophy that class influences have most affected science' (1969: 1247). Thus Bernal hinted this to be more of an epistemological problem.

True that S&T grew in the world of highly unequals. In modern nation states, being dependent upon the politics and the economy, S&T worked as an active partner of the two, devoid its autonomy and its inherent democratic and egalitarian values (Merton's), to be more used as a tool/instrument of change and profit. Particularly in the context of developing countries the role of S&T becomes less effective, unlike it is in the developed countries, because in a traditional society like India, the social structure had been more rigidly divided and inequality was already deep rooted. The access to S&T was and still remains to be unequal because the infrastructure/means required to use S&T is even more unevenly accessible. Hence the benefits of S&T reached proportionately to each class depending upon its place in the social strata. Thus S&T sided more with the developed section in a developing country who in turn used it to perpetuate their advantages by depriving the underdeveloped sections.

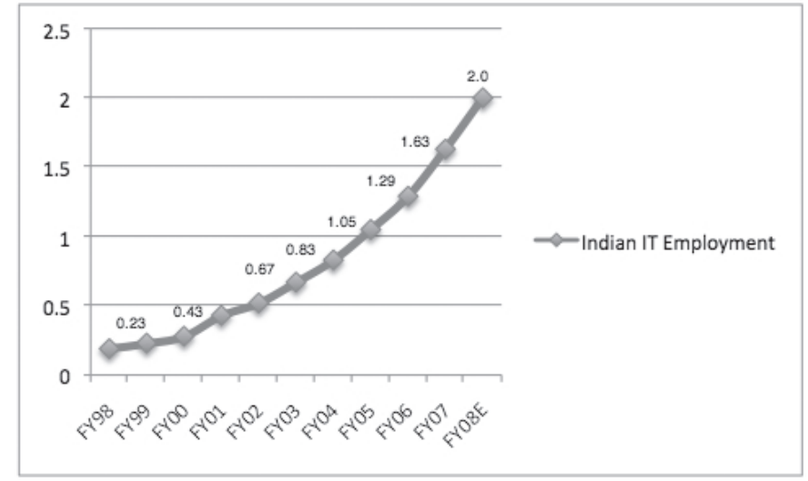
Hence in view of acquiring a more equitable effect of S&T relevant becomes the issue of reviving the indigenous (traditional) S&T and even the notion of appropriate technology or alternate technology that was hotly debated in the recent past. Reviving the issue of traditional S&T does not necessarily mean resurrecting the fossils. Their sustainability are in fact beyond doubt, if backed by supportive policy measures. Because as plural traditions (non-monistic) the traditional S&T are historically rooted in their respective societies and are more community based to be more equally accessible to the laities. Modern S&T need not be the panacea for all the societies even if it happened to be the case in the West.

Table I
Indian IT Employment Figures-ITES-BPO Sector*
(in Millions)



**Figures do not include employees in the hardware sector.*
(Source: Indian IT/ITES Industry: Impacting Economy and Society, 2007–2008, p. 18. NASSCOM)

Table II
Indian IT Employment Figures-ITES-BPO Sector*
(in Millions)



**Figures do not include employees in the hardware sector.*
(Source: Indian IT/ITES Industry: Impacting Economy and Society, 2007–2008, p. 18. NASSCOM)

Appendix

Table I
Indian IT Employment Figures-ITES-BPO Sector

Sector	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007E**
IT Services	215000	297000	398000	555,000
ITES-BPO	216000	316000	415000	553,000
Engineering Services and R&D and Software Products	81000	93000	115000	140,000
Domestic Market (including user organizations)	318000	352000	365000	378,000
TOTAL*	**830000**	**1058000**	**1293000**	**1630000**

**Figures do not include employees in the hardware sector.*
(Source: Indian IT Industry — Fact Sheet, NASSCOM, 2006–2007 updated)

Table II
Stress: Indian BPO Industry Stress Factors

(Source: BPO Employee Survey 2004; DATAQUEST)

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Problems of technology transfer from CSIR laboratories to industry and policy issues in India and Korea

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This paper is an attempt to review the development of indigenous technology in India and Korea over the last forty years. It identifies the problems of technology transfer that the Indian national laboratories are facing. Indian technology does not have strong linkages with the industry with the result the utilization of the research is limited. Protection to domestic industry has been given so long that India could not catch up advances abroad. Whereas Korea made tremendous progress over the years because of its target oriented export policy. Korea became world leader in Semiconductor and left India far behind. On the other hand for India situation became worst after sudden liberalization during 1991 when the import of technology became liberal and indigenous technology had to compete with the mighty multinationals. Some of the industries vanished from the market due to tough competition. This is the high time that India should drastically change her research priorities to face the liberalization. What is required, that India should concentrate on areas where it has build up capabilities and excellence over the years, like software industry in computers. Secondly India should establish strong linkages with the industry to make value additions in the imported technologies.

Keywords: science, technology, CSIR laboratories, National Development Research Corporation, technology transfer

1. Introduction

Achievement of self-reliance has been one of the declared goals of India's development plans. Since technology is basic to any process development, the self-reliance would not be complete without technological independence. This recognition has led to evolution of policies geared to strengthen local technological capability to ultimately achieve technological self-reliance. The industrial trade and fiscal policies pursued over the past four decades have contained policy instruments directly or indirectly concerning technological development. Besides these, the Scientific Policy Resolution, 1958[1], laying down the framework for development of infrastructure for technological development and the Technology Policy Statement of 1983[2], retreating the goal of technological self-reliance and providing a broad perspective and guidelines for the policy instruments have been enunciated.

The *modus operandi* of the technology policy thus evolved has been two pronged as in the case of industrial development in general. They have sought to provide to local technology/

[1] India is the first country in the world, which has passed the Scientific Policy Resolution by the Parliament under the leadership of the first Prime Minister of India Pt. Jawahar Lal Nehru.

[2] Technology Policy Statement was issued by the Department of Science and Technology in Jan. 1983. It emphasized the need to plan technical collaborations agreements in ways that would ensure effective transfer of basic knowledge.