

*Kunda Datar Lectures, 1989*

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**Technology Against Poverty or  
Poverty Through Technology ?**

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this small fraction is spent in just half a dozen developing countries.<sup>1/</sup> Industry and Government in US spent about \$ 100 billion per year in R & D while our total R & D expenditure in the entire VII Plan was about Rs. 14000 Crores, that is, about one tenth of that. Inevitably, the technology gap between the industrialised and the developing countries continues to widen. Indeed, even within the industrialised world, the two technological giants, the US and Japan have moved far ahead of the rest and in some fields of technology, especially electronics and computers, even the US finds itself lagging farther and farther behind Japan. Any talk of the developing world catching up with the industrialised countries in technology is, therefore, altogether fanciful. The former seems to be destined to remain technologically dependent on the latter and therefore vulnerable to domination and exploitation.

Technology, where it is not directed to military objectives, enables us to produce more of various commodities and services and also new gadgets and materials for us to consume. As more and newer things become available for consumption, the desire for still newer and more things grows. Thus, what is referred to as consumerism grows in society. A serious question arises whether beyond a certain point, this ever rising consumerism really makes life happier, healthier and richer for individuals and societies. This is a philosophical question which I do not propose to discuss here. But the question is not unimportant.

As in the international arena, within countries also, especially in the developing countries, grossly unequal access to and control of technology aggravates the already wide socio-economic disparities among different classes in society.

The end of World War II was the beginning of the end of colonialism based on military strength. However, the vast economic and technological inequalities and dependencies that had been a direct consequence of colonialism did not end with colonialism itself. The countries of the developing world are increasingly held hostage by the banks and industrial and trading giants of the industrial world, aided and abetted by international financing institutions. The economic and technological dominance of the industrialised countries is sought to be perpetuated by pressurising the developing countries to change their own patent laws and throw open their markets to the exports from industrial countries while they follow flagrantly protectionist policies at home. It is well known that currently there is a very large net transfer of financial resources under various heads from the developing to the industrial world and technology is an important instrument for effecting this transfer from the poor to the rich.

Damage to the environment by the unrestrained application of technology is now widely recognised. Deforestation, desertification, erosion, water-logging and degradation of soil, acid rain, pollution of water and air, damage to the ozone layer, the greenhouse effect, encroachment of arable land and so on are now recognised as posing serious hazards for the whole human race. Nuclear power, once viewed as a viable alternative to fossile fuels as an abundant source of energy, is also proving to be neither safe nor economical, the glib assertions of our own nuclear establishment notwithstanding. Ambitious projects to tame mighty rivers by the construction of huge dams, forming vast water reservoirs and generating power, are also found to be of doubtful

benefit when the huge costs in terms of destruction of valuable forest areas, inundation of arable land, rapid silting up of reservoirs and the uprooting and marginalisation of large and poor populations are set off against the claimed benefits.

Will it be possible for humanity to go on producing and consuming more and more on the strength of technology? This is a question which has been seriously debated for some time past. The Club of Rome, after an elaborate study published in the middle 70s as 'Limits of Growth' came up with the answer that growth of production and consumption cannot go on for ever but will be constrained by several unsurmountable factors. Later, the US Government sponsored study Global 2000 also drew a generally pessimistic picture of the future, at least so far as production of food and removal of hunger in the Third World is concerned. There are of course, other scholars who strenuously contest these pessimistic prognostications. This is not the occasion to go into that controversy nor do I have the competence to do so. But a question of more immediate relevance to the developing world is, can the underdeveloped countries by adopting modern technology ever achieve the levels of production and consumption approaching those of the industrial countries? I shall try to address myself to this question later in these lectures.

Development of S & T has now become an organised activity. Highly trained and talented scientists and technologists specialise in R & D in specific areas of S & T. Their entire careers are devoted to R & D and their professional progress, reputation and rewards as well as their personal fulfilment depend upon their achievements and successes in discovering and inventing new materials, products and processes and their applications. They tend to become a closed community largely insensitive to conditions and problems outside the areas of their specialisation. With this has arisen a new phenomenon: the Technological Imperative: Everything that can be made must be made.<sup>2/</sup> Only a step removed from this imperative is another imperative: Whatever someone else has made, we must also make.

Several instances can be cited about how inward looking the S & T community becomes. Dr. U. R. Rao, Chairman of the Indian Space Research Organisation (ISRO) declared some time ago that the cost-effectiveness of the Indian space programme 'has been proved by the rapid proliferation of TV stations...' What does one make of this remark in the context of the real needs of our people? He further stated elsewhere that although one of the satellites in the Insat 1 programme was a total failure and another was only half operational, '... we have not lost any money on them as they were insured.'<sup>3/</sup> Dr. Rao seems to believe that insurance itself comes free. Besides, even if the hardware of the satellite is insured, is the huge expenditure on the salaries of the scientists, technologists and lay personnel in ISRO who must have spend tens of thousands of person-hours in bringing the satellite to the launching stage and of the equipment in ISRO also insured? Was the foreign exchange paid to Fords who built the satellite hardware also insured as foreign exchange? Moreover, the insurer in this case was New India Assurance Company, a public sector organisation, who must have had to dish out a tidy sum even if it had reinsured the satellites with several other insurers. Further, after the insurance money is paid by the insurer, ISRO will have to pay lease charges to the insurer for the use of the surviving

payload of INSAT 1C which lost over 50 per cent of its capacity. 4/ Yet, Dr. Rao is happy that ISRO did not loose money in these cases.

To take another example, Dr. N. G. K. Menon, a distinguished scientist holding high policy-making positions in Government, declared some months ago that our country must raise its expenditure on R & D from the present 1.1 per cent of our GDP to 2 or 2.5 per cent in order to achieve rapid growth. A few months before that Dr. V. Gowariker, another distinguished scientist holding high position, had also declared that our R & D expenditure must be raised to 2.5 per cent of GDP in the 8th Plan and to 3 per cent by the year 2000. What is the sanctity of this magic figure of 2.5 per cent? It is because the advanced countries are spending roughly that proportion. Dr. Gowariker went so far as to assert that 2.5 per cent being spent on R & D is the 'trigger off' stage in development.5/ What kind of techno-economic calculus yields this figure of 2.5 per cent of GDP? And is 2.5 per cent of GDP in US, Japan, USSR or the Federal Republic of Germany the same order of R & D resources as the same percentage of GDP in China or India not to speak of Bangladesh or Sri Lanka? How, then, does the percentage of GDP spent by advanced countries on R & D become the norm for a poor developing country and even a 'trigger off' level, whatever that may mean. This quantum jump in our R & D expenditure will mean a diversion of an additional amount of the order of Rs. 3500 crores per year from other heads of expenditure. What kind of cost-benefit study has been made and how has the relative priority of different fields claiming resources been assessed before proposing this large diversion? Yet, according to reports, Government has accepted this proposal to more than double R & D expenditure in the 8th Plan as asked by these high-ranking scientists. The voices of those sectors which will loose these resources are evidently too feeble to be heard among policy-makers.

There is no question that what has been done in the field of space exploration by humankind in a little over three decades is breath-taking and represents a truly impressive achievement for scientists and technologists of all countries who have participated in development of space technology, especially those of US and USSR but also those of other countries including our own. They have demonstrated that things can be done which had hardly been deemed possible in the past. Various benefits are also claimed to accrue from the development of space technology, mainly in telecommunications, remote sensing and weather forecasting. Materials with special properties have also been developed for use in space vehicles. Exploration of outer space has also added significantly to our knowledge of the universe. This technology is also being used for espionage and although all countries strenuously deny this, possibly for military purposes as well. But even allowing for all these benefits, some of dubious value, how much has space technology contributed to human wellbeing either now or in the foreseeable future when viewed against the astronomical resources in money, materials and scientific and technical talent that have gone into it? Have the benefits for humanity as a whole been commensurate with the costs? The scientists and technologists seem to have been driven by the technological imperative of demonstrating that artificial satellites can be placed in orbit and that man can land on the moon. As feats of S & T, these achievements are great; viewed critically

in the context of real human needs, they are conspicuous instances of the operation of the technological imperative unless they are to be justified for their military potential.

It is even more questionable when a poor developing country like India launches on an ambitious space programme costing thousands of crores of rupees and the talents of perhaps a few hundred highly qualified scientists and technologists. Other countries have developed space technology, so we must also do it !

Again, all the usual benefits like weather forecasting, remote sensing and telecommunications are cited to justify India undertaking a major space programme at great cost. But a fair idea of the cost-benefit relationship of satellites can be had from recent experience of satellites in the US. "Scientists have looked at only 10 per cent of data collected by satellites and have closely analysed no more than one per cent."6/

"Notwithstanding falling costs of processing equipment, the price of remotely sensed data is increasing. Remotely sensed data is well beyond the reach of most Third World users."7/

Granting that some of the benefits coming from satellites are real and significant, was it necessary to send up our own satellite for the purpose ? Most countries of the world including many developed countries, are enjoying the benefits of weather forecasting, telecommunications and remote sensing without undertaking expensive space programmes themselves.

#### EMPLOYMENT AND TECHNOLOGY

An important dimension of technology is its impact on employment. For the purpose of our discussion, this dimension is of particular importance since widespread unemployment is an inseparable aspect of the problem of poverty whether in the developing or in the industrialised countries. The immediate effect of the introduction of advanced technology in industry, process or service is generally a rise in labour productivity and reduction in labour requirement for a given volume of output. Indeed, much of the on-going development of technology at any given time aims at saving labour and thereby reducing costs of production. That, of course, does not mean that advancing technology necessarily reduces total employment in society. Protagonists of technology view the relationship between technology and total employment as follows:

"By reducing costs of production and thereby lowering price of a particular good in a competitive market, technological change frequently leads to increase in output demand; greater output demand results in increased production which requires more labour, ~~offsetting~~ setting the employment impact of reduction in labour requirement per unit of output stemming from technological change. Even if a good whose production process has been transformed does not increase significantly, when its price is lowered, benefits still accrue because consumers can use the savings from these price reductions to purchase other goods and services. In the aggregate, therefore, employment often expands."8/

This view, however, is valid only if and when the rate of increase in output demand whether in the goods involved in a given technological change or in other goods and services resulting from reduced prices made possible by that change, is higher than the rate of displacement of labour, that is to say, the rate of increase in labour productivity due to that change. Thus, if due to a given technological change, labour productivity rises and as a result, labour requirement for a unit of output falls by a factor X and output demand rises by a factor Y, Y will need to be higher than X for total employment not to be adversely affected.

Clearly, this will not always be the case; quite often this is not the case. The labour saving potential of many technologies, especially the newer micro-processor and computer based technologies, is so high that it far outstrips any possible growth in output demand. The increase in labour productivity due to a given technological change is usually directly measurable. But the rate of growth of demand is a function of a complex of factors of which technology is only one. Hence, the rate of growth of demand due to a given technological change is not directly measurable. The assertion that technological change creates more jobs than it displaces and hence, has no adverse effect on total employment in the society, seems to be more a faith than a rigorously demonstrable proposition valid in all socio-economic situations at all times.

In view of the great importance of employment in the context of poverty, it would be worthwhile to take a look at the employment picture in a few countries during recent years. In Britain, total employment in all industries and services came down from about 22 million in June 1970, to about 20.8 million in June 1982, a drop of about 1.2 million. But total employment had actually risen during the decade 1970 to 1980 by some 362,000, but came down by 1.58 million between 1980 and 1982. During the decade of the 70s, the rise in employment was almost entirely in services like distributive trades, insurance, banking, finance and business services, professional and scientific services and miscellaneous services; but this growth in employment in these services came to a stop in 1980. In mining, manufacturing, construction, gas, electricity, water and transport and communications, employment dropped continuously from 1970 to 1982; manufacturing, construction and transport and communications losing about 3 million jobs during that period. True, the period covered by these figures was of a severe recession worldwide and specially in the industrialised countries and in the post-1982 period employment situation has shown a slight improvement. Yet, unemployment in Britain still persists at a high level of about 8 per cent of the total work force. The average annual growth rate of industrial production in Britain during the period 1981 to 1986 has been just 1.6 per cent and of the growth of GDP about 2 per cent, hardly enough to offset the labour displacement effect of advancing technology. Examining the effects of technological change on employment, Tim Brady and Sonia Liff, in an article significantly captioned 'Job Losses Now, Maybe Some Later', show that "... a common effect of the introduction of labour saving new technology has been to increase capacity, leading to a concentration of production. This could have serious implications for the number of firms that can survive and hence, for long term job opportunities." They noted that "automation in some of the large iron foundries has reached such a level that the labour force required is as little as a



tenth of that needed in foundries with more traditional forms of production." About industrial robots, their study showed that an average of 1.6 jobs per shift were displaced by each robot while jobs created in producing the robots themselves were estimated at 0.25 to 1.0 per robot over a period of eight years. Regarding the prospect of new jobs being created they comment that through schemes like 'science parks' which are being established in good numbers, "... there will be few jobs created in the short run and these will be high technology based and thus unlikely to provide many opportunities for skilled and unskilled people being made redundant from manufacturing. ... Overall, the number of jobs based on new technology may well increase as the firms grow, but it is likely to take a long time for these to offset the losses from traditional industries."9/

In almost all countries of Western Europe, unemployment has remained at a stubbornly high level inspite of diffusion of the most advanced technologies and access to world markets. The average rate of unemployment for all OECD countries from Europe was only 3.7 per cent in 1974 but rose to 11 per cent of the total labour force in 1985 and stood at 10.7 per cent in 1987. Even for West Germany and Japan, unemployment rates rose from 2.1 and 1.4 per cent respectively in 1974 to 7.9 and 2.8 per cent in 1987. It should be remembered that the populations of the European OECD countries and of Japan are more or less steady. They have considerable control over the markets of developing countries. Most of them have large armament industries and exports. In spite of all these favourable factors and the adoption of advanced technologies, unemployment in these countries has increased steeply and stays stubbornly at a high level. Their average growth rates since 1980 in GDP as well as in industrial output have also not been impressive, below 1.5 per cent per year in most cases. These high unemployment and low growth rates hardly support the proposition that technological advance results in higher output demand, higher production and hence, more jobs than are displaced by it.

The Committee on Science, Technology and Public Policy of the Academy of Sciences of the USA set up a Panel on Technology and Employment whose report was published last year. Emphasising the fact that total employment in the US has increased by several million and that inspite of the entry of the baby boom generation and women into the labour market, unemployment has not risen too much, the Panel recorded the finding that technological advance of the past several decades has not led to unemployment on any considerable scale. Far from it, the Panel asserts that technology has helped create many more jobs than it has displaced. According to figures given by the Panel, almost 70 per cent of the new jobs created during the period 1975-1985 were in wholesale/retail trade and in services. Very few of the additional jobs were in mining, manufacturing, construction, transport and utilities. Traditionally, these sectors have paid higher wages to workers than trade or services. Thus, most of the new jobs have been created in the relatively low wage sectors. Other figures cited by the Panel from studies by other scholars also convey a rather gloomy picture. Higher unemployment in the early 80s resulted from permanent job losses in manufacturing and mining. According to the Bureau of Labour Statistics (BLS) 5.1 million workers were displaced between 1979 and 1983. Podgorsky estimated that 6.4 million jobs were displaced between 1979 and 1982 and the annual rate of job displacement during 1981 to 1984 was 1.5 million. The Roessner Team estimated that office automation could displace 40 per cent

of 1980 jobs by 2000 A.D. Regarding the contribution of new technology to productivity, the Panel has cited the following interesting observations: "In Fremont, California, the joint venture between General Motors and Toyota known as United Motor Manufacturing Incorporated (NUMMI) uses modest levels of factory automation that are embedded in the Toyota production system manned by a unionised work-force; thus far NUMMI has been extraordinarily successful in meeting production and quality targets. By contrast, GM's factory at Hamtramak, Michigan, which uses advanced factory automation technologies operates at roughly 50 per cent of planned capacity and experienced serious quality problems." And again, "With few exceptions, the flexible manufacturing systems installed in the United States show an astonishing lack of flexibility ... They perform worse than the conventional technology they replace... Compared to the Japanese systems, those in the US plants produce an order-of-magnitude less variety of parts ... are not integrated with the rest of the factory and are less reliable."11/

J. David Roessner et. al., after an elaborate study forecast that in the banking industry in US employment will shrink from 1.1 million in 1985 to 824,000 in 2000 A.D. and in the insurance industry, from 924,000 to 568,000 over the same period due to office automation.12/

Leontiev and Duchin 13/ studied the impact of one particular technology: computer based automation, on employment in the US. They assumed three different scenerios: S1 - level of technology of 1981 remaining unchanged upto 2000 A.D., S2 - technology advancing to an intermediate but not to the highest possible level and S3 - the most advanced level of computer technology being in use. They also took as target outputs at 1990 and 2000 A.D., those projected by the Bureau of Labour Statistics and worked out the total employment to achieve these total outputs under the three scenerios using an input-output model developed for the purpose. The figures arrived at by them show that to reach the target output of 1990, 11.4 million fewer jobs would be created under scenerio S3 than under scenerio S1 and for the target output of 2000, the difference between total jobs under scenerios S1 and S3 would be 20.2 million. To repeat, this was the order of difference in employment resulting from advance in only one field of technology, that is, computer based automation.

Of course, even under scenerio S3, they do forecast an increase in employment of about 35 million between 1978 and 1990 and of a further 32.5 million upto 2000 A.D. But these increases are far lower than those forecast under scenerios S1 and S2. In the forecast for 2000, the largest difference in employment under scenerios S1 and S3 appears in categories of managers (-7.8 million) clerical workers (-14.7 million) and sales workers (-2.2 million). A substantially higher employment under scenerio S3 than S1 is forecast for professionals (5.5 million) and marginally higher for craftsmen, service workers and farmers.

In 1968, employment in the US had reached 111.6 million which was more or less on the growth trajectory forecast by Leontiev and Duchin. However, the forecast for 2000 A.D. by the BLS gives figures far lower than those of Leontiev and Duchin both in respect of aggregate employment and of sectoral employment. The BLS forecasts low, medium and high figures of projected employment and even their highest is lower than the lowest of Leontiev and Duchin.

In the US, civilian employment rose by over 10 million from 1979 to 1986. Yet, unemployment also rose from 5.8 per cent to nearly 7 per cent of the labour force during the same period. Employment of blacks rose by a mere 1.5 million and unemployment among them went up from 12.3 per cent to 14.5 per cent. During the worst phase of the depression in 1982 and 1983, unemployment among blacks went up to 19 per cent. This would indicate that the poorest among the US found themselves worse off inspite of the impressive growth in total employment. Mining and manufacturing have suffered a serious fall in employment even between 1980 and 1986 and BLS projections forecast further drop upto 2000 A.D. Even the fast growing industries like electrical and electronic computing equipment in which employment grew fairly rapidly in the 70s showed very little increase after 1980 and the rate of growth in employment in these will fall further till 2000 A.D. according to BLS projections. The sectors in which large increases in employment have taken place and are projected in future are services such as hotels, business services amusement, health services and so on. Retail trade and services are among the lowest paid jobs in the US while mining and manufacturing paid among the highest wages. Thus, most of the jobs lost were in the high wage sector while much of the new employment is in the low wage sectors.14/

That technology has had a grave impact on employment and consequently on the conditions of workers in a number of industries and services in the US is vividly brought out by various scholars in Daniel Cornwal (Ed.), 'Workers, Managers and Technology.' The industries studied include steel, coal mining, automobiles, construction machinery, docks, agriculture and also some services like postal, sanitary, education and air traffic control. Many of these industries constituted the backbone of the US economy. In steel, total employment came down from about 5.33 lakhs in 1967 to about 2.97 lakhs in 1982 and the percentage of production workers came down from 81.4 to 72.8 among the total employees. In coal mining, continuous coal mining technology which produced only about 1 per cent of total coal raised in 1950 produced 75 per cent in 1978. Employment in coal mines went down from about 4.16 lakhs in 1950 to 1.74 lakhs in 1983 and of these, the proportion of underground miners dropped from 89.3 per cent to 64.5 per cent. Production of coal, on the other hand, went up during the same period from 516 million to 778 million tons per year. The automobile industry laid off 2.54 lakh workers between 1979 and 1982 and it was estimated that automation alone would eliminate 5 per cent jobs annually. The number of longshoremen, as dock workers are called in the US, employed on the west coast dropped from about 14,000 in 1952 to 7,500 in 1984 while over the same period, cargo handled went up from 18 million to 133 million tons per year. The new cargo handling technologies have rendered obsolete the skills traditional to the dock workers and have raised the quantum of cargo handled per ganghour from 60 ton pelletised units of the past to 300 tons of 10 ton containers and 650 tons of 20 ton containers bringing down labour cost per ton from \$3.44 in 1960 to \$ 0.79 in 1984 at 1960 prices. The most radical changes in technology, perhaps, have occurred in the newspaper industry or in printing as a whole. Composing rooms are rapidly disappearing from newspaper industry and employment in that section has fallen from 14,500 in 1970 to 6,900 in 1980 and further steep fall is predicted. New York Times alone reduced its composing room staff from 823 in 1970 to 441 in 1982. Thus, one of the most highly skilled and paid jobs not only in the printing industry but in

the entire industrial field is on its way out. The old craft of plate-making, preparatory to printing, is also on way to extinction. Incidentally, newspapers were not adversely affected by the depression to which are usually attributed high job losses. In the postal services 60,000 jobs were eliminated between 1970 and 1979 through the introduction of new mail sorting and defacing machinery, and another 60,000 are slated to go by 2000 A.D. In publicly provided sanitation services, virtually every change in technology has been accompanied by permanent workforce reduction. Even in telecommunications, a rapidly growing service using the newest technologies, although employment has risen from 6.92 lakhs in 1960 to 9.12 lakhs in 1982, future job prospects are far from bright. It is estimated that staffing requirements of switching officers decline by 50 per cent when analog stored programmes replace older systems and a further 40 per cent labour saving occurs when the latest digital switching technologies are introduced. Some 1.4 lakh operator positions were lost between 1950 and 1982. Michigan Bell workforce declined by 5000 in two years. Bell also announced in 1982, the closure of New York International Operating Centre abolishing 800 jobs. Two thousand installers were displaced in 1982 and ATT announced lay off of 24,000 workers in Informatics Systems Division in 1985.<sup>15/</sup>

Apart from elimination of jobs, an important effect of technological change is that skills acquired by workers through training and long experience become redundant. New skills which the new technologies demand can be acquired more easily by relatively younger persons who have a fair level of formal education. A large proportion of the relatively older workers displaced by new technology find themselves without jobs for long periods if not for ever.

The large scale elimination of jobs in the major, high wage industries seriously undermined the bargaining strength of the workers and their unions. Faced with the prospect of loss of employment, many unions had to accept lower wages and surrender some of the benefits they had won in the past through collective bargaining and direct industrial action. Thereby, they sought to minimise the job losses and to secure some relief for those whose jobs could not be saved. Once powerful unions like those of coal miners, steel workers, auto workers, longshoremen and in the printing trades have been put totally on the defensive and many of them had to change their strategy from militant action and bargaining to collaboration with management with a view to ensuring the survival or profitable operation of the employing industries themselves. Their success even with this strategy has been doubtful. The first profit-sharing payments at GM and Ford averaged \$ 640 and \$ 440 respectively per employee, in contrast to \$ 3,400 given up by each worker in annual improvement factor and cost of living payments.

Thus, modern technology has given American managements greater unilateral control over operations and labour and organised labour has attempted to defend itself against this trend by resorting to formal labour-management cooperation systems, but with rather limited success.<sup>16/</sup>

It is held almost axiomatic that technological upgradation brings down cost of production per unit and also improves quality of product, thereby making industry more competitive and promoting

industrial and economic growth. Since most technologies are labour saving, they do, indeed, reduce labour cost per unit of production. But labour is only one item of cost. If we think of total production cost per unit, it cannot be asserted that in every case it will come down with more advanced technology. Newer technologies are almost always capital-intensive and demand higher investment in plant, machinery and equipment per unit of output. Their productive capacity is also usually high. Hence, the capital cost, that is interest and depreciation per unit of output, can be much higher with more advanced technologies than with relatively older ones. Even more so if the usually high production capacities of these newer technologies cannot be fully utilised due to internal or external constraints such as maintenance problems due to the novelty and sophistication of the machines, shortages of power or raw materials, low market demand and so on. Often, these higher capital costs cannot be fully recouped through savings in labour cost. In such situations, total production cost per unit goes up. This is all the more likely in societies in which capital is scarce and expensive and labour is plentiful and relatively cheap.

During the past decade or so, integrated circuits and micro-processors have become quite cheap and so have computers, at least the smaller ones. This has created the impression that newer manufacturing technologies have also become cheap. This, however, is not true in most cases. For, microprocessors and computers provide only the controlling or steering gear for productive plant or machinery. But to lend themselves to computer control, the productive plant and machines themselves have to be more complex and sophisticated and therefore, more expensive. The computerised numerically controlled (CNC) machine tools, according to Leontiev and Duchin, cost on an average in 1978, about 11 times as much as conventional machine tools doing similar kind of work and each such CNC machine too can replace  $4\frac{1}{2}$  conventional machines in the matter of output capacity. They also estimate that only about 10 per cent of the total price of a CNC machine is accounted for by the controller computerised gear. For robots, they estimate a 1979 price including peripheral equipment, of about \$ 84,000 of which only about 7 per cent is on account of the robot's controller. At current prices, these relative proportions of computer or controller costs are likely to be even lower since computers have become much cheaper while other materials that go into the machines have become much dearer. Leontiev and Duchin estimate that one robot could replace 3 workers on 2 shift working.<sup>17/</sup> These figures show that, output for output, CNC machines cost about 2.35 times as much as conventional machines and only a very small part of their cost is for computerised control devices. Unless this increased incidence of capital cost in the form of depreciation and interest per unit of output can be recouped through savings in labour cost per unit and through some other savings, a CNC machine will not be economical in comparison with a conventional machine.

Other benefits with CNC machines are stated to be improvement in product quality, flexibility in the production flow, reduction in lead time and so on. These are important benefits although they are not precisely quantifiable in most cases. But even with these benefits and the reduced labour cost per unit it cannot be asserted that in all cases the high technology CNC machine will turn out to be more economical than a conventional machine.

Dr. R. C. Datta of the Tata Institute of Social Sciences, Bombay, and I tried to do a small study of the advent of CNC machines in some engineering organisations in Bombay. The study covered 3 large, multiunit companies reputed to be highly technology oriented and having a strong position financially and in their respective markets. The wage level in all the three companies is high compared to wages in the Bombay Engineering Industry as a whole although there are fairly wide differences among their wage levels. Together, these organisations employ some 10 to 12-thousand workers.

These companies began acquiring CNC machines around the early 80s for their manufacturing operations and today, have a total of about 40 to 45 CNC machines among them. More such machines are being currently acquired. We were able to obtain fairly detailed information about 21 of these machines drawn from all three organisations.

Considering the size and the total plant and machinery at work in these companies, the total number of CNC machines must be considered quite small, almost insignificant. The current rate of acquisition of such machines is also not high. In relation to the engineering industry as a whole, the sample accessible to us was small. The organisations covered were also among the largest and most profitable in the industry and therefore not representative of the industry as a whole. Drawing any macro-level conclusions from such information as we could obtain would, therefore, not be warranted. Full evaluation and interpretation of the information is also still to be done. All the same, I venture to present here for what it is worth, some of the information which is relevant to our present discussion.

The aspects that we tried to get information on are: the decision making process within the organisations about acquiring new technology, the method of cost-benefit assessment of the proposed machine, the considerations that prevailed in getting CNC machine, the time taken for different stages like ordering, delivery, installation and commissioning and so on and the time and cost overruns, changes needed if any, in the work layout and process and the cost thereof, the cost of the CNC machine, its tools and accessories, spares, transportation and installation, etc, cost of comparable conventional machine, the relative cycle times for some typical operations on the CNC and the conventional machine and the response of workers to the introduction of CNC machines.

It was found that every single one of these CNC machines was imported. In each case, the proposal for acquiring a CNC machine was initiated by technical managers at the departmental level, but approval of senior and top management was necessary for the decision to be finalised. The need for the machine and the cost-benefit relationship for it were assessed at the departmental level. The rigour of the cost-benefit analysis varied from organisation to organisation. In one, which did a lot of job work of very specialised kind for which it had virtually no competitors, the cost-benefit study was rather perfunctory as the organisation was able to quote on a 'cost plus' basis for such jobs.

We tried to identify in order of importance the considerations which induced the managements to acquire CNC technology. They

were requested to rank in order of importance the following seven factors :

- i. Lower unit cost of production;
- ii. Larger volume of output;
- iii. Reduced labour input;
- iv. Quality level;
- v. Acquiring higher technological capability;
- vi. Because competitors have it; and
- vii. Any other

Ranking of these factors done by the managers showed that they regarded quality as the most important factor in deciding to introduce CNC technology, the average rank for this factor being 2.07. This was closely followed by the need for larger volume of output (rank average 2.25) and the thrust to acquire higher technological capability (rank average 2.71). Lowering unit cost of production came a poor fifth with a rank average of 3.8 and reducing labour input, sixth with a rank average of 4. Thus neither reducing cost of production per unit nor reducing labour input weighed very much with the managers in deciding to install CNC machines.

It was interesting to find that although these organisations have been operating CNC machines of various kinds for several years, they still have no access to the in-built system software in the computer that controls a CNC machine. The programmes for specific operations to be performed are, of course, written by the personnel in these organisations but the system software in the computer is closed book to them. In fact, it is reported that Indian Machine Tool makers who claim to manufacture CNC machines obtain not only the designs of the machines from their foreign collaborators, but also the computers with the built-in software to which even these manufacturers have no access.

Out of the 21 CNC machines covered, we could obtain information on prices of comparable conventional machines in only 16 cases. For the other CNC machines, in the view of the managers, comparable conventional machines were not available. In such cases, the question of comparative cost advantage did not arise. For the 16 machines for which comparative cost data was available, the average ratio of the capital cost of the CNC and the conventional machine works out to 1.66:1. This is a much lower ratio than that reported by Leontiev and Duchin which is 11:1 or allowing for their estimate that one CNC machine can replace 4.5 conventional machines, 2.35:1.

A possible explanation could be that these companies procured only proven machines whose production was already standardised and which, therefore, were priced somewhat lower while the machines in the US which Leontiev and Duchin must have studied, might be freshly developed, genuinely state-of-the-art machines whose price, therefore, would be comparatively higher. Another explanation could be that while the CNC machines were all imported, the comparable conventional machines were generally indigenous. It is well known that prices of indigenous machines are higher than the international levels. We also found that rival foreign firms offered very substantial discounts on their quoted prices to the purchasers presumably with a view to getting a foothold in the Indian market. Finally, the companies themselves must have chosen only such CNC machines as did not involve too high a capital

expenditure in relation to conventional machines. Whatever the explanation, the fact is significant that in our sample, the cost of the CNC machines was, on an average, not as far above that of conventional machines as is reported by Leontiev and Duchin.

Comparative figures of typical operation cycle times could not be obtained in a sufficiently large number to make meaningful comparisons. Since the number of CNC machines introduced so far is, as mentioned earlier, quite small compared to the size of the manufacturing activities of these companies they do not seem to have caused any actual lay offs of labour. In fact, in each of the companies, specific assurances have been given to workers and their unions that there will be no lay offs as a result of introduction of new technology. But though output has risen substantially in all these organisations little additional employment has been generated. Regarding their competitive position in export markets also, it is not possible to say anything on available information.

Historically, growth of technology was accompanied by an international division of labour: the colonial world mainly producing raw materials and food for the industrialising countries and the latter producing finished manufactured goods from those raw materials to be exported back to the colonies. This exchange was always a highly unequal one because of the political, military and trading dominance of the industrial countries. These countries became prosperous while the colonies were pauperised. But with prosperity, wage levels in the industrial countries went up. Manufacturers in the industrial countries found that goods requiring large input of labour could be manufactured more economically in the developing countries, that is, in the erstwhile colonies, with the cheap labour available there. Thus, some of the relatively labour-intensive manufacturing began to be shifted from the industrial to some of the developing countries where abundant supply of labour which could be trained in the necessary skills was available on low wages. This was the second stage in the international division of labour and through it, some industrial and technological development began to take place in some developing countries. A few of these developing countries, because of some favourable factors, could take advantage of this division and expand their own manufacturing fairly rapidly, acquiring considerable technological capability and economic growth in the process. The so-called Four Asian Tigers: South Korea, Taiwan, Hong Kong and Singapur and to some extent, Brazil and Mexico are cited as instances of this.

With the advent of the most modern, electronic and micro-processor based technologies, however, two divergent trends seem to be under way. On the one hand, with the great spread and speed of telecommunications and informatics, it is no longer necessary that all components of an end product are produced at one location. It is possible for large corporations to develop products, production plans and technology centrally and do the actual manufacturing at several different locations according to relative advantages in raw materials, labour and markets, do the final assembly at still different locations and market the end product world over. This global sourcing of materials and components makes both manufacturing and marketing economical while the big corporations in the industrial countries retain control over the development of the most advanced technologies as also over worldwide markets.



The other trend is a reversal of the prevailing international division of labour itself. The most modern technologies are highly capital intensive but their labour requirement is very low and falling continuously. Hence, the relative advantage of cheap labour available in the developing countries is no longer as important as it was in the earlier phase. In the newly industrialised countries (NICs) the earlier phase of international division of labour led to a rise in wage levels which resulted in labour no longer being very cheap there. Hence, there is now a trend of some high-tech manufacturing moving back from the developing to the industrial countries.

It is said that modern technology, especially informatics, has internationalised the economics of all countries of the world. There is talk of the emergence of a 'world market' superseding the productive and distributive systems of individual countries. The sweep of modern technology, we are told, is worldwide and it is futile for any country to try to resist it or to evade it. Indeed, this is a part of the technology ideology referred to by me earlier. It is no doubt, to the advantage of the industrial countries to promote this view. For, thereby, they can preempt any efforts by the developing world to explore and pursue their own paths. All advances in what are referred to as modern technologies are taking place in the industrial countries. Much of the manufacturing and trade in the world is also controlled and dominated by these countries. The immense benefits from this dominating position in technology, manufacturing and trade can be perpetuated and further enhanced if the developing countries can be persuaded - or coerced - to accept this view of the inexorability of modern technology and the futility of taming it.

In the prevailing unequal distribution of technology as well as industrial and economic power, internationalisation of world economy can only mean tying all economies of the world to the apron-strings of the industrial countries, more precisely, of the giant multinational corporations in those countries. And emergence of a 'world market' can only mean a market dominated by these countries and their multinationals.

Yet, the developing world seems to enthusiastically accept both modern technology and the ideology of technology promoted by the industrial world in toto. How does one explain this? The people at large in the developing countries do not know much about modern technology and know even less about the ideology of technology. It is the groups who have economic and political power who decide issues in the field of technology, as indeed, in all other fields. They, in turn, are under pressure from other groups, a small minority in the developing countries, who, because of their educational and economic advantage, have access to and are the real beneficiaries of new technology. Even in the industrial countries, development of technology is for maximising the profits of those who have control over their economies. They view technology as the means by which their own consumption standards can go up continuously. The industrial and business community in the developing countries sees and actively promotes a similar consumerist urge among a small section of their own countrymen and turn it into an opportunity for easier gain for themselves than could be made through normal industrial growth and trade, by becoming the agents and surrogates of the multinational corporations of the industrial world. If, in the process, the

vast majority of people in the developing world are left out of the developmental process and even marginalised even further, that is too bad, but cannot be helped!

According to Karl H. Ebel of the ILO, "...These technologies have been developed in the industrialised countries to solve economic, social and communication problems ... and to improve military and aerospace equipment ... They are not value-free... As regards information technology ... marginalisation of developing countries seems to be preprogrammed. They have reasons to fear total tutelage. Data banks and data networks and about 90 per cent of research capacity are already monopolised by the industrial nations. Developing countries are practically disconnected from the transnational data flow....

..It is in the nature of these technologies to push ahead in the modern industrial and administrative sector usually at the cost of traditional industries and agriculture. Existing imbalances will be aggravated. Traditional sectors tend to be starved of investment....

Technological dependence increases instead of being diminished. ...Informatics in development plays many other roles that are absent in the periphery. The general dynamisation of the economy, the transformation of production practices, the integral remodelling of training schemes, the continuous drive towards research and development activities, all these are extreneous to them ...."18/

According to Manuel Castells, most developing countries are bypassed by the technological revolution. Only a few segments of their productive structure participate in any peripheral industrialisation. New technologies are increasing labour redundancy, accelerating rural-urban migration. In large areas of the Third World, particularly Africa, "unemployment, misery and hunger are on the increase particularly in the major urban centres, the new magnets for all forms of despair ... By inter-connecting the economically and technologically valuable elements of each country at the world level while disconnecting social groups, cities and sometimes whole countries that do not belong in the new dynamic techno-economic system, the current process of restructuring is fragmenting the social fabric of the planet... It is also recomposing it ... into a structure that primarily suits the areas or institutions for which the dominant powers have specific interests."19/

Castells, of course, does not include China, India, the NICs and a few other developing countries in this dismal scenerio. However, we in India are quite familiar with the features of this scenerio in our country: the rural-urban migration, rising unemployment, misery and hunger, the connecting up of our economically and technologically valuable elements and disconnecting of the mass of people, the aboriginals, landless labourers, marginal farmers, dalits, rural craftsmen and so on, from the world structure, the fragmentation of the social fabric and the structural subordination to the dominant corporations and governments of the industrial world. We should, therefore, be under no illusions about what the high technology based new industrial international structure has to offer to us as to most of the developing world.

The Asian NICs are often held out as models of how developing countries can make impressive progress industrially and economically through modern technology, especially through electronics and informatics. There is no denying that these countries have, indeed, made remarkable progress during the past two decades. But closer examination shows that the NICs are special cases which cannot be replicated everywhere else, especially in very large and populous countries like China and India. All four Asian NICs are small countries, two of them, just cities. All of them had a fair supply of reasonably well educated young men and women. When American and Japanese multinational giants started locating some of their electronics manufacturing in these countries to benefit from the educated and cheap labour there, they could make a sizeable impact on their labour markets due to their small size. In the year 1979, as much as 57 per cent of the industrial labour force in Hong Kong, 38 per cent in Singapore, 30 per cent in South Korea and 27 per cent in Taiwan was engaged in multinational owned, export oriented electronic consumer product assembling units.<sup>20/</sup> For all these countries with the exception perhaps of South Korea, export orientation is a situational imperative since they have to depend upon imports for a great many of their essential requirements. Employment generation and exports growth under the umbrella of the multinationals on such a large scale, no doubt, brought notable benefits to these relatively small countries.

Even among these four, South Korea is a special case. The country which was a part of the Japanese empire, became free after the defeat and withdrawal of Japan at the end of World War II. The extensive productive assets in the country which were owned by the Japanese, were seized by the state and farm assets were redistributed on a relatively equitable basis. Farm tenancy was reduced from 70 to 33 per cent. The country remained under a harsh, dictatorial regime all along and workers were denied genuine trade union rights. But the dictatorial government did grant ownership of land to the tillers and enforced a land ceiling of 3 hectares. The state purchased rice at set prices and assumed the major role in developing industry. The US government, because of its geopolitical interests and the American corporations provided massive economic and military assistance to South Korea. It is estimated that between 1953 and 1974, US grant aid constituted some 60 per cent of all investment in that country.<sup>21/</sup> The economic development of the country took place under state initiative in a protected market and with such massive American aid. Its achievements in technology and exports are, no doubt, impressive. It has also maintained a high rate of growth of GDP. But not everything about it is so rosy. South Korea carries a very heavy foreign debt, next only to the US, Mexico and Brazil.

It is inconceivable that multinational-promoted, export-oriented, high-tech-based industrial growth can make an impact of that order on the incomparably larger and more populous countries like China or India as it made on the NICs. To do that, high-tech industries will have to provide employment to not a few thousands or lakhs, but to crores of persons and the investment needed for that will be astronomical. If somehow, that is done, will the torrent of output from so large an industry find ready markets in the world? Already, the industrial countries are seeking to protect their domestic markets from electronic and other high-tech products from the NICs, not to speak of Japan. Will the multinational giants from the industrial countries assist,

as they did the NICs in the early 70s, countries like China and India build up high-tech industries which will necessarily be far larger than in the NICs to make any significant impact on their total development ?

In a recent article, Philip Oldenburg, a well known American India watcher asks a question which according to him poses the crux of the deep-layer divergence of interest between US and India: "Would the United States welcome an India growing at Korean-style rates and moving into a position of real economic great powerdom?" and proceeds to answer the question by another rhetorical question: "Would the United States have given so much aid to Japan, one wonders, had policy-makers forty years ago imagined that Japan would ultimately be able to rebuild to its present level ?"22/

Modern technologies are knowledge and information based as distinct from skill based. For both their successful operation and for their development, they demand a fairly high level of formal education in a society. Societies in which formal education is not widespread nor high - and these include majority of developing countries - are naturally at a disadvantage in the field of modern technology.

Development of these technologies also demand very large resources of all kinds: expensive specialised equipment and facilities, money and highly trained research personnel. Developing societies like our own, even when they have a fair supply of highly educated scientific and technical personnel, cannot command the other resources to carry on worthwhile R & D work in modern technology on any significant scale. Hence, they loose much of their scientific and technical personnel educated and trained at very high public cost. And what is their loss is the industrialised countries' gain since these countries can offer to this personnel far more attractive facilities and rewards for R & D work.

#### SOME IMPORTANT MODERN TECHNOLOGIES

The technology of technologies in the present age is, without doubt, electronics, especially computers and informatics. The amazing versatility of this technology has enabled it to enter virtually every field of human activity: agriculture, mining, manufacture, transport, power, various kinds of services such as banking, insurance, commerce, communications, entertainment, education, health and medicine and so on. In R & D work in other sciences and technologies as well as in social sciences, use of electronics and computers is virtually unavoidable. Indeed, other technologies like nuclear power, space, biotechnology or medicine could not have advanced as much and as fast as they have without the help of electronics and computers.

Within the span of just three decades or so, electronics and informatics has become the fastest growing industry in many industrialised and even in some developing countries. In some countries it is already the largest industry in terms of contribution to GDP.

What electronics and computers can do to any process or activity to which they are applied, surpasses what could have been imagined a couple of decades ago. The wonders that they can perform sound like the stuff fairy tales are made of. Hardly a week passes without some new and more amazing feats being made possible by

these technologies. Electronics and informatics have, without doubt, proved themselves to be overwhelmingly powerful and versatile technologies and it is no exaggeration to say that they are revolutionising all aspects of life in the developed world and to some extent, even in some developing countries.

This is also, perhaps, the most fast changing field of technology. What is state-of-the-art today becomes obsolescent within a matter of a few years. The product and process cycle time is short and the market for any few product or process must be exploited by the innovator in as short a time as possible before a still newer product or process pushes it into obsolescence. The frenetic pace of innovation and change in these technologies has two results. Firstly, much productive equipment and product is rendered obsolete long before its really useful life is spent and the investment made in it goes waste. At the same time, a very high premium is placed on massive R & D effort. Those who aspire to stay in the race must make vast investment of money and talent in R & D in these technologies. Such investment also proves worthwhile for those who can make it and thereby stay ahead in the race. Those, on the other hand, who cannot make such massive investments in R & D, have little chance of staying in the race on their own. They must get reconciled to a subordinate, dependent and a precarious existence on the periphery. The race progressively eliminates those who lag behind till a very few, only a handful super-giants survive and even these are constantly under threat from one another. The Wang Corporation which took by storm the electronic and micro-chip market and became a legend only a decade ago, is today reported to be in trouble. Honeywell, a computer giant of yesteryear is out of business today. The dominance of the US in semiconductor manufacturing equipment field has declined sharply and its share in the Japanese market has declined from 90 to only 35 per cent in recent years.<sup>23/</sup> Investing between \$ 700 million and \$ 1 billion in the development of High Definition TV, Japan has far outstripped the US which spent only \$ 30 million in that quest. "Years of delay and general erosion of America's manufacturing base in several critical technologies will most likely make the cost of getting back into the game far higher than US government and industry are now discussing"<sup>24/</sup> The US which so vigorously promotes privatisation elsewhere, especially in the developing countries, is itself pleading for a government-industry tie-up to upgrade electronic technology to face Japanese competition. X-ray lithography, a technology developed by Japan at a cost of \$ 1 billion produces high density chips that can hold 1000 times more data than the most sophisticated chips currently produced in the US and can match the computing power of the largest IBM mainframes.<sup>25/</sup> The US has practically gone out of the production of dynamic random access memory chips (DRAM) because of severe international competition.<sup>26/</sup>

How do developing countries fare in this frenzied technological race ? Dr. Judith Sutz, a sociologist from Uruguay who is also an electrical engineer, describes the role of informatics in most Latin American countries as 'solution in search of a problem'. In a paper aptly captioned 'Which Informatics for which Development?', she quotes from an article by Claudio Mammana, Chairman, Brazilian Society of Informatics: "we would only have had a group of salesmen selling foreign companies' products, specialised in catalogues. These people would probably have a great ability in inventing problems for solutions available". According to Sutz, every technological change relating to computers

takes place outside the region, that is, Latin America, and administrative decisions about what to buy, when and why, are influenced by external agencies.27/

Brazil is credited with having made greater progress in electronics and informatics than most other Latin American countries. But when it started to develop its own computers and barred imports of US computers, it was put under tremendous pressure by the US who threatened to shut out imports from that country. In spite of their relatively greater achievements in technology, Brazil and Mexico today find themselves in an external debt trap from which they are unable to come out. Share of manufactures in their exports is low and the rate of growth of their GDP is also poor.

As Rene Eksal and Gerard Metayet have correctly emphasised in regard to information technologies, the balance sheet of experience in France is disquieting; "nowhere have these applications brought about the slightest social dynamism. ... These technologies have systematically eluded questions of redistribution of power and the creation of a new balance between economic and social groups..... The pervasive use of computers may generate new forms of social exclusion, where some become computer illiterate in a society where those who have been computerised become illiterate in every sense of the term."28/

According to Elkington and Shopley, "The market mismatch between Third World needs and the predominantly First World locus of IT industries means that most existing programmes are merely scratching the surface of problems and potential of IT in sustainable development."29/

There is a general impression that electronics is a 'clean', non-polluting industry. But this impression is not quite correct. Louise Kehoe, a knowledgeable commentator on the subject, writing in the Financial Times, London, of 18 January 1989 says about the manufacture of semi-conductors, "Toxic chemicals are an essential part of the manufacturing process. Highly toxic Arsine and Phosphine gases are used to 'dope' silicon to produce electrical properties needed to create semiconductors."

"Hydrofluoric acid is used to clean wafers while organic solvents such as trichloroethylene which has been linked with cancer in animal tests, are used to remove impurities from wafers. The semiconductor industry is also a big user of chlorofluorocarbons which are damaging to the earth's ozone layer."

Kehoe points out that according to data collected through the industry's Occupational Health Service, the incidence of health problems among semiconductor production line workers range from 10 to 23 per 100 workers. Similarly, according to data collected by the National Safety Council of USA, the number of reportable cases of injury or illness among all employees in the industry rose from 1.56 per 100 workers in 1985 to 5.98 per 100 in 1987, the latest available data.

Kehoe further reports that a study conducted by researchers from the University of Massachusetts indicated a higher than expected rate of miscarriages and illness among the predominantly female workforce at a Digital Equipment Corporation semiconductor

plant near Boston which has been viewed as raising 'serious concern'.

Kehoe proceeds, "despite their superbly clean appearance, the lawned campuses of Silicon Valley chip makers mask a mess of underground pollution that is expected to cost hundreds of millions of dollars to clean up." Some 165 underground storage tanks built in the 70s and holding waste solvents are known to have leaked toxic material into the soil, contaminating ground water and underground aquifers. Cleaning up of one site alone viewed as particularly bad, will cost about \$ 55 million and may take as long as 300 years !

Policy makers in our country have fallen under the spell of electronics and informatics, like those in many other developing countries. The official policy on electronics was announced by government on 14 November 1984 and that on computers on 21 March 1985. A production target of Rs. 10,000 crores per year of electronic goods was set for the end of the VII Plan. Wideranging concessions were announced for the industry to grow rapidly. Broad banding of licenses, welcome to foreign equity companies to set up manufacture of components, electronic materials and high-tech items, free import of technology, exemption from MRTP restrictions, removal of excise duty on computer components, delicensing and dereservation of a number of items, permission for assembling from intermediate stages were some of the concessions granted. Import of computers costing less than Rs. 10 lakhs and of designs and drawings of computer components were placed on open general license. Duty on import of computers was reduced and import of advanced computers was allowed duty free.

The break up of the overall electronics production target into different sub-sectors and the actual achievement upto the year 1988 are given below:

SUB-SECTOR	TARGET VII PLAN	Rs. Crores	
		OUTPUT 1981	OUTPUT 1988
Consumer Electronics	2,000	251.19	2,400
Data Processing Units and Office Equipment	870	35.27	650
Broadcasting and Communications	3,100	154.43	900
Industrial Electronics	2,010	149.97	935
Components	2,000	178.16	1,025

Source: CMIE; Electronics Production 1981 to 1987; Introduction.

According to the then Secretary of the Department of Electronics (DOE), the output of electronics in 1988-89 was worth about Rs. 7085 crores. Yet, the DOE was optimistic that the end VII Plan target, that is 1989-90 output would reach Rs. 10,800 crores a jump of some 45 per cent in a single year. This seems improbable.

Exports of electronic goods were targetted to reach Rs. 1,000

crores per year and of computer software to Rs. 300 crores per year by the end of the VII Plan. Actual exports under these heads in the year 1988 were only worth Rs. 475 crores and Rs. 100 crores respectively. Thus, under both these heads, export performance lags well behind targets.

In production, the target for consumer electronics has been far exceeded one year ahead of schedule. But under all other subheads, production lags much behind the targets. Indeed, consumer electronics along with broadcasting and communication equipment constitutes more than half of our electronics output in terms of value. The shortfall in the critical sub-head of components as also in exports is particularly serious. What has evidently happened is that our electronics industry has concentrated disproportionately on the consumer sector in the domestic market and catered to it mainly by assembling imported components and sub-assemblies. The expectation that this will become a major manufacturing and exporting industry as in the NICs has been largely belied not only in respect of electronic components but also of computer software for which India is claimed to be especially well endowed.

The Bureau of Industrial Cost and Prices (BICP) observes in its report, "What has emerged in the computer industry is trading culture and merchant sales sustained largely by imported materials and components of whatever vintage...."

There has been a negative value addition in case of certain products like PC, PCXT and Micro 3.2 with the bill of materials close to or exceeding the CIF price of these items in the international market.

With the current outgo of FE on components and materials, one could buy many systems and peripherals than could be manufactured domestically."<sup>30/</sup>

The situation in consumer electronics was not any different than that described by BICP for the computer industry. DOE had envisaged 90 per cent indigenisation of TV manufacture by 1989-90 and the DOE Secretary actually claimed that 100 per cent indigenisation of B/W TV sets had already been accomplished. However, according to P. S. Deodhar, Chairman of the now defunct Electronics Commission and currently Media Adviser in the PM's secretariat, "...Whether the picture tube, the resistor or capacitor, every part is imported including copper wire."<sup>31/</sup> Even parts claimed to be manufactured in India, including colour picture tubes have at least 70 per cent import content.

There are numerous indications that there is quite a bit of confusion and waste in the field of electronics and informatics in our country. The National Informatics Centre was set up at a cost of about Rs. 160 crores and recurring annual expenditure of Rs. 35 crores to 40 crores under the Planning Commission. It has the capacity to meet the entire data collection needs of government administration. Yet, even the DOE is reported to make no use of it. Some 30 per cent departments of government are totally indifferent to it.<sup>32/</sup> The F.T. & T Development Council imported 10,000 decoders in October, 1985; till April, 1988, it sold only 300 of them. The Shipping Corporation of India imported an IBM mainframe computer at a cost of over Rs. 3 crores. It lay



unused for over 8 months as the Bureau of Public Enterprises did not give its consent to an agreement between the SCI and the union of its employees about its use.<sup>33/</sup> The National Informatics Centre imported an ND 550 computer for its Calcutta centre in November, 1986; it was still uninstalled in June, 1988. Its storage had already cost Rs. 2.4 lakhs and parts of it were found to have begun to get corroded.<sup>34/</sup> Picture tubes imported against hard currency were detected to have been reexported to rupee payment countries. In a single case, some 3 lakh colour picture tubes were involved in such dubious transaction.<sup>35/</sup> The Chairman of the Informatics Technology Manufacturing Association unabashedly pleaded with the Government that the value added component for computer exports should be brought down from 30 or 40 per cent to only 5 or 10 per cent.<sup>36/</sup>

#### NUCLEAR POWER

There has been a sea-change in the field of nuclear power in the industrialised world. What was once viewed as a viable alternative source of abundant power to replace fossil fuels is now recognised to be neither safe nor economical. The change, although speeded up by the accident in the N-power plant at Chernobyl in the USSR three years ago, had actually started well before that accident. The present position is that most countries in the developed world are turning away from N-power. USSR itself, according to Nikolai Lukomin, has abandoned projects to set up six N-power plants in Azerbaijan, Minsk, Byelorussia, Odessa and Krasnodar, the last after about 32 million roubles were already spent on its construction. Work on a similar project in Lithuania has been suspended. Proposals to set up additional units in the N-power plants in Armenia and Georgia have also been dropped.<sup>37/</sup> France, Britain and West Germany had signed an agreement to promote fast breeder reactors and a plant of 1500 MW was planned to be set up at a cost of DM 6 billion. But neither France nor FRG now want that plant on its soil.<sup>38/</sup> In the US no new N-power plant has been ordered since 1978 and those ordered after 1974 are all cancelled. More cancellations are expected. In fact it is expected that N-power will be on the way out in the US in the 90s.<sup>39/</sup> Half of the OECD countries have no N-power plants and do not plan to have any. A referendum at Sacramento, California, USA, voted for closure of the N-plant. The Greenpeace International in Western Europe has made it a cardinal point in its programme to oppose all nuclear technology. The Social Democratic Party in FRG has declared that if it comes to power it will dismantle all N-power plants in the country. Two N-power plants already built in the Phillipines are not being commissioned by a government decision. In the US, the states of New York and New Hampshire have refused to permit any N-plants in their states.

This worldwide trend away from N-power is because N-power is now recognised to be too expensive, too risky and not acceptable to people in many parts of the world. These plants are expensive to build and the costs are constantly rising because of the increasingly stringent safety requirements being prescribed for them. They often do not operate at rated capacity. Disposal of the radio-active wastes that arise in the course of their operation is exceedingly expensive. The cost of final decommissioning of the plant is not even fully known anywhere in the world. In fact, really satisfactory technology and procedure is not still settled for disposal of the radio-active wastes and final decommissioning of a N-power plant after its economic life is over.

First stage of decommissioning of the first British N-power plant has cost 200 million, five times as much as the original estimate. Final decommissioning, it is now estimated, will cost 500 million.<sup>40/</sup> That is about Rs. 13,000 million at current rate of exchange. Actual costs may well be much higher. Because of the difficulty of estimating the investment needed for facilities for disposal of radio-active wastes and the costs of final decommissioning, it is found to be almost impossible to put a capital cost on a N-power plant as the British Government found when it was planning to privatise N-power in that country and had to give up the proposal. The newer AGR plants have performed poorly, the one at Hartleford producing only about 16 per cent of its originally rated capacity.

The Worldwatch Institute estimates that in the next 25 years some 360 nuclear reactors will need to be retired and the job would cost somewhere between \$ 63 billion and \$ 270 billion. Apart from the cost, other aspects of the decommissioning operation are also not fully understood. The dismantling of these plants will produce some 150 million tons of low level radio-active waste, 70 times as much as the annual output of all the currently operating reactors. Besides, over 100,000 tons of high level radio-active wastes will also arise and these may remain active for some 10,000 years.<sup>41/</sup>

N-power is not economical. Sir Robert Haslam, Chairman, British Coal, asserts that N-power is 40 per cent more expensive than coal based power in Britain.<sup>42/</sup> According to a Worldwatch Institute study N-power is twice as expensive as power from alternative sources. Its capital cost is estimated at about \$ 3,700 per installed KW.<sup>43/</sup> In France, the Super Phoenix fast breeder reactor produces power at a cost 2.5 times that of first generation reactors.<sup>44/</sup> The French Electricity Authority lost FF 1.8 billion in 1988 alone and carries a cumulative loss of FF 233 billion, that is, \$ 38 billion.<sup>45/</sup> As is well known, about 70 per cent of power in France is produced in N-plants. The US Energy Department lost \$ 15 billion on faulty atomic projects.<sup>46/</sup>

The Sellafield waste disposal facility in Britain has already cost £ 240 million. At this facility, waste will be sealed in stainless steel capsules for 80 to 100 years; but that is only a temporary solution. USSR has spent 900 million roubles in Byelorussia alone on decontamination of the area affected by Chernobyl accident and the job is not done yet.<sup>47/</sup> The clean-up of the 3-mile Island accident in the US has also cost \$ 1 billion.<sup>48/</sup>

Few people apart from those who have some kind of a stake in it, now view N-power as safe. The safety requirements for these plants are constantly being made more stringent in all countries precisely because the possibility of an accident is always present, assertions to the contrary by some N-power people notwithstanding. And such accidents can spell devastation. Hazards also accompany the handling, transportation and disposal of radioactive wastes as also the final decommissioning of the plants. These hazards are not momentary or transitory; they can persist for decades, even centuries. According to the Worldwatch Institute 'inherent safety' for N-plants is a 'technological mirage'. Professor Hans Alfvén, a Nobel Laureate in physics from the Royal Institute of Technology, Stockholm, says that ingenious methods devised by

technologists like enclosing nuclear wastes in capsules and burying them for ever at great depth may work in a 'technological paradise', that is, 'in a world in which all gadgets work as they are designed to and all operators do exactly as they are instructed to do', and points out that unfortunately do not live in such a technological paradise. Professor Alfvén further says that, "It is possible that nothing happens near the waste disposal site for the first five or ten years. But later, we - or our children or grandchildren - will find that the whole region is uninhabitable because of leaking radioactivity."<sup>49/</sup> How the material in which the whole reactor is entombed after retirement will respond to continuous exposure to radioactivity and resulting heat over decades and centuries is something that no scientist can predict today. In the US alone, some 3000 accidents in N-plants have been reported after the 3-mile Island accident. In Britain, Dr. Roger Clerk, Director, National Radiological Protection Board, has advised the N-power industry to cut down the level of radiation.<sup>50/</sup>

The protagonists of N-power usually advance two arguments to justify it, apart, of course, from bland assertions that N-power is both safe and economical. They argue that N-power is non-polluting that it does not aggravate the greenhouse effect caused by the emissions from burning fossil fuels. Their other argument is that fossil fuels are a diminishing resource the world over while N-power is almost inexhaustible. One hundred British scientists, doctors and engineers, however, have asserted that the greenhouse effect is not primarily due to coal-burning power plants since their emissions are only a small percentage of the total greenhouse gases released into the atmosphere. They also contest the claim that N-power is non-polluting because radioactivity is a more serious pollutant. Regarding the worldwide need for additional energy, these hundred eminent persons stress that raising the efficiency of energy generation from conventional sources and minimising waste of energy, offer far greater scope for increasing the availability of energy and that these are far quicker and cheaper ways of achieving it than N-power.<sup>51/</sup> The Worldwatch Institute has also indicated the available options for obtaining more energy: improve the efficiency in the use of energy, burn coal more cleanly, develop renewable sources of energy.<sup>52/</sup> The weakness of the argument about the need for additional energy is also seen from the fact that according to present plans the proportion of N-power in OECD countries will actually decline from the present 25 per cent to 21.8 per cent in 2000 A.D.<sup>53/</sup>

I have dealt with this subject at such length because our country has launched on an ambitious programme of expanding N-power generation. The target is 10,000 MW of N-power capacity by the year 2000 A.D. at a total investment of Rs. 10,000 crores. The people from the country's nuclear establishment glibly assert that N-power is both safe and economical and further that the country has 'no alternative to N-energy'. We need to take a hard look at this programme and these assertions.

The statement that there is no alternative to N-power is patently absurd. For, even if the official target is fully reached, N-power will constitute no more than 10 per cent of total power capacity in the country. According to official projections, the additional need for power in 2000 A.D. will be roughly 70 to 80 thousand MW above the capacity installed as in 1986, that is, an increase from about 60,000 MW to about 1,30,000 MW. Out of the projected increase of 70,000 MW, only about 9,000 MW is to be

N-power. As much as 87 per cent of additional power will have to come from conventional sources. In fact the demand projection itself has a range of 10,000 MW, that is as much as the projected total N-power capacity in 2000 A.D. Yet, for our nuclear establishment, there is no alternative to N-power !

The budgetary provision for N-power was raised from Rs. 833 crores in 1988-89 to Rs. 1115 crores in 1989-90, that is by as much as about 34 per cent. But the provision for non-conventional energy sources was a meagre Rs. 105 crores in 1988-89 and Rs. 115 crores in 1989-90, a rise of a merely 10 per cent or less. And at that figure, the provision was actually lower than in 1985-86 even at current prices ! That speaks for the concern of the power establishment for finding and developing alternative energy sources.

The claim that Indian N-power plants are safe and that there can be no serious accidents there, is equally absurd. In support of this claim, Dr. Katti, Managing Director, Nuclear Power Corporation, in an interview published in the Sunday Observer on 12 May 1989, made the following statements among others: 1) Our design is totally different from that of Chernobyl; 2) We have introduced far better measures than existed in Chernobyl; 3) Chernobyl accident occurred because six safe operation regulations were violated by the personnel there; 4) An emergency cooling system is installed for the first time at our Narora plant; 5) Two independent shut down system, each on different principles, in our Narora N-plant design; 6) We are learning as we go along, narrowing the possibility of accident.

There is no reason to doubt that the precautions mentioned by Dr. Katti have, in fact, been taken to make our N-plants as safe as our nuclear scientists and technologists could. That, however, only means that they have made sincere efforts to preempt the kind of accidents that they could imagine or conceive of. Presumably, designers and builders of N-plants in other countries also do precisely that, that is, try to preempt to the best of their ability all known or conceivable kinds of accidents. Which scientist or technologist will knowingly leave anything possibly unsafe in anything designed or built by him, especially if it is any part of N-power plant ? But can that really amount to an absolute guarantee that a serious accident simply cannot occur in something so large, complex and sensitive as a N-power plant. Such a guarantee can only be given in what Professor Alfvén calls a technological paradise. Dr. Katti himself talks of 'learning as we go along and narrowing the possibility of accident'. So, there are things yet to be learnt by our nuclear establishment. And yet, they insist that no serious accident can take place in our N-power plants-!

Apart from accident hazards, our nuclear scientists do not say much about how the problem of waste disposal and final decommissioning are planned to be handled. Currently, reports say that the wastes are sealed in capsules and stored not far from the plants themselves. Sites for their permanent disposal are yet to be identified. Transportation of large quantities of both low level and high level radioactive materials over long distances will inevitably be involved. Will the same degree of safety rigour be possible in this transport operation in a country where transport accidents are so lamentably common ? Is there any guarantee that international smuggling gangs or desperate terrorists will never be able to lay their hands on any of these materials

during transportation ? In the matter of final decommissioning, Dr.Kattifrankly admitted that information is rather limited.

What about the cost of N-power in India ? The nuclear establishment claims that it is lower than coal-based power or hydro power. Dr.Katti has claimed in his interview that all our N-plants have earned profits. He has also claimed that waste disposal charges are accounted for and that the tarrif has been loaded by 1.25 paise per KWH towards decommissioning costs 'notionally'. But the Public Accounts Committee of Parliament found that no provision was made for disposal nor for major repairs and that tarrif was not according to accepted commercial norms of accounting. The reduction in tarrif, according to the PAC amounts to subsidy.<sup>54/</sup> Further, according to Dr.Katti, interest is charged only at 8 per cent which itself amounts to a substantial hidden subsidy. The decommissioning cost, according to Dr.Katti is loaded on the N-power tarrif at the rate of 1.25 paise per KWH. A 500 MW plant operating continuously at 80 per cent capacity without any shut down for 25 years will generate roughly 87.5 billion KWH of energy. This will yield a mere Rs. 100 crores at the rate of 1.25 paise per KWH for decommissioning. Even taking credit for accumulated interest, the amount so available for decommissioning even on this very optimistic operating assumption, will be nowhere near the actual requirement which, even at present prices will be of the order of Rs. 1500 crores if the actual and estimated cost of decommissioning the first British N-power plant is any indication.

The actual performance of our N-power plants so far has been far from impressive. According to the report of the Department of Atomic Energy for the year 1988-89, out of 6 N-reactors erected so far, only two are generating at about 90 per cent of rated capacity. One in Rajasthan never worked, had to be shut down after numerous efforts at repair and will involve a huge expenditure, no one knows how much, for its final disposal. One of the two units at Madras has so far never generated more than 50 per cent of rated power and is not expected to do any better in future. One unit at Tarapur generated at an average about 69 per cent of rated capacity during that year.

According to Dr. Katti, the capital cost of putting up a N-power plant is about Rs. 14,000 per KW, but according to the Worldwatch Institute, it is as high as \$ 3,700 (about Rs. 60,000) per KW.<sup>55/</sup> Apart from this, comparably large amounts are needed to run the plants. Thus, Rs. 700 crores are to be invested in 3 N-fuel plants in Bihar, Kerala and at Hyderabad. The Manuguru Heavy Water plant of 185 tons per year capacity which was originally estimated to cost about Rs. 421 crores is now estimated to need an investment of nearly Rs. 650 crores, half of it in foreign exchange. The performance budget of the Narora unit envisages import of Rs. 130 crores of heavy water. The country's total foreign exchange outgo for heavy water, according to the PAC report was Rs. 1936 crores instead of the originally estimated Rs. 7 crores.<sup>56/</sup>

The first unit of the Narora N-power plant cost some Rs. 530 crores instead of the originally estimated Rs. 230 crores. Similarly, on the Kakrapar plant, Rs. 497 crores were spent till May, 1989 when only about 55 per cent of the work was completed, against the original estimate of about Rs. 383 crores for the whole project.<sup>57/</sup> It, thus appears that a realistic estimate of the

capital cost per KW for a N-power plant is simply not possible on the basis of experience in our country so far.

All aspects considered, there seems to be no doubt that the worldwide experience that N-power is unsafe and more expensive than thermal power is being replicated in our country and the facile claims of the nuclear establishment are untrue and highly misleading.

#### AGRICULTURE

The agricultural technology which made the green revolution possible in our country as in several other countries, is based on the use of high yielding varieties of seeds responsive to chemical fertilizers, high doses of such fertilizers, pesticides, weedicides, irrigation and farm machinery. This highly capital and input intensive technology is within the reach of only relatively larger farmers. Most of the inputs are also highly energy intensive. Fertilizers and other farm chemicals are energy intensive products. Farm machines including the metal they are made of, also demand much energy for their production and operation. So does irrigation. Yields from land, no doubt, go up impressively, but at the expense of a great deal of energy. Besides, the doses of fertilizers have to be constantly increased even to maintain steady yield levels, not to speak of increasing them. Between 1953 and 1972, total energy input into agriculture in the industrialised countries of the capitalist world increased by around 70 per cent, but food production rose only about 30 per cent. Researchers at Cornell University found that between 1945 and 1970, corn yields in the US had risen by 138 per cent, but energy inputs had increased threefold.<sup>58/</sup> A calculation made in 1975 showed that to provide the developing world with a European level diet based on fossil fuel energy subsidies used in the British system of food production, would have required a doubling of the total energy consumption in these countries just for food production and consumption.<sup>59/</sup>

While modern agricultural technology raises yields from land it is doubtful if it increases the total productivity of agriculture. In the EEC countries, although prices are maintained at 30 to 70 per cent above world prices and imports are strictly controlled, agriculture has to be heavily subsidised, to the tune of about \$ 16 billion in 1984. In the US too, state budgetary support to agriculture amounted in 1982 to about 38 per cent of agricultural value added. Agricultural subsidies in the US which amounted to an average of about \$ 3 billion per year in the 70s rose to \$ 19 billion in the early 80s. In India too, although land yields are highest in the green revolution states of Punjab and Haryana, total cost of cultivation per ton of grain are also highest there. In 1983-84, cost of cultivation per quintal of paddy was Rs. 77.94 in the Punjab and Rs. 84.38 in Haryana compared to Rs. 56.20 in Bihar, Rs. 51.88 in Madhya Pradesh, 60.06 in Orissa and 67.49 in West Bengal. For wheat, the cost of cultivation per quintal in the same year was Rs. 84.32 in the Punjab, 84.28 in Haryana compared to 77.01 in Madhya Pradesh and 79.65 in Rajasthan.

Thus, modern agricultural technology does not lead to reduced cost of cultivation per unit of output. In many developed countries, inspite of the use of high agricultural technology, agriculture can be sustained only through massive support from Government. We lament the heavy and increasing public subsidies that have

to be extended to foodgrains and fertilizers. Experience from developed countries, however, suggests that there may indeed be no escape from them, given the same kind of input and energy intensive agricultural technology being promoted here. The real beneficiaries of these subsidies, of course, are the relatively large farmers.

Long term effects of this technology on the quality of soil, it is feared, are likely to be serious. Ever increasing doses of fertilizers and other farm chemicals needed to maintain farm yields adversely affect soil texture and lead to progressive desertification. Increasing use of irrigation results in salination of the soil on the one hand and fall in the subsoil water level on the other, reducing the productivity of the soil and making irrigation ever more expensive. The more recent irrigation technologies like sprinkler and drip irrigation are devised to save on water needed for irrigation. But they are highly capital intensive. Drip irrigation system is estimated to need an investment of 10,000 to 15,000 rupees per hectare. It will be beyond the means of a vast majority of farmers in our country, and even for those who can afford it, it will push up the cost of cultivation significantly. The generous subsidies offered by Government to such irrigation technologies simply mean that the costs are transferred from the large and relatively prosperous farmers who will benefit from them to the society at large.

Irrigation based on large dams creates its own problems. Valuable forests and arable land gets submerged under the water reservoirs so created. Tens of thousands of families mostly from the poorest sections are uprooted and experience so far is that assurances of their rehabilitation are hardly ever fully kept. Again those who pay the price for these huge projects are quite different from those who reap the benefits. Besides, the reservoirs tend to silt up much faster than anticipated, reducing the useful life of the irrigation system, often by as much as half. Water-logging of the irrigated land is also an accompanying problem.

Farm machinery is patently labour displacing and those who are displaced by it do not have the skills or training to find work in any other activities in a developing society. In a country in which the numbers of landless labourers and the unemployed is vast and constantly rising, replacement of farm labour by machines cannot but add further to rural unemployment.

Biotechnology is the newest factor about to be introduced into our agriculture. It is claimed that this technology will revolutionise agriculture by introducing genetically engineered seeds which will be high yielding, pest resistant, disease resistant and adapted to specific soil conditions and climates. Horticulture and livestock also, it is claimed, will be greatly improved. That biotechnology has the potential of doing these things may perhaps be true. But whether it will really be applied for these purposes may be doubted. The development of this technology is already under the control of a handful of powerful multinational corporations from the developed countries. These are also the corporations who control the production and/or markets of farm chemicals, seed and grain markets worldwide. Their objectives in promoting this technology is naturally to gain greater control of the entire agricultural activity in as large a part of the world as possible for their own profit. These multinationals are known to use developing countries for gathering

genetic material and for experiments and product trials on their fields, fruits and livestock. The wide diversity of strains in the same trees, species of fruits, vegetables, grains or livestock so valuable economically, gets narrowed and standardised worldwide and pass under the control of the genetic engineering corporations. Above all, all the research and development in this technology is going on almost in secrecy in private corporations and its results will be used to manipulate the destiny of hundreds of millions of farmers and consumers especially in the developing countries for the profit of these corporations. No one can calculate today what the cost of such manipulation will be to the ecology and to the people in the developing world.

Closely related to agriculture is the food processing industry. During the past three or four years public policy in our country has placed much stress on developing this industry and it has been raised to the status of a 'thrust industry' for exports. The development of this industry is planned with the help of multinational giants who are being given various concessions here.

Almost by definition, processing of food adds to its cost and subtracts from its nutritional values. In a country in which half or more of the population finds it difficult to buy any kind of food, to make food more expensive to make it saleable in foreign markets is itself an indication of the perverse priorities of our policy makers. Besides, food processing is also an energy intensive industry. A survey of the industrialised capitalist countries undertaken by the OECD found that on an average, the food system used 20 per cent of all energy and that within the food system, 75 per cent of the energy was used beyond the farm gate. It is estimated that on an average it takes 10 Kilocalories of energy to place 1 Kilocalory of food energy on the table in the industrialised capitalist countries. Norman Borlaug, Nobel Prize winning agricultural scientist, described the American food system as an 'energy sink'. 60/ Evidently, the thrust on food processing will place food even further beyond the reach of the poor in our country than it already is. Above all, since the food processing industry is also dominated by multinational giants, our farmers will find themselves at the mercy of these giants about what to grow, whom to sell and at what price.

#### TECHNOLOGY IN INDIA

I have already dealt at some length with what is happening in our country in some important technologies like informatics, nuclear power, agriculture and biotechnology and so on. But it will be useful to take a more systematic look at technology in our country : the official policy, actual developments and their impact particularly in the context of the problem of poverty.

The technology policy for India was announced by the then Prime Minister Indira Gandhi on 3 January 1983 at the Annual Session of the Indian Science Congress at Tirupati. The aims of the policy were stated to be:

1. Attain technological competence and self-reliance, reduce vulnerability, particularly in strategic and critical areas, make maximum use of indigenous resources;



2. Provide maximum gainful and satisfying employment to all strata of society with emphasis on the employment of women and weaker sections of society;

3. Use traditional skills and capabilities making them commercially competitive;

4. Ensure correct mix between mass production technologies and production by the masses;

5. Ensure maximum development with minimum capital outlay;

6. Identify obsolescence of technology in use and arrange for modernisation of both equipment and technology;

7. Develop technology which is internationally competitive, particularly that with export potential;

8. Improve production speedily through greater efficiency and fuller utilisation of existing capabilities and enhance the quality and reliability of performance and output;

9. Reduce demand on energy, particularly energy from non-renewable sources;

10. Ensure harmony with the environment, preserve the ecological balance and improve the quality of the habitat; and

11. Recycle waste material and make full utilization of byproducts.

The basic objective of the technology policy was stated to be the development of indigenous technology and efficient absorption and adoption of imported technology appropriate for national priorities and resources. Government was to evolve instruments for the implementation of the policy and spell out detailed guidelines for ministries and agencies of Government and for industries and entrepreneurs. As is usual, a committee was appointed in June, 1983, to do this, whose term was to expire in February 1987.

Subsequently, an official declaration of policy on computers and electronics was issued by Government on 14 November 1984 and 21 March 1985 respectively. These have been dealt with by me earlier in these lectures.

Apart from the official policy declarations, high government dignitaries including ministers and the Prime Minister continue to make, from time to time, declarations relating to technologies and programmes.

The kind of catch-all formulation of policy as announced by the PM in the beginning of 1983, can mean, in practice, everything or nothing. Whatever those in authority at any given time want or do not want to do, can be justified on the basis of one or another of the items of such a policy. The declaration gives no indication of priorities among the various objectives. Those who take specific decisions have, as a class, their own perspectives and policies and they take decisions according to these. Since entry into the 21st century, catching up with the West and not missing the electronic revolution became the catch phrases with

the policy makers, and decisions began to be made under advice of scientists and technologists who have earned their spurs in the industrialised world, several of the objectives of the 1983 statement on technology went by the board. Technological competence is now sought even in sectors like food processing through import rather than self-reliance. Indeed, we proudly advertise the rising figures of foreign collaborations year after year as a mark of our development and progress. Providing gainful employment has gone out of the field of technology and into the haze of Jawahar and Nehru Rozgar Yojanas. Traditional capabilities and skills are rapidly being superceded by the latest electronics and informatics, mostly imported, and even drinking water and literacy are made subjects for so-called technology missions inspired by foreign returned technologists rather than of harnessing traditional skills and capabilities. In the mix of mass production technologies and production by the masses, the latter is being increasingly displaced by the former as products formerly reserved for the small sector are thrown open for large scale industry. The capital intensity of agriculture, mining and manufacturing rises steeply while planners and policy makers rejoice that capital output ratio appears to be falling. They conveniently cover up the fact that this apparent fall is due to the breathless growth of government administration and the low capital intensity service sectors which contribute little or nothing to satisfying the real needs of the people at large. Development of technology is made synonymous with import of technology. Far from reducing demands on energy, these demands rise steeply due to mindless encouragement to energy intensive agriculture, automobiles, air services and so on. Harmony with the environment and protection of the planet are slogans now carried to the international fora while environmentally hazardous nuclear plants are enthusiastically promoted and monstrosities like the Narmada project and the Tehri dam are launched in the face of the bitter opposition of the local populations. The important point to note is that almost every decision on priority that gets made formally and deliberately or informally through administrative acts of commission or omission, goes against the interests of the poor and the weak and favours the rich and the powerful. Thus a high-sounding, catch-all declaration of technology policy really becomes a trap for the poor, "...the slogan of science and technology as the essence of progress has given rise to a 'silicon state' under which banner the ruling classes have ruthlessly carried out their strategy of development to consolidate their power. This development strategy is a part of the world process which creates structures of dominance and dependence and generates forces of militarisation."61/

This kind of a technology policy operates in practice to sustain and promote a particular pattern of economic development. Between 1983-84 and 1987-88 over Rs. 1000 crores were invested in fixed assets of civil aviation and currently we are acquiring a number of airbuses and Boeing 474 aircraft at a cost of well over Rs. 2000 crores. Most of this will be in foreign exchange and in future too, spares and components for the aircraft will need to be imported. Employment potential of this investment will not be significant in our country although it will create jobs in other countries. And hardly one in ten thousand Indians ever travels by air. At the same time the railways which directly or indirectly serve all our people, which provide direct and indirect employment to lakhs of our people are starved of investment and forced to borrow from the public. Even proper track renewal and upkeep of rolling stock suffer because of shortage of funds, not

to speak of expansion of the railway network. Road transport, the other transport which is so vital for all our people, fares equally badly because of low investment and miserable state of the roads.

According to the Economic Survey, 1988-89, the production of railway wagons in our country has increased by a mere 16 per cent from 1980-81 to 1987-88, that of commercial vehicles by 68 per cent and of bicycles by 59 per cent. But over the same period, the output of passenger cars and jeeps rose by 247 per cent and of automobile two wheelers by 245 per cent. It is well known that per passenger-Km, the cost, both capital and running, of a car or jeep is much higher than that of a bus. Cars and jeeps are useless for goods transportation. They also occupy too much road space per passenger carried than the buses and thereby slow down urban traffic. One two wheeler manufacturer loudly advertises that it is infra-dig for a young boy or girl to ride a bicycle after going to college. In a country in which it is a privilege to be able to go college at all, and in which most parents have to pinch themselves to put their offspring through college, these youths are being incited to feel deprived if their parents cannot give them two wheelers to ride. Thus, a grievance among the youths against their parents and a guilt feeling among the parents are deliberately sought to be planted because a two wheeler producer must make a profit by selling his product which, in respect of ecology, economy and health, is distinctly inferior to a bicycle, especially for youths who have to travel perhaps only a couple of kilometers to and from college. What better example does one need of technology deliberately creating a want - not a need - for private profit at the expense of so many values.

In electronics, much of the growth, as already discussed, is in consumer products and informatics in the service sector which is highly labour-displacing. Even this growth is in the strength of imported kits and components. High priority is assigned in current programmes to rural telephone exchanges. How many villagers apart from the rural elites and the power brokers need or will have any use for telephones in the foreseeable future? What will they speak over these telephones and with whom?

Diffusion of advanced technology in mining and manufacturing leads to increase in capital-output ratio, that is, to less productive use of capital. It also leads to increase in labour productivity and stagnation if not actual fall in employment. In the factory sector in our country, according to the Annual Survey of Industries, total employment was about 77.15 lakhs in 1980. It rose to about 80.10 lakhs in 1982 but came down to 78.72 lakhs in 1984. However, over the period 1980 to 1984, value added by manufacture in the factory sector at 1970 prices rose from about Rs. 4106 crores to about 6031 crores that is by about 47 per cent. According to the Economic Survey, 1988-89, total employment in private sector manufacturing industry actually fell from 46.61 lakhs in 1982 to 42.09 lakhs (provisional) in 1987. Similarly, in mining and quarrying, private sector employment fell during the same period from 1.29 lakhs to 0.91 lakhs. Total private sector employment was 75.47 lakhs in 1982 but only 73.60 in 1987. These losses in the private sector were compensated by almost equal increases in employment in public sector mining and manufacturing. But aggregate employment in these sectors has remained almost stagnant although production has increased significantly. For instance, in coal mining total employment has fluctuated between

5 and 5.5 lakhs while output of coal has risen from 10.9 crores tonnes to almost 15 crores tonnes from 1980 to 1985. Thus, we seem to have arrived at the stage of jobless growth at least in the mining and factory sectors. Indeed, the most recent trends indicate that we may be actually entering the stage of growth with job losses in these sectors.

It is usually argued, as has been done by the Panel on Technology and Employment of the National Academy of Sciences, US, in the quotation I cited earlier, that by reducing prices and stimulating industrial and economic growth, more jobs may be generated elsewhere than are displaced at the place where advanced technology is introduced. At least in our country's organised sector, we do not see much evidence of this happening. Even in the fast growing service sector employment is rising sluggishly if at all. In finance, insurance, real estate, etc., less than one lakh new jobs were created between 1980 and 1987 and only about 25,000 in wholesale and retail trade. In construction too, only about one lakh additional jobs came up over the same period. The only significant employment generation during this period was in community, social and personal services.

It could, of course, be argued that jobs may have been created in the informal sector as a result of the advent of advanced technology in the organised sector. Such an argument has the dubious merit that it cannot be tested. But even if we were to concede this argument, it would really mean preemption or relatively better jobs and generation of poorly paid, sweated and insecure jobs.

Actual diffusion of new technology takes place not so much in accordance with policies prescribed by Government, but through decisions taken by numerous individual managers, technologists and entrepreneurs in industries to meet their own immediate perceived or real needs. This is all the more so since the advent of the liberalisation policies in the 80s. Profit is the overriding consideration behind such decisions whether in the private or in the public sector. Their whole perspective is circumscribed by their own social background, life-styles and career aspirations. Broader socio-economic implications and consequences of their decisions hardly enter their calculations of costs and benefits.

Behind much of the R & D effort in S & T in our country, the idea seems to be whatever is being done or attempted in the developed world must also be attempted by us, regardless of its relevance to the present stage of our development or the real needs of our people. Since some years ago, the developed countries were devoting much effort to R & D in superconductivity. Our policy makers also decided that we must also follow suit. It is doubtful if the likely costs of undertaking major R & D effort in this field and the possible benefits that could be expected from it were ever considered seriously. Now, research in this field has run into certain possibly unsurmountable problems which raise serious doubts about the future of superconductivity as a usable technology.

62/

Similarly, when biotechnology became the buzz word in the industrial countries, we also got excited about it, set up a department of biotechnology at the Centre and started looking for help from abroad for R & D work in that field. But, as mentioned earlier, most research in biotechnology in the industrial countries

is being done in secrecy in private corporations whose objective is larger profits through domination of world markets. Nevertheless, our country has permitted unrestricted entry through private channels for foreign bred, probably genetically engineered seeds marketed by multinational giants for their own commercial objectives. We have perhaps no means of finding out before it is too late, what such freely imported foreign bred seeds will do to our agriculture, farmers, genetic stock and ecology.

Again, as mentioned earlier, one of the thrust areas for development and exports has been identified as food processing and we are enlisting foreign technology and collaborations for the purpose. Goetze (India) which has little standing in the food processing industry in the past, has applied for official clearance under the monopoly laws to enter the liquor market. Their plan is to produce 10,000 kololitres of potable alcohol per year from grain in a backward district in UP with an investment of Rs. 10 crores and expected annual turnover of Rs. 60 crores.63/

In the year 1987-88, a drought year, we exported Rs.324 crores worth of rice, a staple food of our people, and Rs. 525 crores worth of sea foods, an important source of protein for our people. We also exported over Rs. 3000 crores worth of textiles and garments, the other basic need of our people. These went to sustain massive imports of capital goods and petroleum products. When the resulting trade deficit grew to a size that invited adverse criticism, one of the import items to be slashed first was edible oils. Thus items of basic needs of common people are exported in large quantities to support imports which benefit a relatively small, affluent group. Such is the pattern of development which modern technology serves to promote in the existing socio-economic and power structure in our country.

For the pursuit of this strategy, S & T must be raised to the status of an article of faith, a holy cow. Thus, when the National Science and Technology Commission was set up recently with the PM at its head, it was stated that its purpose is to blend S & T with planning. The declared idea is that at the turn of the century, S & T should make inroads into planning at the village, district and state levels. "...Once these efforts bear fruit, we may expect a total change in the national attitude to S & T. ...A widely prevalent scientific temper among a section of our people will make our society culturally richer and more vital..."  
64/

Advent of advanced technology into services like medical and education does, no doubt, bring many significant benefits. But thereby, the already wide gap between the standards of service available to the elites and the poor is widened further. For, it is only the institutions catering for the relatively rich that can afford to acquire advanced technology. We thus have, on the one hand, a handful of large, modern hospitals with highly qualified doctors, paramedical staff and all kinds of diagnostic, clinical and surgical aids provided by modern S & T; but only the relatively wealthy few can avail of them. On the other hand, people in general even in the urban centres must remain content with such medical aid as they can get at overcrowded, poorly equipped government or municipal hospitals. And the health centres in the rural areas are often without doctors, equipment and medicines. To a great many of our people, even this kind of medical service is not accessible.

The same disparity obtains in the field of education. A large number of rural primary schools are without buildings, equipment and even teachers. Municipal schools in the cities and towns are only slightly better. But a few exclusive schools are able to extend the benefits of modern teaching aids including computers, to their students who come mostly from the relatively better off families.

A great deal of R & D effort in technology goes into military applications. While we deprecate the appalling waste of resources resulting from the arms race between the superpowers, we ourselves behave no differently and gloat over our success in achieving the technological capability of carrying out nuclear explosion and developing missiles like Prithvi and Agni at costs that a country like ours can ill afford. The superpowers are, mercifully, slowing down their arms race and we applaud President Gorbachev for his unilateral initiatives in bringing about this slow down. But we go on building up our military strength. Defence has been made into a holy cow in our country and to say anything against this rampant technology-based militarisation is to invite the charge of being unpatriotic. Yet, it is time that concerned citizens raise their voices and question whether national defence capability is really advanced by this diversion of vast resources and technology to military applications, or we merely drive our neighbours to do likewise leaving the military power balance unchanged. Sections of our society do, no doubt, benefit directly and substantially from this huge military expenditure, but the cost has to be borne by the common people.

"Should we then live perpetually in the bullock cart age", some people ask when they hear the kind of views expressed in these lectures about technology. They believe that this rhetorical question clinches the argument in favour of modern technology. In reality, the question is irrelevant and misleading. For, the choice is not between the bullock cart and the jet plane or the nuclear power plant only, apart from the fact that the bullock cart is not something inherently shameful for the society.

Technology is not a homogeneous entity. It is also not value free nor neutral to the socio-economic and power structure. It is, therefore, dangerous to adopt it as an ideology or an article of faith. Technology is a power which lends itself, as it has done all along in history, as much for conquest, destruction, domination, exploitation and private profit as for doing good to humanity, perhaps, more for the former than for the latter. This power tends to go under the control of those who are already powerful socially, economically and politically, and make them even more powerful in all these respects. In our approach to technology, we cannot afford to be unmindful of this reality.

Technology has many streams and stages and it is possible to make intelligent choices among them rather than view all technology, technology in an abstract or fundamentalist sense, as benign, or inexorable or to take a 'take it or leave it' attitude towards it. Some streams of technology, like the nuclear, deserve to be discarded totally as the Greenpeace International and so many others round the world are urging. The dangers inherent in it are too grave for the entire humanity. There are, no doubt, some benefits too; but the dangers far outweigh the possible benefits.

For a rational and beneficial choice and application of technologies, our developmental model and strategies must themselves be clearly and unambiguously formulated with a firm people-orientation rather than mere growth-orientation. Objectives of development as also priorities among them must be clearly defined and the intended beneficiaries clearly identified. The choices of technological tools must subserve the accepted developmental model and strategy as well as the priority objectives. This choice is too important to be left to technologists whose vision is usually circumscribed by their own field of specialisation. Nor must the choice be made under any technological imperatives nor imposed upon us by external agencies like multinational corporations and international financing institutions. Considerations of private profit and consumerism of the elites can also not be permitted to dictate the choice of technologies. Appropriate policy and administrative instruments must be forged to ensure effective enforcement of the choices made.

In making actual choices of technology, policy makers must ask themselves some questions: The very first question should be the criterion set by Gandhiji: think of the poorest, weakest, most oppressed and ask whether the proposed technology will reduce or increase his poverty, weakness, oppression. Will the proposed technology create additional gainful jobs or take away existing jobs? Will it make the intended beneficiaries less dependent or more, on outside agencies and the bureaucracy? Will it make us less dependent or more as a nation on multinational corporations? What will be the cost of the intended technology in relation to the likely benefits to the society? Which groups will benefit from it and who will bear the cost? How will it affect the environment? Clear and unambiguous answers to questions like these will enable us to use technology as a weapon against poverty. Else, we shall only spread poverty through indiscriminate adoption of modern technology as we seem to be doing today.

## EPILOGUE

When one expresses doubts about the benignness of technology as it has developed and is developing in the modern age and in the prevailing socio-economic and power structure in the world as also with in many countries of the world, one is often misunderstood as if rejecting all technology under all socio-economic and political conditions. It is necessary, therefore, to repeat that discussing the nature of technology in the abstract is pointless as its nature and impact cannot be discussed apart from its specific and the political and socio-economic context.

This raises the question whether in discussing technology and poverty, we should not focus on the socio-economic and power structure first since it is this structure that leads to specific developmental models and technology choices that operate against the poor. The question is important. Conceptually, it would be right to say that correct development, choices and applications of technology for the removal of poverty, are not possible within the prevailing structure. But in real life, at any given time, the existing structure is a datum, whether we like it or not, and the task of minimising the harm and maximising the benefits of technology through right choices and applications, has to be faced within the structure. It cannot be postponed till the structure is first transformed according to our ideas. Some improvement, admittedly quite limited, in the way technology choices and applications take place today, is not impossible even within the present structure. Hence, efforts in that direction need to be kept up. Besides, intensive discussion of the linkages between modern technology as applied currently and poverty is also necessary to expose and resist the process of strengthening and perpetuating the present structure through technology.

"But how can we go back? How can we put back the clock of technology?" is another question that is often asked. This question assumes the inexorability of the sweep of modern technology and our helplessness to stop or even to influence it. Objectively, there is no ground for such an assumption. It is indicative of the effectiveness of high pressure salesmanship of the protagonists of modern technology who are also its main beneficiaries. It also betrays a dependency complex. What is there to prevent us from choosing and developing technologies needed to tackle the real problems of our people, especially of the poor, and suited to our resources and natural endowment? Which technologies to develop and for what objectives, can be decided by us if we have the will to do so. And in doing so, if we get convinced that somewhere along the line, we have been led to take the wrong turns away from our real goals of poverty removal, self-reliance and social justice, will it not be right to 'go back'?

Advanced technology, it is argued, is necessary because we must raise our exports and for doing that, our industry must become internationally competitive. Actually, our corporate industrial sector, which is the main user of modern production technology, is a net spender and not earner of foreign exchange. (Vidya Pitre, EPW, 23-9-1989). The worst offenders in this foreign exchange profligacy, according to Pitre, are the engineering and chemical industries, the leaders in the use of (mostly imported) modern technology, plant and machinery. The real foreign exchange



earners are the traditional sectors and the low technology industries.

More basically, does a large country like India, generously endowed by nature, need to view itself so dependent on exports as to subordinate other vital socio-economic objectives in the pursuit of larger exports. After all, exports go to support ever larger imports and in our present system, there is enough evidence that much of the imports go to whet and feed the consumerist appetites of the elites rather than contribute to removal of poverty.

Requirements of national defence, according to many, not only justify but dictate the adoption of the most advanced technology even at very heavy cost. Some even go to the length of urging that India should develop nuclear weapons for defence. Our neighbour, Pakistan, is acquiring advanced military aircraft and weapon systems and is also reportedly acquiring nuclear weapon capability. China, the other big neighbour, already has nuclear weapons. Hence, it is argued, we too need the most modern weaponry to defend our country. So overbearing is this argument that it does not admit of a critical-examination of questions like how much is enough, who is pushing whom in this arms race and what is the cost-benefit relation of what we do in the name of defence.

Our main concern is with the military balance with Pakistan. Over the past two decades, both countries have spent untold thousands of crores of rupees, and continue to do so, in the hope of altering that balance to their respective advantage. Yet, that balance does not seem to have altered decisively either way. The world as a whole continues to view India as the stronger of the two militarily. This is a typical arms race scenerio and there is no point in debating who started it. What is needed is a bold initiative to deescalate it.

To feed our growing population and provide raw materials for some of our major industries, it is necessary that agricultural production rises and, in turn, yield per hectare also rises. The green revolution technology achieved this in respect of wheat and that was, without doubt, a vital achievement. But serious questions are now arising whether that technology is really viable in terms of sustainable increases in yield in the long run. According to Vandana Shiva, "Punjab is neither a land of prosperity nor peace. It is a region riddled with discontent and violence. Punjab has been left with diseased soils, pest infected crops, water-logged deserts and indebted and discontented farmers. Instead of peace, Punjab has inherited conflict and violence." And again, at the root of the Punjab crisis, are 'tensions between a discontented and disillusioned farming community and a centralising state which controls agricultural policy, finance, credits, inputs and prices of agricultural commodities. At the heart of these conflicts and disillusionment lies the Green Revolution" (Vandana Shiva : The Violence of the Green Revolution: Ecological Degradation and Political Conflict in Punjab).

Serious efforts to develop alternative technologies that will nourish, not impoverish the soil, that will not be profligate in the use of energy and chemicals and that will not place the farmer, especially the small and marginal farmer at the mercy of external agencies, that will make optimal use of available labour, are being made. But most of these are being made by voluntary groups

on very small scale on shoe-string budgets. Yet, these efforts do raise the hope that alternative, more viable agricultural technology is distinctly possible.

If modern production technology is often not cost-effective, how is it that managements show so much enthusiasm for it? There may be several reasons. One is the influence of the technology ideology on the people who take the decisions. Another may be that the organisation may be thinking of markets in which some increase in price may not be an adverse factor. But one important factor is that by extending various concessions and incentives, public policy has made the price of capital cheaper than it should be in a capital-scarce country like ours. In at least some cases, wrong decisions are induced by the high pressure salesmanship of the vendors of capital equipment.

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