

Training /

TECHNOLOGY FOR PROGRESS

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**Training Division
Department of Personnel and Administrative Reforms
Government of India
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DEPARTMENT OF PERSONNEL AND ADMINISTRATIVE REFORMS
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FOREWORD

Earlier this year the Government of India issued a Technology Policy Statement (January, 1983). The Policy Statement underlines the premise that for a country of India's size and enormity, self-reliance is of utmost importance and the use and development of technology must relate to the needs and aspirations of the people. Prof. M.G.K. Menon, Member, Planning Commission has in a recent lecture "Technology for Progress" analysed various aspects of the Policy Statement especially technology forecasting, assessment and observation. We hope the publication will prove to be of interest to all concerned.

U.C. Agarwal
(U.C. AGARWAL)

Secretary,

July 29, 1983.

Department of Personnel and A.R.

With Compliments From

A. P. SAXENA
Joint Secretary (Training)

Department of Personnel and Administrative Reforms
Ministry of Home Affairs
New Delhi.

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TECHNOLOGY FOR PROGRESS

Technology and Science: Their Separate Development

Let me start by asking the question: What is technology? Humankind has, through the ages, moved along the path of evolution, acquiring new traits and skills and adapting itself to the environment. This was necessary to survive and to develop. There was a succession of capabilities which defined the various Ages: the Stone Age, the Iron Age, the Bronze Age and the Copper Age. These were periods when skills were developed to make tools to accomplish what was essential for life and growth; for hunting and for fighting. These tools were further improved in quality and capability with time. A major development was that relating to agriculture, which transformed society from a nomadic life style to one based on human settlements.

A basic point to remember is that, at this stage of evolution, what was developed were really empirical skills, which had a close relationship with everyday human life and activity. Parallel developments took place in a variety of places in the world, one sees evidence for the Neolithic Age or the Megalithic Age or the Chalcolithic Age at many places in the world and at different points in time.

None of these developments awaited a basic understanding of underlying principles. What was developed was a skill or a technique. Later, those who practised a skill or technique came together, for example in the form of craft guilds, and so on. These skills involved coordination between the hand and eye; but there was no process of intellectual understanding and reasoning. What was important was to do something, and to do it well; survival and growth depended on it. This can be clearly seen, for example, in many of the crafts which we have in our country: we have outstanding artisans; they produce superb artefacts with great artistic content as well as functional elements; but they cannot explain the reasoning behind their work. Technology, at that stage, progressed in terms of the development of techniques, on an empirical basis. A remarkable example was the steam engine which has had such a significant societal impact, but which was not developed, as often assumed, from an improved understanding of thermodynamics which came only much later.

Science developed in parallel, fuelled by man's desire to understand his surroundings and the natural phenomena that he observed. Its origins lie in man's sense of curiosity and the process of logical reasoning (inherent in the human brain), which is the one capability which separates man from all other forms of living systems in a significant way.

I do not want to dwell on these historical or anthropological developments at any length, except to say that today the position is completely different. It is different essentially because of the coming together of these two streams: of science on the one hand and of technology and skills on the other.

Science is not so much a vast repository of knowledge, or complicated instruments and equipment demanding specialized capabilities, as often assumed. These are, no doubt, a part of a great deal of science as practised today. But primarily, science represents the spirit of enquiry and the process of logical reasoning. What is important is the scientific method: which consists of making observations, making measurements with the greatest precision possible, analysing the observations and measurements, building a hypothesis or theory which could involve generalization and prediction of other phenomena, experiments to test the hypothesis or theory; and so on. There is no acceptance of authority. What is involved is a combination of observation, experimentation and theory. What is accepted finally is that which can be confirmed independently by anyone desirous of verifying the facts. It is also true that there are many aspects in life, and phenomena, that are inexplicable at any point of time, even with the best of available scientific knowledge and capabilities.

Science and Technology Today: A Symbiotic Relationship

This process of logical reasoning, and the scientific method, has now merged with the area of skills and techniques. There are some who assume that now we are in a technology spiral, and that technology is an independent entity which can progress on its own. This is true in many cases of gradual, gentler and more easily assimilated changes. But it is not so in the case of the many innovations that are now being made,

whose social impact is orders of magnitude larger than the gradual technological changes; these major changes on the technological scene are science-based. I assert that technological change and advancement of such magnitude takes place only through the use of the scientific method. Further, the use of the scientific method to understand natural phenomena without the end objectives of producing items for use, enlarges the stock of knowledge and brings out new possibilities that later find undreamed of applications, as we shall see from examples cited later in this paper. It may be that an individual is called an engineer or technologist and is highly trained technically to perform tasks that demand such training and skills. It is, however, when he uses the scientific method that he innovates and becomes creative to produce technological change.

For example, you can have an enormously skilled glass-blower; he may produce wonderful pieces of glass work, and indeed can be a creative artist in his work. He needs to understand some of the properties of the material he is working with to achieve his results. But new technologies in the use of glass and ceramics have come about when the scientific aspects have been developed, resulting in new material with new properties and new machines etc.

Thus the first feature that needs to be stressed is: there is today a symbiotic relationship between science and technology. Technology is spectacularly moving forward essentially through the use of the scientific method in technology. Equally, great scientific advances are taking place because of the technological tools that are becoming rapidly available.

Let me illustrate this with one area of modern science and technology. We talk today of an entire interconnected area of nuclear science and technology covering nuclear weapons systems, nuclear power systems, applications of isotopes in medicine, industry etc. But only about fifty years ago there were none of these technologies. How did this field develop? The important early steps were entirely science-related: namely, the discoveries in radioactivity by Becquerel and the Curies; the discovery of the nucleus of the atom by Rutherford; the conceptual relationship discovered by Einstein between Mass and Energy,

characterized by the famous equation $E=mc^2$; the discovery of the neutron by Chadwick; of nuclear fusion by Hahn and Meitner; and of the chain reaction by Fermi. The demands of war set a major technological goal - to make the atomic bomb. The Manhattan Project to accomplish this involved physicists, mathematicians, chemists, material scientists, and technologists of all types. One had the awesome result: the first successful explosion at Alamogordo, and the bombs dropped over Hiroshima and Nagasaki, which has since led to the weapons stock-pile of today. We now have an entire nuclear industry relating to nuclear reactors for producing power and isotopes. After the Manhattan Project technology assumed command. But this technology has in turn depended on related scientific advances in materials science, in chemistry, in electronics and instrumentation, and so on. The development of the symbiotic relationship of science with nuclear technologies is clearly seen.

The second point which needs to be emphasized is that technology is not related to industry alone, as many tend to assume. Technology relates to all areas of production and end-use. Thus, there is today Agricultural Technology as also Medical Technology. Some of the greatest advances that are going to take place in the decades ahead are based on scientific discoveries of the past thirty-odd years in the field of Life Sciences; it is this which has given rise to the range of Biotechnologies.

A new area of technology which is going to fashion the future of the very nature of human society is information technology. This deals with information storage, processing, transfer, communication, retrieval and utilization. There is a whole information industry which has been created in recent years. It has its hardware in the form of computers, displays, communication devices and so on. It has also its software, for which there is a rapidly developing technology. So we must get out of the concept of technology as being related purely to hardware.

Therefore, it is not only industry, in the sense of factories and production units of that nature, or hardware, which one must take note of when one refers to Technology. One is talking of the use of the scientific method to produce advances in skills and capabilities for a variety of end-uses.

The Innovation Chain

At this point, it is important to mention one other basic element: the concept of the innovation chain. When we refer to "production based on innovation", we must understand that there is a long chain of steps that is involved in this—from an original idea or discovery in a research laboratory being translated into a workable proposition, through aspects of: applied research to demonstrate the feasibility of a product, process or use; engineering design; pilot plant production to establish technologies relevant to large-scale production, and the related economics; extension services in the case of agriculture; and so on. All this has to take place before actual manufacture or use is established. The number and nature of the steps differ from area to area, and for different technologies; they can often be telescoped. But the fact that there is such a chain needs to be understood. Investment all down this chain are essential. Further, investments in the earlier stages of the innovation chain, in pure or applied research, are of the order of only ten per cent of the total investments involved. Programmes of research and development aimed at achieving end-products, processes etc., should be initiated only if it can be assured that the much larger investments down the innovation chain can be provided; otherwise the initial investments will be only in the nature of competence or capability building.

Let me illustrate, with one area of recent development, some of the aspects that have just been considered on general grounds. Lasers or devices based on Light Amplification by Stimulated Emission Radiation can today be bought as end-products turned out by factories. One can see the use of lasers in a wide range of applications: by surveyors to define straight lines; for range-finding; by doctors who wish to do surgery such as attachment of detached retinas; in electronic industry, for trimming resistors to obtain exact values of resistance; for cutting metal etc., in the metallurgical industry; in environmental monitoring; in inertial confinement experiments in fusion physics where the aim is to produce, finally, energy through fusion; in weapon systems; and so on. Lasers have given new life to areas of science such as

spectroscopy, that were important as fundamental areas earlier and characterized by great discoveries. They have opened up a whole new field of quantum electronics.

This is quite an extensive and impressive range of applications. However, lasers are not all that old. Of course, they are quite old in basic principle, and spring from the work of Einstein of about three quarters of a century ago. But the development of masers (Microwave Amplification using Stimulated Emission Radiation) and that of lasers took place during the 1950s in what were essentially university laboratories. It was the rapid appreciation of their potential and emergence of needs that could make use of them which resulted in their entry into society on the intensity and diversity seen at present. Lasers represent a highly science-based technology; and we see clearly in this field the symbiotic relationship between science and technology. A detailed study of the development of this field will also show how steps in the innovation chain can be compressed. Many other such examples that can be given: for example, the field of Solid State Electronics based on quantum mechanical understanding of solid state phenomena, which gave rise to the discovery of the transistor has rapidly progressed to the capabilities earlier unimaginable of present-day Very Large-scale Integrated Circuits that have transformed the face of electronics. These recent developments represent a technology-push and a demand-pull. Many are tempted to say that except for the science base of technology, in terms of the scientific method, there is no real science input. This is not true. Surface studies, amorphous materials, the range of instruments used in a solid state electronics development laboratory, which were all earlier developed through scientific innovation and for use for scientific experiments and discoveries, all illustrate the essential scientific content of modern solid state electronics technology.

Technology Is Part of a Total Socio-Economic System

The next point that needs to be emphasized is that technology cannot be considered as an element that exists and is relevant purely in its own right. It has to be regarded as part of a total system. This

can be illustrated by considering the changed situation that is encountered today, as a result of new perspectives relating to energy and environment.

It was only a little over a decade ago that the cost of energy was regarded as a small part of the total cost of any output. This arose out of the historical situation when populations were small and energy resources in the form of wood, coal, oil and hydro-potential appeared to be infinite. As a result, technological development was based on the concept that energy would be available: (a) easily; and (b) at low cost. Neither of these assumptions is valid today. Energy is not going to be available easily, for the simple reason that the world population has grown tremendously and continues to grow. The world population doubled from 1 billion to 2 billion in 125 years, from 2 billion to 4 billion in 75 years; the next doubling from 4 billion to 8 billion is expected to take 50 years. Not only are there increased needs on account of the growth of population, but also increased needs because of greater expectations and larger energy requirements per capita. The principal sources of energy thus far have been the fossil fuels - oil and coal. Over the past decade we have been aware of the limited reserves of oil in terms of long-term perspectives; and oil prices have gone up significantly. Coal is also a nonrenewable source with finite reserves. It is less of a "mobile" fuel and more "dirty"; and yet it will be necessary to make increasing use of it over the next few decades as the world cuts back on oil as a source of bulk-power generation. There is a great deal of hydroelectric potential to be tapped, but the capital investments are high. Though this is a renewable resource, there is still a final potential that can be tapped. Another energy resource that will become significant is nuclear power; but it has been beset with problems of high capital costs, long gestation periods, radioactive waste disposal and objections from the environmental angle. And finally, renewable non-conventional energies will be increasingly tapped and become particularly important for decentralized application. All in all, it is clear that the future lies in the development of technologies that are not energy-intensive; this is a distinct change from the situation that obtained only a decade ago. This represents an

opportunity for India to leapfrog into the technologies of the future which must be lower energy-intensive and where everyone in the world is roughly at the same starting point.

Equally, over the past decade, we have begun to recognize the importance of the environment. Earlier, man was but a small entity, consisting of small population, with small activities, on a globe which by comparison was infinite. The sea around, the river waters, the atmosphere were essentially infinite to absorb all the end-products of human activity. If you were a technologist planning for production in 190, you did not have to bother about the environment. It did not matter what waste products were to be produced; they could be, and were discharged into rivers, the sea or into the air. Today, the position is quite different: with large and growing populations, increasing human activities and the limited carrying capacity of the earth to absorb the outputs. Over the past decade, in particular, environmental aspects have come to the fore. There are increasingly stringent regulations relating to air and water pollution that are being enforced. Much more careful studies relating to short-term and long-term toxicities are being carried out. We have begun to recognize the importance of carbon dioxide, from the large-scale burning of fossil fuels which goes into the atmosphere and can affect the global heat balance; of temperature changes that are taking place in water bodies; and the hazards of many pollutants being discharged into the air and water. It is clear that development of future technologies must be directed towards increased harmony with the environment e.g., processes that result in lesser production of pollutants and steps to absorb or destroy pollutants. This again is a recent development.

Over recent decades, many technologies developed in the advanced, industrialized countries have been directed towards labour-saving, in view of the high costs of labour. These conditions do not apply in developing countries, where one of the principal needs is to provide gainful employment for large parts of the population.

Thus, if we look at the position in India today, we encounter the following constraints: energy is expensive and not easily available; environmental protection must be ensured; we have to work for maximum

gainful and satisfying employment. Therefore, we have to look at technological options in relation to these economic and social imperatives of society. Thus, technology is really a component, and one component of a total socio-economic system.

Self-Reliance

I would now like to mention an aspect of importance for any technology policy for India. We have to recognize that India is a large country of sub-continental dimensions, with a population above 700 million. The very size of our country, and the diversity and complexity of the problems we encounter, which are quite different from those of smaller developing countries, demand self-reliance. The Prime Minister, Smt. Indira Gandhi, has remarked: "Self-reliance must be at a country of our size and endowments. While we all readily pay obeisance to his concept, there are too many and too frequent lapses. Considerations like security, the time factor, performance guarantee and costs often compel us to buy the very heart of S & T planning. There can be no other strategy for advanced technology from the international market. But in the ultimate analysis, neither true defence nor true development can be bought or borrowed. We have to grow them ourselves". She has further said: "Self-reliance does not mean making everything ourselves but acquiring the capacity to do so when things come to a head".

The pathway to self-reliance is not to set out to rediscover independently what has already been discovered, nor to invent what has already been invented. It implies the ability to analyse problems, and to define tasks and objectives; to obtain information/know-how etc., which is needed from wherever it is available, but on a specific basis; to have self-confidence to develop whatever needs to be developed; and most important, the ability to start from a base which may be a mix of indigenous and imported know-how, to move into the future on an internationally contemporary basis through innovation and original thinking. Self-reliance should also not be confused with self-sufficiency. Self-reliance demands a national commitment and political will; and involves many facets such as technology policy; management and

technical skills etc. But clearly a crucial element of self-reliance, in a world whose economy and life styles are dominated by scientific and technological advances, has to be a self-reliant base of S&T.

Thus the Technology Policy Statement says:

"In a country of India's size and endowments, self-reliance is inescapable and must be at the very heart of technological development. We must aim at major technological break-throughs in the shortest possible time for the development of indigenous technology appropriate to national priorities and resources."

The Field of Agriculture: An illustration

I would like to illustrate what I have just said about self-reliance by looking at our needs and performance in the field of agriculture. We all agree that food is a prime need of humanity. If adequate food is not grown, one either has to import to the extent of the deficit or face malnutrition or famine. The possibility of imports depends clearly on the availability of food elsewhere in the world for this purpose. In the case of a country as large as India with a population of 700 million and current food production levels of around 130 million tonnes, even a deficit of a few per cent of the requirements would demand an import of several million tonnes. Apart from availability, there is the requirement of foreign exchange to pay for such large imports; in these circumstances food can be used as a weapon of economic warfare. Clearly, there is need to grow more than just the immediate needs; and to build up a food security system.

India has a wide range of items that it grows. wheat, rice, jowar, bajra, maize, sugarcane and a spectrum of oilseeds, of pulses, of fruits, of spices and cash crops. These have to be produced under the widely varying agro-climatic conditions encountered in the country, covering wet and humid high monsoon areas, irrigated and rainfed areas, dryland, drought-prone and desert areas, and hill and temperate zone regions. Being in the tropical belt, there are about ten times as many pests on the agricultural scene in this country as compared to what is encountered in the temperate zone. Appropriate pest control is of prime

importance, particularly with high-yielding varieties. The total ecological system, involving the nature of the crop and its pest resistance, climatic conditions, such as temperature, humidity and their variations, other elements in the flora and fauna, which define host-predator relationships, have all to be understood in any scheme of appropriate pest control. One can certainly bring selected germplasm and seeds from elsewhere in the world. But they have to be acclimatized of the conditions obtaining in the varying agro-climatic zones of the country. For improved adaptation, they are crossed with local varieties and the total cycle relating to increased yields, reduced inputs, pest control, acceptability, reduced hazards etc. optimized. This demands basic indigenous effort by the scientists and technologists working on research and development in the country, those concerned with trials and extension services, with education and awareness programmes and finally the farmers who have to actually produce the food. One can certainly get brilliant scientists covering various aspects of plant breeding, genetics, agronomy, soil or water management, etc., from abroad to come and work together with their Indian colleagues, to assist and advise in the overall programme. It was thus that a great figure in the field of food production, regarded very highly by the Indian agricultural and scientific community, Norman Borlugh, contributed in terms of ideas, advice, and suggestions for improved food production in India. The essential point that needs to be emphasized is that this is an area of such complexity and scale that the effort has to be without any question indigenous; and there is no question of obtaining technology on OGL (Open General Licence). Any inputs from abroad, and these can certainly be of value, have to be absorbed, adapted and modified based on endogenous capabilities to achieve success.

In the mid-1960s India had to import large quantities of food-grains. To avoid this on a continuing basis, strategies were adopted in the mid-1960-s to transform Indian agriculture. Agricultural research, education and extension was reorganized, bringing the State and Central Institutions into a cooperative partnership. The Indian Council of Agricultural Research was the umbrella for the purpose: integrated programmes of agricultural research and education, involving research institutions, agricultural universities, science centres, experimental

farms and liaison units; all-India coordinated projects on various projects were organised. This effort brought about much greater coordination of activities at various levels from advanced research on the one hand to the farmer and his problems of weather, pests, inputs (fertilizer, chemicals, seeds etc.) finances and so on at the other end; and of communication across these levels. The innovation chain was thus largely completed to indicate the returns from this approach.

Between 1960-61 and 1964-1965, over a five-year period, for every rupee spent on agricultural research, the return was roughly 1.91 rupee, and the internal rate of return was 14. In a later five-year period, from 1967-68 to 1972-73, the return increased from 1.91 rupee to 14.91 rupees, by a factor of almost seven; and the internal rate of return went up from 14 to 71. Here one dealt with a total system which yielded results in economic terms; it was not just pure research resulting in publication of papers and putting out great ideas, but converted through the innovation chain to results on the field and in the farms.

In the largest sector of national development in terms of GNP, there was a clear demonstration of what can be achieved on the basis of self-reliance.

The population of India, according to the February 1981 census was 684 million; it will be close to 1000 million by the turn of the century. To provide nutrition to these numbers, and to have buffer stocks to ensure food security, particularly with vagaries of the weather, we will need to think of doubling our food production. This can be achieved only by boot-strapping ourselves through our own efforts. This does not mean, however, that we cut ourselves away from the world. We live, as earlier stated, in an interdependent world.

There are important aspects of technology transfer in this area also. Let me give one illustration of it. There has been great success in increase of food production, in terms of food grains; particular successes have been in the case of wheat and high-yielding hybrid varieties. Technology transfer from the laboratories to the fields turned out to be relatively simple. But at present we have a problem concerning oilseeds. We are aware that next to petroleum products,

where the import is of the order of about Rs 5000 crores, the second largest import is of edible oils, roughly at a figure of Rs 800 crores. What is the problem here? After all India used to be once an exporter of edible oils. There are high-yielding oilseed varieties available from our research laboratories. But the technology for their growing is more complex. Pest control has to be carried out more carefully and there has been difficulty in transferring the know-how from the laboratory to the field and providing support to the farmer. We have to learn to do this. This will no doubt come about through the efforts, in education, extension services, availability of equipment and inputs and so on.

The Industrial Sector

Let us now consider the Industrial Sector. Soon after independence, import of goods, equipment and consumables was handled by the Chief Controller, Imports and Exports of the Government of India. Import of technology was handled as invisibles, by the Reserve Bank of India. In those days, technology was almost on OGL. Foreign collaboration and investment was freely allowed on cosmetics, toothpaste and much else with royalties going up to 15 per cent. It was only later that the Finance Ministry of the Government of India took over the responsibility relating to foreign technology and investments and the present structure was evolved to deal with this area.

There are many in India and abroad who make the assumption that there has been a severe restriction on import of technology into India. It is adequate to point out that we have more than 7000 foreign collaboration agreements that have been entered into; even today we are entering into collaboration agreements at the rate of around 500 per year. That is certainly not "restrictive".

As far as India is concerned, if anyone goes round the industrial sector, technologies from the Soviet Union and East European countries, from Japan, from UK, France, Germany and Italy, from the United States etc. will all be seen. One of the largest sectors of industry, steel, will illustrate this. Bhilai, rourkela, Durgapur, and Bokaro have been based on technologies from USSR, West Germany, Britain an USSR. Again

if one looks at the aeronautical industry, it will be seen that HAL produces Avros, Gnats and jaguars, with British know-how, MIGs with Soviet know-how, helicopters with French know-how, etc. One cannot argue that technology imports have been on a restrictive basis either in numbers or origin.

I had earlier pointed out that technology should not be looked at by itself; it has to be related to the total socio-economic scene including markets, employment, energy, environment, available skills, etc. Let us look at the case of Western Europe and the field of micro-electronics. Europe is certainly very advanced scientifically. This was where the scientific and Industrial Revolutions took place which started the pace of industrialization that we see today. Every year, in the Nobel Prize awards there are one or more names from Europe. Consider now one of the highly science-based technologies - micro-electronics. Where is the major micro-electronics production in the world today? It is either in the United States or in Japan - on a significant, large-scale world-wide basis. It is not as though one can regard Western Europe as being scientifically backward or "restrictive" in technology imports. They are part of the free enterprise market economics. One clearly sees that it is not just a question of development of or access to technology, but the total system that is relevant, covering: financing, markets, efficiencies in the system relating to scale; coupling between innovation and production, etc. Thus even total freedom for import of technology can achieve little by itself.

The Technology Policy Statement in the preamble to Aims and Objectives, states: The basic objectives of the Technology Policy will be the development of indigenous technology and efficient absorption of and adaptation of imported technology appropriate to national priorities and resources.

Four elements can be seen here: (i) development of efficient indigenous technology; (ii) efficient absorption and adaptation of imported technology; (iii) the fact that there will be a mix of indigenous and imported elements; (iv) the prime importance of national priorities and resources.

The first stated objective in TPS is: attain technological competence and self-reliance, to reduce vulnerability, particularly in strategic and critical areas making the maximum use of indigenous resources.

The second objective is particularly important to India and to developing countries: provide the maximum gainful and satisfying employment to all strata of society, with emphasis on the employment of women and weaker sections of society.

The third objective is again of particular relevance to developing countries, and certainly to India: to use traditional skills and capabilities making them commercially competitive. We do have a large part of production in India which has economic and social significance, arising in this sector, based on traditional skills, but which need to be modernized to the extent of making them competitive. The traditional capabilities could also have fertile possibilities for new developments. The objectives thereafter are:

ensure the correct mix between mass production technologies and production by the masses (to take into account the need to provide gainful employment for the large masses, particularly in the rural areas of the country);

ensure maximum development with minimum capital outlay (because obviously capital is one of the very scarce resources of a developing economy);

identify obsolescence of technology in use and arrange for modernisation of both equipment and technology (this is clearly essential to make industrial production viable and internationally competitive. In many sectors we have now got technology and equipment, a large part of it imported, which is obsolete, and which must be modernised;

develop technologies which are internationally competitive, particularly those with export potential.

Improve production speedily through greater efficiency and fuller utilization of existing capabilities, and enhance the quality and

reliability of performance and output. This can be illustrated by an example such as the power sector. We need and provide for investments, for new capacity for power generation. But it is equally important to ensure that the existing investments give the maximum returns through better utilization of capacity and improved power load factors, as they are called. We are operating at a relatively low figures of power-load factor. There are State Electricity Boards where the power-load factor has been of the order of 38 per cent. National averages have been in the region of 47 per cent. But we could go to figures which are between 55 per cent to 60 per cent. Improvements may mean simply better management, improved maintenance etc.; and technology as such may not be involved. On the other hand, there are, in many cases, technological factors to which due attention needs to be paid. Stress has to be laid on technologies which can improve efficiency and result in fuller utilization, since this can save new investments to produce the same necessary output.

The next set of objectives are: reduce demands on energy, particularly energy from non-renewable sources; ensure harmony with the environment, preserve the ecological balance and improve the quality of the habitat; and recycle waste material and make full utilization of by-products. The background relating to these has been dealt with earlier.

These are the basic objectives which have been specified in the Technology Policy Statement. I read them out to you particularly since I had earlier emphasized energy, environment, employment; and I thought I would clarify some of the other objectives.

Design Engineering and Engineering Consultancy

Immediately after Independence, the thrust was on import substitution, turn-key implementation of large projects and the building up of an infrastructure for science and technology. India has got well past that stage now. As a result of the increased capabilities in the country, involving elements both in the scientific as well as industrial infrastructure, it is now possible to spell out projects in detail and to define the technologies needed for the various component elements. Capabilities exist to "unpackage" technologies, so that only the

essential elements, not available indigenously, need be imported; and these can then be obtained from the most optimal source. As a result, technologies can be acquired at lower costs from the best sources. This aspect has been specifically covered in the Technology Policy Statement under the head "Unpackaging".

An important element in the innovation chain relates to Design Engineering and Engineering Consultancy; these capabilities have grown significantly in the country in recent years. They are essential elements for putting up large industrial plants, for unpackaging technology, for acting as the link between Research & Development and the setting up of production units etc. One statement which is often made by industrialists is: "We cannot get know-how for setting up and running plants from our national laboratories." In general this is true and that is how it should be. A laboratory is not set up to provide know-how for production in a plant. When technology is imported, it is normally from another production undertaking or a technology vendor. Technology transfer involves information on capital machinery and its specifications, drawings relating to layout of machinery and items of equipment, specifications of all inputs, process details, transfer of skills through training of those who will be concerned with installation, commissioning, operation and maintenance and a wide range of associated documentation. It is clearly not possible for a research laboratory to transfer technology covering this spectrum of elements.

With the coming into existence and strengthening of the essential links in the innovation chain of design engineering and engineering consultancy, possibilities for converting ideas or capabilities from laboratories to final production have greatly increased. These areas need further growth and strengthening.

Technology Absorption

A basic feature relating to the import of technology which is covered extensively in the Technology Policy Statement, is: "What happens to technology that is imported?" Is it going to be just a black box which has been purchased of which use is made exactly as instructed, to be discarded in time when obsolete or no longer effective? Or with

the transfer of technology is one also acquiring basic information on aspects that went into the generation of that technology or a particular design? Apart from the use of the acquired technology or production, is an R&D unit associated with the acquisition which can help in the absorption, and through this later modification and improvements as might be needed; and to use this as a spring board for further development? It is on these aspects that Japan has been enormously successful. Technology imported into Japan is fully absorbed. With that as a starting point, they have been able to adapt and improve on it; and thereafter to generate wholly new technologies. For instance, Japan decided ten years ago to get into the field of advanced micro-electronics, which they saw as the most significant transforming entity in electronics. They also decided that they would go into computers and digital technologies on a major basis. They imported know-how, bought patents and invested significant amounts of money. Industry and Government worked in close coordination to accomplish the breakthrough. And today they have reached the position of being among the leaders in micro-electronics and a major power in the field of computation and communications.

It is important to emphasize that the investments needed are across the entire innovation chain, and therefore large. There is no escape from this. If these investments are not made, money will flow out on imports of goods, capital equipment and technology; and these payments will include the amounts that were spent initially abroad on the innovation chain. Let me point out that the total investment during the entire Sixth Five Year Plan on S&T is roughly that spent in a single year by a large firm in the category of General Motors or Siemens on research. The major developed countries of the world spend of the order of 2 per cent of their GNP on science and technology for research and development. In India we spend about two-thirds of our Gross National Product on S&T and related activities.

Importance of Utilizing Existing S&T Infrastructure

Since Independence, we have built a large infrastructure for R&D in science and technology. This exists in the form of national laboratories of CSIR (Council of Scientific & Industrial Research),

Defence Research & Development Organization, Department of Atomic Energy, Department of Space, Department of Science & Technology and the Department of Electronics; in the areas of agriculture and medicine which, as earlier stated, also involve technologies, we have a large base under the auspices of the Indian Council of Agricultural Research and the Indian Council of Medical Research. In addition, there is the very large educational sector and laboratories in public and private sector industries; in recent years many autonomous research institutions have also come into being. What is important is that this base be coupled to those who need and use technology on the basis of cooperation rather than confrontation. The different sectors involved in generation, absorption and use of technology have to come together to work as a team in the national interest. And this is what the implementation of the Technology Policy Statement will hopefully lead to

Those concerned with ultimately using technology, particularly in industry, would do well to spend some time in seeing for themselves what this infrastructure has to offer them. How many have really gone and assessed the extent to which this scientific infrastructure, built out of public funds can be of use to them. I have visited many of these scientific centres often almost on a cyclic basis, at intervals of time. Each time I have been amazed by new ideas, new capabilities, new potentials that have come up and which exist right in the country waiting to be made use of. What is needed is more initiative and entrepreneurship on the part of Indian industry. There is need for an inward look at what we are capable of. We should first define national goals, rather than the narrow goals of an individual producer. I would like to urge that goals be defined for entire sectors of Industry. For example, one could look at the goals of the Textile Industry of India. These, rather than the goals of an individual textile manufacturer, could relate to problems of modernization, export competitiveness, decentralized vs centralized production and employment, energy saving through conservation, use of renewable energies and new technologies etc. Thereafter, a national view on import of machinery, financing, R&D (inhouse, on a cooperative basis or through the existing R&D infrastructure), import of technology, etc. could be taken. In the final implementation there could be decentralized actions. Similarly,

we could set national goals for the computer field, the telecommunication field, the sector of renewable energies etc. When such goals are set it should be possible to put major coordinated efforts behind them. What we must ensure is to function as a total Indian capability. In the final implementation small individual entities will be involved: the educational institutes, national laboratories, private and public sector R&D, engineering design and consultancy units, and individual production units. But the overall approach should be defined together and not involve confrontation between these different sectors.

Demands for import of technology on grounds of superior technology leading to better production, lower prices, lower energy consumption and lower pollution, increased efficiency etc., can be appreciated. But I fail to see why the fact that an item is produced with foreign technology needs to be flaunted as is so often done. India was led to Independence with the slogan of Swadeshi. At least industry could take the initiative to proclaim their products based on indigenous know-how; their quality and standing in the market, must be ensured, this will lead gradually to a tide of confidence in our own capabilities.

Conclusion

The Technology Policy Statement covers fiscal aspects, regulatory aspects, technology forecasting, assessment and absorption, perspective planning and a whole range of other aspects. These have to be spelt out in the form of detailed guidelines for operational purposes. This will be a major task in its own right. When this is done and implementation initiated, the country will be well on its way to self-reliance. The Technology Policy Statement concludes by stating:

Success in implementation demands a conscious integrated approach covering technology assessment, development, acquisition, absorption, utilisation and diffusion; and connected aspects of financing based on overall national interests, priorities and the attainments of the most challenging technological goals. Above all, the entire population must be imbued with self-confidence and pride in national capacity. Indian Science & Technology must unlock the creative potential of our people, and help in building the India of our dreams.

GOVERNMENT OF INDIA

TECHNOLOGY POLICY STATEMENT

PREAMBLE

Political freedom must lead to economic independence and the alleviation of the burden of poverty. We have regarded science and technology as the basis of economic progress. As a result of three decades of planning, and the Scientific Policy Resolution of 1958, we now have a strong agricultural and industrial base and a scientific manpower impressive in quality, numbers and range of skills. Given clear-cut objectives and the necessary support, our science has shown its capacity to solve problems.

The frontiers of knowledge are being extended at incredible speed, opening up wholly new areas and introducing new concepts. Technological advances are influencing life-styles as well as societal expectations.

The use and development of technology must relate to the people's aspirations. Our own immediate needs in India are the attainment of technological self-reliance, a swift and tangible improvement in the conditions of the weakest sections of the population and the speedy development of backward regions. India is known for its diversity. Technology must suit local needs and to make an impact on the lives of ordinary citizens, must give constant thought to even small improvements which could make better and more cost-effective use of existing materials and methods of work. Our development must be based on our own culture and personality. Our future depends on our ability to resist the imposition of technology which is obsolete or unrelated to our specific requirements and of policies which tie us to systems which serve the purposes of others rather than our own, and on our success in dealing with vested interests in our organizations: governmental, economic, social and even intellectual, which bind us to outmoded systems and institutions.

Technology must be viewed in the broadest sense, covering the agricultural and the services sectors along with the obvious manufacturing sector. The latter stretches over a wide spectrum ranging from village, small-scale and cottage industries (often based on

traditional skills) to medium, heavy and sophisticated industries. Our philosophy of a mixed economy involves the operation of the private, public and joint sectors, including those with foreign equity participation.

Our directives must clearly define systems for the choice of technology, taking into account economic, social and cultural factors along with technical considerations; indigenous development and support to technology, and utilization of such technology; acquisition of technology through import and its subsequent absorption, adaptation and upgradation; ensuring competitiveness at international levels in all necessary areas; and establishing links between the various elements concerned with generation of technology, its transformation into economically utilizable form, the sector responsible for production (which is the user of such technology), financial institutions concerned with the resources needed for these activities, and the promotional and regulating arms of the Government.

This Technology Policy Statement is in response to the need for guidelines to cover this wide-ranging and complex set of inter-related areas. Keeping in mind the capital-scarce character of a developing economy it aims at ensuring that our available natural endowments, especially human resources, are optimally utilized for a continuing increase in the well-being of all sections of our people.

We seek technological advancement not for prestige or aggrandisement but to solve our multifarious problems and to be able to safeguard our independence and our unity. Our modernization, far from diminishing the enormous diversity of our regional traditions should help to enrich them and to make the ancient wisdom of our nation more meaningful to our people.

Our task is gigantic and calls for close co-ordination between the different departments of the Central and State Governments and also of those concerned, at all levels, with any sector of economic, scientific or technological activity, and, not least, the understanding and involvement of the entire Indian people. We look particularly to young people to bring a scientific attitude of mind to bear on all our problems.

2. AIMS AND OBJECTIVES

2.1 Aims

The basic objectives of the Technology policy will be the development of indigenous technology and efficient absorption and adaptation of imported technology appropriate to national priorities and resources. Its aims are to:

- (a) attain technological competence and self-reliance, to reduce vulnerability, particularly in strategic and critical areas, making the maximum use of indigenous resources;
- (b) provide the maximum gainful and satisfying employment to all strata of society, with emphasis on the employment of women and weaker sections of society;
- (c) Use traditional skills and capabilities, making them commercially competitive;
- (d) ensure the correct mix between mass production technologies and production by the masses;
- (e) ensure maximum development with minimum capital outlay;
- (f) identify obsolescence of technology in use and arrange for modernization of both equipment and technology;
- (g) develop technologies which are internationally competitive, particularly those with export potential;
- (h) improve production speedily through greater efficiency and fuller utilization of existing capabilities, and enhance the quality and reliability of performance and output;
- (i) reduce demands on energy, particularly energy from non-renewable sources;
- (j) ensure harmony with the environment, preserve the ecological balance and improve the quality of the habitat; and
- (k) recycle waste material and make full utilization of by-products.

2.2 Self-Reliance

In a country of India's size and endowments, self-reliance is inescapable and must be at the very heart of technological development. We must aim at major technological break-throughs in the shortest possible time for the development of indigenous technology appropriate to national priorities and resources. For this, the role of different agencies will be identified, responsibilities assigned and the necessary linkages established.

2.3 Strengthening the Technology Base

Research and Development, together with science and technology education and training of a high order, will be accorded pride of place. The base of science and technology consists of trained and skilled manpower at various levels, covering a wide range of disciplines, and an appropriate institutional, legal and fiscal infrastructure. Consolidation of the existing scientific base and selective strengthening of thrust areas in it are essential. Special attention will be given to the promotion and strengthening of the technology base in newly emerging and frontier areas such as information and materials sciences, electronics and bio-technology. Education and training to upgrade skills are also of utmost importance. Basic research and the building of centres of excellence will be encouraged.

Skills and skilled workers will be accorded special recognition. The quality and efficiency of the technology generation and delivery systems will be continuously monitored and upgraded. All of this calls for substantial financial investments and also strengthening of the linkages between various sectors (educational institutions, R & D establishments, industry and governmental machinery).

3. PRIORITIES

3.1 Need for Perspective Planning

The time scales involved in the generation of technology are long, even with imported elements. Therefore, relevant technologies in all areas of priority, particularly where large investments are to be made,

should be clearly identified well in advance. The cost and time element involved in the import of technology and indigenous development will be given consideration. Components which could be assigned to the various institutions which are capable of developing them or which could be built up for such activities will be identified. Ministries concerned with large investments and production activities in areas such as food, health and energy will be provided with appropriate technical support through suitably structured S & T groups.

3.2 Employment

Human resources constitute our richest endowment. Conditions will be created for the fullest expression and utilization of scientific talent. Measures will be taken for the identification and diffusion of technologies that can progressively reduce the incidence of poverty and unemployment, and of regional inequalities. The application of science and technology for the improvement of standards of living of those engaged in traditional activities will be promoted, particularly household technologies. Technologies relevant to the cottage, village and small industries sector will be upgraded. In the decentralized setetcor labour must be diversified and all steps taken to reduce drudgery. In all sectors, the potential impact on employment will be an important criterion in the choice of technology.

3.3 Energy

Energy constitutes an expensive and sometimes scarce input. Therefore, the energy requirements both of a direct and indirect nature for each product and each production activity and the associated technology employed will be analysed. Measures will be devised to avoid wastage or non-optimal use of energy. Fiscal measures as necessary will be introduced to ensure these. Research and Development in the energy sector will aim at improving the efficiency of its production, distribution and utilization, as well as improvement of efficiency in processes and equipment.

3.4 ~~Efficiency and Productivity~~

Technologies already employed will be evaluated on a continuing basis to realise maximum benefits in terms of increased production and lower costs, specially in the public sector enterprises. Every effort should be made to utilise by-products and wherever possible to recycle waste materials, especially those from urban areas. Programmes to make use of easily available and less costly materials will be supported.

3.5 Environment

Development should not upset the ecological balance for short as well as long-term considerations. Poorly planned efforts to achieve apparently rapid development, ignoring the long-term effect of many technologies on the environment, have resulted in serious ecological damage. It is, therefore, essential to analyse the environmental impact of the application of each technology. Due regard will be given to the preservation and enhancement of the environment in the choice of technologies. Measures to improve environmental hygiene will be evolved.

3.6 Some Specific Areas

In technology development special emphasis will be focused on food, health, housing, energy and industry. In particular, stress will be laid on:

- agriculture including dry-land farming;
- optimum use of water resources, increased production of pulses and oilseeds;
- provision of drinking water in rural areas, improvement of nutrition, rapid reduction in the incidence of blindness, eradication of the major communicable diseases (such as leprosy and tuberculosis), and population stabilization;
- low-cost housing;

- development and use of renewable non-conventional sources of energy; and
- industrial development.

4. INDIGENOUS TECHNOLOGY

4.1 Importance of Technology Development

Fullest support will be given to the development of indigenous technology to achieve technological self-reliance and reduce the dependence on foreign inputs, particularly in critical and vulnerable areas and in high value-added items in which the domestic base is strong. Strengthening and diversifying the domestic technology base are necessary to reduce imports and to expand exports for which international competitiveness must be ensured.

4.2 Inventions

The spirit of innovation and invention is the driving force behind all technological change. We must awaken our science and technology to the exciting challenges of our times, provide incentives to encourage inventors, and direct their efforts to areas of special importance. The system of rewards and incentives will be strengthened for inventions, innovations and technological breakthroughs and their utilization. The fullest opportunity will be provided to make use of inventions.

4.3 Enhancing Traditional Skills and Capabilities

Traditional skills and capabilities will need to be upgraded and enhanced, using knowledge and techniques generated by advances in science and technology. Technologies which will result in low-cost production and in products marketable close to the point of manufacture, particularly in the rural sector, will be promoted. Support will be given to technologies which reduce pressure on items in short supply and utilize improved local materials and methods. Government will give preference to products of such technologies in its own purchases. The adoption of technologies that can promote decentralized production will be helped through the support to design, marketing, quality control and other services.

4.4 Ensuring Timely Availability

The time cycle from scientific research to utilization is a long one. Hence the need to initiate action well in advance to identify and ensure timely availability and delivery of new technologies. Encouragement and support (fiscal, commercial and administrative) will be given to the production and user organizations to be associated with and participate in technology development efforts at appropriate stages.

4.5 Upgradation to Prevent Obsolescence

Technology is constantly on the move. The base of indigenous technology should be capable of utilizing world-wide advances and adapting them to local needs. The creation and strengthening of institutional structures for keeping track of international developments will receive urgent attention.

A strong central group will be constituted to undertake technology forecast and technology assessment studies and will inter alia draw up programmes of purposeful research. Arrangements will be made to provide high-level scientific advice in major sectors of the economy. Where big investments are involved or a large volume of production is envisaged, it will be incumbent on the Ministry or agency concerned to provide a technology forecast covering its requirements over a ten-year or longer period and evolve a strategy for development based on priorities.

4.6 Increasing the Demand for Indigenous Technology

Our country has already invested significant amounts in setting up research and development facilities as well as design consultancy and engineering capabilities. The technological potential inherent in this system of interlinked capabilities must be fully utilized, and in turn provide a fillip for further development from within the system. Incentives will, therefore, be provided to users of indigenously developed technology, and for products and processes resulting for such use.

4.7 Preferential Treatment

In view of the cost of technology development and the time necessary for successful marketing of a new or improved product, indigenously developed items are invariably at a disadvantage compared with imported products or those based on imported technologies and brand names. Support must therefore be provided through fiscal and other measures, for a limited period, in favour of products made through indigenously developed technologies, care being taken to ensure quality.

4.8 Fiscal Incentives

Suitable financial mechanisms will be established to facilitate investment on pilot plants, process demonstration units and prototype development in order to enable rapid commercial exploitation of technologies developed in laboratories. Linkages between scientific and technological institutions and development banks will be strengthened. Gaps in technology will be identified and suitable corrective measures taken with adequate allocation of resources. Fiscal incentives will be provided in particular to: promote inventions; increase the use of indigenously developed technology; enhance in-house Research and Development in industry; and efforts directed to absorb and adapt imported technology.

4.9 Design Engineering

Capabilities in design engineering are essential for the translation of know-how to commercial production. This is particularly important in areas relating to: agricultural production; agro-industries; metallurgical, chemical and petrochemical processes; machine tools; industrial machinery and capital goods; as well as for the construction and erection of entire plants. Building up and enhancing these capabilities will have a catalytic beneficial impact on the utilization of indigenous efforts that have resulted in product and process know-how. Existing design engineering capabilities will be strengthened and upgraded, and interaction encouraged between design engineering organizations, academic and research institutions and

industry. Wherever gaps exist, design engineering capabilities will be developed and nurtured.

4.10 Engineering Consultancy

Engineering consultancy is a vital area for ensuring speedy technological and industrial development. It ensures the appropriate utilization of indigenous materials, plant and machinery. Engineering consultancy provides an essential link between R & D institutions and industry, and thus promotes effective transfer of technology. Capability for total systems engineering, process development and project management should be developed with collaboration if required. Wherever capability exists, utilization of Indian consultancy engineering organizations will be promoted. Even where foreign technical collaboration or consultancy is considered unavoidable, association of designated Indian consulting engineering organizations would be preferred. Indigenous engineering consultancy, in both private and public sectors, will be promoted on a sound professional basis in the context of the overall national perspective of technological self-reliance.

4.11 In-house R & D

In-house R & D units in industry provide a desirable and essential interface between efforts within the national laboratories and the educational sector as well as production in industry. Appropriate incentives will be given to the setting up of R & D units in industry and for industry including those on a cooperative basis. Enterprises will be encouraged to set up R & D units of a size to permit the accomplishment of major technological tasks.

5. TECHNOLOGY ACQUISITION

5.1 Mix of Indigenous and Imported Technology

A policy directed towards technological self-reliance does not imply technological self-sufficiency. The criterion must be national interest. Government policy will be directed towards reducing technological dependence in key areas.

Advantage should be taken of technological developments elsewhere. This can also be achieved through well-defined collaborative arrangements in research and development.

At any given point of time, there will be a mix of indigenous and imported technology. However, technology acquisition from outside shall not be at the expense of national interest. Indigenous initiative must receive due recognition and support.

In the acquisition of technology, consideration will be given to the choice and sources of technology, alternative means of acquiring it, its role in meeting a major felt need, selection and relevance of the products, costs, and related conditions. A National Register on Foreign Collaboration will be developed to provide analytical inputs at various stages of technological acquisition.

5.2 Principles of Acquisition and Technology Assessment

Where the need to import technology is established, every effort should be made to ensure that it is of the highest level, consistent with requirements and resources. The technology import will be so planned as to have effective transfer of basic knowledge (know-why) and to facilitate further advancement.

Where the import of technology is contemplated, the level to which technology has been developed, or is in current use, within the country, shall be first evaluated. Lists of technologies that have been adequately developed to the extent that import is unnecessary will be prepared and periodically updated; in such areas no import of technology would normally be permitted; and the once will be on the seeker of foreign technology, be it industry or a user Ministry, to demonstrate to the satisfaction of the approval authority that import is necessary.

Technology assessment systems will be reviewed. A technology assessment mechanism consisting of competent groups will render advice in all cases of technology import relating to highly sophisticated technology, large investments and national security. Aspects of employment, energy, efficiency and environment will be kept in view.

The basic principles governing the acquisition of technology will be:-

- (a) Import of technology, and foreign investment in this regard, will continue to be permitted only on a selective basis where: need has been established; technology does not exist within the country; the time taken to generate the technology indigenously would delay the achievement of development targets.
- (b) Government may, from time to time, identify and notify such areas of high national priority, in respect of which procedures would be simplified further to ensure timely acquisition of the required technology.
- (c) There shall be a firm commitment for absorption, adaptation and subsequent development of imported know-how through adequate investment in Research and Development to which importers of technology will be expected to contribute.

5.3 Unpackaging

Technology to fulfil a particular need consists of many components. It is necessary to develop capability to break down the total package of technology required for a purpose into components, some of which may be readily available or could be indigenously developed, and others that will need to be imported. Norms and guidelines for such unpackaging will be evolved.

5.4 Absorption of Technology

There shall be a commitment to ensure an adequate scale of investment in R & D for the absorption, adaptation and, wherever possible, improvement on and generation of new technology, making fullest use of overall national capabilities. Only thus can self-reliance be ensured and a technology generation process established firmly. Appropriate mechanisms will be evolved at the stage of technology assessment to ensure the absorption of imported technology.

5.5 Technological Information

The availability of an efficient system of collection and analysis of relevant technological information, including cost and other economic aspects, is a prerequisite for the appropriate choice of technologies. This will considerably enhance the possibility of obtaining favourable terms and conditions in acquisition of technology. Such a technology information base will be established.

6. TECHNOLOGY TRANSFER

6.1 Diffusion

Special efforts need to be made for the diffusion of technology in use to all beneficiaries who can employ them optimally. Appropriate measures shall be evolved to facilitate technology diffusion, including: horizontal transfer; technological support for ancillaries from large units; technology inputs to small units; and upgradation of traditional skills and capabilities

6.2 International Competitiveness and Technology Exports

It is necessary to maintain international competitiveness in products, services and technologies that have export potential. Conditions for the marketing of indigenous technology and of products based on it will be improved. It is important in all such cases to conform to the highest international standards.

6.3 Technical Cooperation among Developing Countries

A concerted effort will be made to participate fully in technical cooperation among developing countries. Encouragement will be provided for participation in technology development programmes with other developing countries which can contribute to mutual national development.

6.4 Protection: Legislative Framework

Development of technology calls for large investments and often involves considerable risk. Encouragement will be given to obtaining necessary protection in all cases of indigenous technology development.

A mechanism will be set up to ensure that national interests arising from the generating of technology are fully protected internationally in terms of industrial property rights.

7. IMPLEMENTATION

The success of the Technology Policy and the speed with which the various facets of the policy are implemented will depend to a considerable extent on a system for efficient monitoring, review and guidance and a scheme of incentives and disincentives.

Government will evolve instruments for the implementation of this Technology Policy and spell out in detail guidelines for Ministries and agencies of Government as well as for industries and entrepreneurs.

Success in implementation demands a conscious integrated approach covering technology assessment, development, acquisition, absorption, utilization and diffusion, and connected aspects of financing, based on overall national interests, priorities and the attainment of the most challenging technological goals.

Above all, the entire population must be imbued with self-confidence and pride in national capacity.

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