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A COMPENDIUM OF
TECHNOLOGY PLANS AND POLICIES
IN SELECTED DEVELOPING COUNTRIES*

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with an introduction by
the UNIDO Secretariat

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SUMMARY

The objective of this compendium of technology plans and policies is to enable senior government officials in developing countries to know how some other developing countries have approached the problem of formulating technology plans and policies; to compare the approaches of different countries; and have reference material at their disposal while drafting their own technology policies and plans. The compendium consists of extracts from original documents from 10 countries, namely, Brazil, Cameroon, Ghana, India, Indonesia, Ivory Coast, Kenya, Republic of Korea, Mexico and Turkey.

The extracts are arranged in accordance with the priority areas of the Operational Plan of Action adopted by the Intergovernmental Committee for Science and Technology for Development as a means to implement the recommendations of the United Nations Conference on Science and Technology for Development.

Most countries in this compendium have adopted a technology plan in the form of a chapter in the overall development plan. A brief analysis is made in the introduction of the nature and coverage of the documents. Generally speaking, the documents do not spell out the physical and financial resources available nor the detailed programmes which will be undertaken. There is a very limited attempt to integrate technology policy with industrial policy. However, the role of the State as a promoter of science and technology capability comes up very clearly in all the documents. Generally speaking, countries more advanced in scientific and technological development have been able to articulate and provide more specificity to their objectives and plans.

The introduction also analyses the contents of the documents in relation to the priority areas of the Operational Plan of Action. Many of the documents were formulated at a time when the impact of technological advances, such as microelectronics and biotechnology had not been clearly felt. It is expected that in future in documents of this kind the policy response to technological change will be covered.

Extracts from technology plans and technologies of the countries selected are contained in pages 10 to 92. Annex I contains a list of the official documents cited and Annex II a bibliography of selected UNIDO documents on technology policy.

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I. INTRODUCTION

In addition to presenting to the United Nations Conference on Science and Technology for Development (UNCSTD) a framework for national action for strengthening technological capabilities of developing countries,^{1/} the UNIDO Secretariat has over the years carried out several studies and organized a series of national workshops in developing countries to stimulate and assist the formulation of technology policies and plans.^{2/} This compendium is seen as an integral part of this effort, particularly designed to enlarge its empirical base. The objective of the compendium is to enable senior government officials in developing countries to know how some other developing countries have approached the problem; to compare the approaches of different countries; and have reference material at their disposal while drafting their own technology policies and plans. The compendium will also be used as a background document in national technology policy workshops organized by UNIDO.^{3/}

The compendium consists of extracts from original documents.^{4/} The original documents were obtained by the Senior Industrial Development Field Advisers (SIDFAs) of UNIDO from the respective government departments. The present compendium covers 10 countries and it is expected that extracts of documents from some more countries will be published as an addendum at a later date. The countries covered in this compendium are: Brazil, Cameroon, Ghana, India, Indonesia, Ivory Coast, Kenya, Republic of Korea, Mexico and Turkey. They represent broadly countries at different stages of economic and technological development.

The extracts are arranged in accordance with the priority areas of the Operational Plan of Action^{5/} adopted by the Intergovernmental Committee for Science and Technology for Development as a means to implement the recommendations of UNCSTD. The documents were, of course, written not keeping this classification in view. Hence, a certain measure of overlapping in the extracts between one priority area and another may be noticed. Besides, judgement had to be exercised as to what portions should be extracted for the purposes in view. The manner in which the extracts have been presented are accordingly unofficial and does not naturally commit the governments. It is not also the intention of the compendium to evaluate the approaches adopted by

different countries or to assess the extent to which these approaches have been operationally implemented. The extracts therefore present more the perceptions of individual countries and their intentions on actions to be taken in the field of technology and related matters. The extracts are basically explicit policy statements and the "implicit" policies of the countries are not necessarily reflected.

It may also be noticed that most countries have adopted a technology plan in the form of a chapter in the overall development plan. Notable exceptions are Brazil and Mexico which have separate documents in the nature of technology plans and India, which has also issued a technology policy statement. Table 1 indicates the nature of the policy documents of the countries covered in this compendium and the periods to which the documents relate.

Some general characteristics of the documents may be noted. Most of them make general statements on a number of aspects and also do not necessarily cover the several priority areas of the operational plan of action. They do not spell out the physical and financial resources available for operationalizing the recommendations or the specific programmes which will be implemented. There are, of course, several exceptions to this statement which may be noticed, but the general trend is more towards the articulation of broad overall objectives rather than specifying concrete action. In general there is also a very limited attempt to integrate technology policy with industrial policy, though again there are notable exceptions, particularly in the documents of Brazil. The role of the State as the promoter of science and technology capability comes out very clearly in all the documents. Chart I makes a schematic presentation of the general characteristics of technology plans of developing countries, it being understood that these characteristics do not necessarily apply exactly to each case and that the delineation of these characteristics should not overlook the important fact that the countries concerned have initiated positive steps to accelerate their technological development and have through the documents committed themselves to these tasks. Generally speaking, countries more advanced in scientific and technological development have been able to articulate and provide more specificity to their objectives and plans.

Some brief observations on the content of the documents, particularly in relation to the priority areas of the Operational Plan of Action are in order. In regard to overall objectives of technology policy formulation all the countries have recognized the importance of technology for socio-economic development. Countries, such as Brazil and India, also stressed the quality of life of the people and the need for self-reliance in technology. In this connection one of the Brazil documents defines technological autonomy as the capacity to select and generate the most adequate technology among the options available, in addition to promoting its effective absorption while giving special emphasis to long-term socio-economic criteria in the decision-making process. The Mexican document also refers to technological self-determination defined as the capacity for making independent decisions which will determine the country's future development.^{6/} The policy objectives give attention to various aspects such as creation of technology, endogenous capacity, energy (Brazil); consolidation of existing structures (Cameroon); labour-intensive measures (Indonesia); relation to science policy (Ghana and Kenya); and research and development for a dynamic production structure (Turkey). One of the Brazil documents refers to the situation in Brazil where state enterprises and transnational corporations and their subsidiaries have a greater role to play in the country's development than the domestic enterprises and points to be needed for changing the situation. The use of purchasing power of the State is also mentioned as an important policy objective.

In regard to science and technology infrastructure, the creation of an apex institution or its strengthening figures prominently in most of the documents, such as those of Cameroon, Ghana, India and Kenya. In India the arrangements include a cabinet committee on science and technology supported by a scientific advisory committee to the cabinet. In Ghana a science and technology planning and analysis group in CSIR is seen as a major step. In Kenya a national council for science and technology has been established. The importance of co-ordination of science and technology activities is recognized in several documents, such as those of Cameroon, Ghana, India, Ivory Coast, Kenya. The Indonesian document lays particular emphasis on simplified procedures, "implicit" policies and marketing, while in the Republic of Korea the merger of some of the research institutes is seen as an important step in improving efficiency. In Turkey the document refers to the elaboration of a scientific and technological master plan which would conform to the long-term

targets and strategies and to the economic, industrial and social development objectives of the country. A study completed in 1983 on Turkey's science policy 1983-2003 will be taken as a starting point for this purpose. The Brazil documents on the other hand stress physical (e.g. public transport) as well as technological infrastructure (e.g. standardization, metrology, quality control, patents information and consultancy services).

In regard to choice and acquisition of technology, the documents from Brazil and Kenya view the transfer of technology as a stimulus to endogenous development. The documents from India stress the need for absorption and adaptation of imported technology and for exercising selectivity in the imports of technology. Objectives, such as maintenance of competitiveness and research and development on imported technology are also emphasized. Ghana and Indonesia stress the importance of appropriate technology and adaptation of imported technology. The Indonesian plan gives priority to labour-intensive technologies and improving traditional technologies. The documents of the Ivory Coast and Kenya emphasize the importance of their nationals taking charge of the managerial and technological functions. In the Republic of Korea importance is attached to the import of technology to close the technology gap and to maintain international competitiveness. Special emphasis is given to imports of technology as essential inputs for production and exports. An automatic approval system has been introduced under which imports of all types of technology except for nuclear and defence technology are approved immediately by the Bank of Korea when a contract calls for a royalty of 10 per cent or less for the duration of 10 years or less. It may also be mentioned that Brazil, India, the Republic of Korea and Mexico have arrangements involving in varying degrees the regulation or monitoring their imports of technology.

In regard to development of human resources, practically all documents underline its importance. One of the documents from India describes human resources as the richest endowment and emphasize the need to give priority to nurturing talent. The importance of education and the relationship between universities and industry is stressed in several documents. The document from Cameroon makes an estimate of the human resources required for science and technology. The documents from Brazil stress the need for strengthening capability in specialized fields, such as patents, standardization etc and also for advanced training for researchers and teachers.

The question of financing science and technology is addressed in varying degrees. The documents from Brazil note the decrease in real terms of the funding for science and technology and emphasize the importance of the government departments at all levels and public enterprises participating in funding science and technology. The role of fiscal and credit policies and the sharing of risks is also emphasized in the documents from Brazil as well as from India. The documents from Cameroon and Ghana are mainly concerned with allocation of R and D funds while the document from the Ivory Coast mentions possible actions in the field without indicating which options will be followed. The plan of Kenya refers to the need to reach a target of 1 per cent of the GNP for S and T expenditure and enumerates various funds available including a nearly established research fund of the National Council for Science and Technology. In the Republic of Korea a technology development corporation has been initiated to help business and research institutions. The documents from India also stress the need for investments in pilot plants and for involving development banks in funding science and technology. Moreover, a new policy approach appears to be adopted in regard to the involvement of government departments concerned with production: "Certain areas of work in science and technology agencies such as CSIR, particularly those calling for large S and T expenditure will be taken up only on the basis of a clear cut indication of the need of priority in the concerned economic sector; the S and T agency will then take up its part of the programme on the basis of funding provided from the S and T allocation of the concerned economic ministry or department. This would ensure both the rationale for the programmes and their need and also utilization of the technology developed."

As regards information systems, the importance of technological information is recognized in varying degrees in the documents. Brazil places special emphasis on the mobilization of all information resources and the regulation of foreign firms involved in information transfer and dissemination. A document from India stresses the valuable role of information in understanding the current status and future prospects of economic and technological development. The documents from Cameroon and Ivory Coast refer to information centres being established in their respective countries. The Mexican document emphasizes the need for strengthening technological information for small and medium industry while the document of the Republic of Korea states that a consultation service centre has been set

up at the Korea Advanced Institute for Science and Technology in order to provide information on imports of technology. The document from Turkey and India stresses the need for computer networks. The documents from Turkey stress the need for data flows at the enterprise level through computers and for training manpower in this field.

The subject of research and development is stressed in several documents and some of the well-known problems, such as links with industries and universities, need for pilot testing and demonstration programmes etc are stressed. The document from India stressed patents as an important development in promotion of research and development. Both Brazil and India stress enterprise-level R and D and technological innovation. Emphasis is placed in Brazil on sectors such as capital goods, communications and informatics. The documents from India describe R and D programmes in several industrial sectors and also emphasize the importance of engineering consultancy. The Mexican document stresses the importance of basic engineering services. Indonesia has launched five main national research programmes. 2/

As regards international co-operation, several documents refer to the need of technological co-operation with advanced countries (e.g. Brazil and Republic of Korea), while documents from the Ivory Coast and Turkey also discuss the approach to foreign assistance in science and technology. The document from Kenya refers to East African co-operation and that from the Ivory Coast to the importance of regional co-operation. The documents from Brazil, India and Turkey stress the importance of co-operation among developing countries.

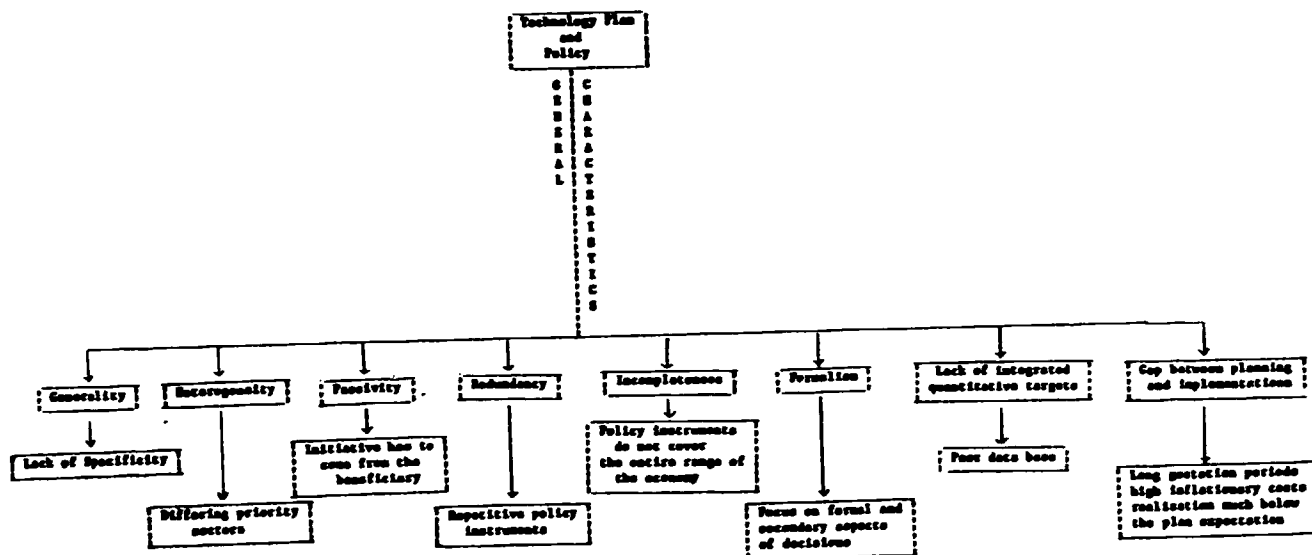
In concluding it may be stated that many of the documents were formulated at a time when the impact of technological advances, such as microelectronics and biotechnology had not been clearly felt. Hence the technological advances do not receive particular attention in the documents. It is to be expected that in future documents of this type the policy response to technological change will be discussed, since several countries covered in the compendium, such as Brazil, India and Mexico have already started taking actions in the field of microelectronics and biotechnology. The recent industrial development plan of Mexico discusses the strategy for structural

change, highlights in this respect the new technological pattern envisaged and also lists the area of high technologies which will be taken up for development in the short, medium and long-terms.

It should also be mentioned that though the proportion of developing countries which have published specific technology plans, policies or other similar documents is rather small, a larger number of countries have formulated policies on specific technological aspects, such as acquisition of technology or development of endogenous technology. Such countries may still need a comprehensive framework for national action in technology. Countries at an early stage of development will also require a minimum set of policy tools and programmes to initiate and strengthen their technological development.^{8/}

CHART I

Schematic Presentation of
General Characteristics of Technology Plans and Policies
of Developing Countries



Source: M.S. Kanthi, UNIDO Consultant

Notes

- 1/ A/CONF.81/BP/UNIDO, Vienna, July 1979.
- 2/ A bibliography of UNIDO documents on technology policy is in Annex II.
- 3/ Countries in which such workshops have been held by the UNIDO Secretariat in the past include Cameroon, Dominican Republic, Malaysia, Madagascar, Kenya and Trinidad and Tobago. Workshops have also been organized in Argentina, Iraq and Sri Lanka.
- 4/ The list of official documents cited is in Annex I (pp. 95-96).
- 5/ Scientific and technological policies and plans are themselves listed as the first priority area but it has obviously links with other priority areas.
- 6/ cf. Technological Self-reliance of Developing Countries : Towards Operational Strategies (ID/262) where self-reliance is defined as the autonomous capacity to make and to implement decisions and thus to exercise choice and control over areas of partial technological dependence or over a nation's relations with other nations.
- 7/ An unofficial translation of Repelita IV arrived too late for inclusion in this compendium.
- 8/ See Industrial Technology in Africa, UNIDO/IS.222, p.14.

II. EXTRACTS OF TECHNOLOGY POLICIES AND PLANS

A. BRAZIL

General

"To:

- stimulate the creation of technology through the promotion of greater integration of the different elements involved, especially the universities, financing agencies, research centers, consulting firms and national producers;
- promote and broaden specific finance schemes and lines of credit to attend, more efficiently and rapidly, the research and development programmes, be they directly carried out by national firms or contracted from technical and scientific institutions, including those that are on credit incorporating the idea of risk, linking their payments to the commercial returns obtained through the sale of the product or the process developed;
- ensure the continuity of research and development programmes directed towards priority subsectors of industry, guaranteeing the steady flow of resources;
- support national consulting firms, seeking to increase their capacity, making it possible for them to act not only in the steps of detailing but, creating better conditions for them to develop the basic engineering of products and process;
- support, through the scientific and technological agencies, the efforts of improvement and control of quality, innovation and increase of the productivity of the national enterprises;
- support the research and the development of materials and services of interest to the Armed Forces;

- broaden the system of support to firms that need to train technicians and research workers, and need to increase managerial capacity in research and development, in order to execute projects which include the creation and absorption of technology, the improvement of productivity and of industrial quality;
- promote the development and adoption of technologies that save energy and that use alternative sources of energy, as well as the use of techniques and processes that guarantee the preservation of the environment. In this sense, the industry should also be encouraged to look for innovations and changes that lead to an improvement in the energy consumption of boilers, heat exchangers and, especially, engines for the automotive industry, as well as support the initiatives that aim at a better use of the petro-chemical raw materials;
- use the buying power of government organs and state enterprises in the support of the technological development of national firms, by giving preference to those which incorporate the findings of the national scientific and technological research efforts."

(1, pp. 59-60)

"We should initially analyze certain aspects of the Brazilian economy that, apart from setting the general lines of the development process, have a direct bearing in the conception of the country's scientific and technological policy. The advanced level of industrialization achieved in Brazil resulted from an economic system in which the state enterprises and the multinational corporations have a dominant role.

The private domestic enterprises very often face unfavourable conditions in their competition with the other two types of enterprise. In one side, the conditions prevailing in the private domestic firms and the dominant participation of foreign companies in certain dynamic sectors prevent the development of an autonomous technology.

The domestic firms do not have the financial and managerial capability and administrative structure to conduct alone extensive programmes of industrial research. Furthermore, the multinational corporations are not, in general, interested in developing more complex research in their subsidiaries operating in developing countries.

On the other hand, the presence of the state enterprises in the productive system permits the direct intervention of the Government in the creation and diffusion of technology. The state enterprises not only do technological research, but also they use their position as an important buyer of capital goods and inputs, and as partner in joint-ventures to force and to make possible technological research in private companies.

Although this picture is the natural result of the development process of the country, it is an objective of economic policy to avoid, via the strengthening of the private domestic enterprises, any further increases in the dominant participation of the state enterprises. This objective is implicit in the basic options of economic strategy included in the I National Development Plan, and it has significative implications for the scientific and technological policy." (2, p.10)

"The policy for science and technology will continue to have as its main premise the improvement in the quality of life of the population, and will seek continuous growth of scientific capability, as well as greater technological autonomy.

Scientific capability will be attained through quality, continuity and expansion of the activities of research. It is understood that these are valuable in themselves as they form an integral and essential part of the social and cultural development of the country, provide an environment for the formation of high-level human resources, and represent a source of knowledge for the creation of new technological perspectives for a given sector.

Technological autonomy defines the capacity to select and generate the most adequate technology among the options available, in addition to promoting its effective absorption while giving special emphasis to long-term socio-economic criteria in the decision making process.

Because of its direct influence upon the productive system, science and technology have a fundamental function in problem solving related to the country's rapid economic growth. Given the advantage of having technical capability available to be put together to seek, adapt or consolidate these solutions, it is appropriate that it should be given continuous and extended treatment over a long period." (1, p.13)

Science and Technology Infrastructure

"The centres of research and development constitute an important repository of technical knowledge and play a significant role in the diffusion of technology and in the preparation of human resources in this field. The use of the full potential capacity of these centres is of fundamental importance and will require the creation of mechanisms of interaction among them and other institutions requiring technical knowledge. In harmony with the directives of the Government which aim at the economic decentralization of the country, there is also a need for the strengthening of regional centres of research and development." (1,p.15)

"Finally, it is vital to promote and to consolidate a technological infrastructure to support the industrial activity and the export promotion of manufactured goods. This will mean an extensive programme of industrial standardization, including metrology; uniformity of quality seals; modernization of the patent control system; establishment of a system of technological information; and the strengthening of the project engineering and technical consulting firms." (2, p.12)

"The structuring of the Sistema Nacional para Desenvolvimento Científico e Tecnológico (SNDCT) should be concluded while this plan is in effect, and in such a way as to achieve the integration of the various

organs and actions related to science and technology, under the coordination of the Conselho de Ciencia e Tecnologia (CCT) (Scientific and Technological Council) of Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq).

To this effect the following actions will be implemented:

- consolidation of the CCT as an organ of the definition of policy, establishment of directives and priorities in the area of science and technology, and of coordination, follow-up and evaluation of their implementation and of their compatibility with the policies and objectives of the Government;
- articulation of the CCT with other collegiate organs which influence scientific and technological policy by sending resolutions and submitting propositions to the CCT for consideration;
- promotion and creation of federal, regional and state organs and systems of science and technology articulated with the SNDCT and of programmes or state foundations able to stimulate scientific and technological development." (1, p.17)

"The Use of Infrastructure:

To stimulate the domestic production of components and products, the establishment of storage and supply centers, the remanagement of equipment among research institutions, and the importation of products which are indispensable for the continuation of research projects, improve the use of physical infrastructure in addition to the provision and maintenance of didactic and scientific equipment." (1, p.23)

"Agroindustrial technology, for the storage and utilization of agricultural surpluses and the improvement of the quality of semi-processed or industrialized products, must be emphasized with a view to increasing their internal and external markets." (1, p.36)

"In the traditional industrial sector the emphasis will continue being on modernization and reorganization. The expansion of the processed food industry will permit improvements in the living standards of vast segments of the population; and agroindustrial complexes will play an important role in the development of the poorest regions of the country." (2,p.12)

"The main directives of the (transport) sector are: priority allocation of resources for the expansion of the infrastructure of the rail and maritime modes, both more energy-efficient; the development and intensification of the use of cargo and public transport vehicles employing energy derived from national sources, intermodal integration and the rationalization of the use of existing infrastructure, by means of the maintenance and improvement of the highway system.

The consolidation of the sector system of science and technology will be indispensable for restructuring the country's transport system, with a view to achieving the improvement of personnel and the improvement of the process of creation, transmission and application of technology." (1, p.38)

"The necessity for maintaining and creating programmes and regional research and development centers must be stressed here. In this sense, there are two geo-economic areas where scientific research and technological development play an essential role: Amazonia and the Northeast." (1, p.39)

"Communications:

To:

- stimulate the market aiming at the installation of Brazilian companies which develop their own technology and which are able to absorb that technology which has been created in other national enterprises;

- develop products adapted to Brazilian requirements and peculiarities, especially as regards the necessity of simple and low cost equipment, in order to fulfill the requirements of population groups in areas of low population density and in peripheral urban areas;
- stimulate teaching and research centers for the training of human resources for the sector, by contracting research projects in the communications area;
- strengthen the Centro de Pesquisas e Desenvolvimento da Telebras (CPqD) (Telebras=Telecominacoes Brasileiras S.A.) (Research and Development Centre of Telebras), in order to guarantee the continuation of projects presently underway, as well as the celebration of new agreements with existing laboratories or with those that may be created in the future, for the effective completion of its research and development programmes;
- support the installation, in Brazil, of the full process - from research to assembly and final testing - of the production of components, through the execution of development projects of dedicated components and developed materials, guaranteeing the initial demand and contributing to the development of the scientific-technological-industrial infrastructure of the country regarding components and their inputs;
- develop and consolidate the national capacity and technology in regard to: equipment and processes utilizing digital techniques; switching systems with stored programme centers; data communications networks; optical communications systems; satellite telecommunications systems; telephonic equipment employing modern technology; national models and processes in the area of antennae and microwaves; devices, equipment, techniques and processes, component part or associated to the telephone network and to the subscribers' system;

- develop capacity in the measurement of terrestrial conductivity and the distribution of the levels of atmospheric noise, including the study of methods for the calculation of fields received in HF and the measurement of the characteristics of the ionosphere in Brazilian territory;
- develop techniques and instruments for the planning and design of telecommunications systems;
- supply the sector, with all the computerized instruments necessary to support, directly and on full-time basis, research activities;
- provide the necessary assistance to guarantee the products developed in the sector may be adequately industrialized, as well as carry out economic studies in order to determine product costs composition, necessary investments, and the technical and economic requirements for manufacture;
- develop and consolidate the national capacity and technology regarding materials of interest to the security of the country."
(1, pp.67-68)

"Industrial Property:

To:

- implant the Patent Bank of the Instituto Nacional da Propriedade Industrial (INPI) (National Institute of Industrial Propriety), in order to transform it into an effective aid to the local process of technological innovation, for the concession of privileges and control of technology imports;
- increase the interchange between INPI and the universities and research centers, so that they all may participate in the evaluation of contracts for the purchase of technology;
- intensify the follow-up of the research projects and personnel training activities included in foreign technology transfer contracts, with a view to their effective absorption;

- promote a horizontal dissemination of technology, avoiding, therefore, its repeated importation;
- stimulate the creation of departments specialized in industrial property and technology marketing, effectively linked to the operation of medium and large national companies, especially the state companies;
- seek means of promoting the patented national inventions, even by means of financing the development of new products and industrial undertakings;
- promote the integration of the existing industrial property legislation with the tax legislation, in order to encourage local creativity and discourage the contracting of foreign technology, particularly in the form of closed technological packages;
- perfect the normative instruments, while adapting them, progressively, to the peculiarities of the various industrial sectors;
- dynamize the process of obtaining patents and trade-marks, as well as the contracting of technology, by means of technical and administrative training of governmental personnel and of procedure simplification." (1, pp.61-62)

"Metrology, Standardization and Industrial Quality:

To:

- consolidate and reinforce the National System of Metrology, Standardization and Industrial Quality, even through adoption of pertinent legislation;
- integral adoption of the International Unit System and the implementation of the legal, scientific and industrial metrology; to this end the national network of metrological laboratories will be strengthened and expanded;

- substantial expansion of the system of technical standards adequate to the real necessities of the country, by strengthening of the Brazilian Association of Technical Standards; (1, pp.61-62)
- incorporation of the network of national and regional technological centers, including laboratories, in the elaboration of standards and of test for product quality checks;
- harmonize the country's quality certification system with internationally adopted procedures, including at the General Agreement on Tariffs and Trade (GATT) level;
- restrict the introduction into the country of new industries, machinery or equipment which do not use the International Unit System. (1, pp.61-62)

Choice, Acquisition and Transfer of Technology

"The focus of the industrial strategy is the import substitution, particularly in basic sectors, reserving for the private domestic enterprises the key roles in this process. This strategy aims at the correction of the imbalances in the industrial structure and at the elimination of the balance of payments difficulties, resulting from changes in the world economy.

This explains the increase emphasis of the industrial policy on the production of capital goods, on the electronic industry and on the production of basic inputs - steel, non-ferrous metals, petrochemical and pharmaceutical inputs, fertilizers, insecticides and pesticides, pulp and paper, cement and sulphur. These are the sectors responsible for the most important deficiencies of the industrial structure and the biggest share of our import costs." (2, pp.11-12)

"It is obvious that the nature of the economic action will vary with the industrial sectors. In some cases the problem is spreading technical knowledge already existing in the country; in other cases it is

necessary to import technology and to adapt it to the domestic needs; and there are also cases where a new technology should be developed as an indispensable condition for the expansion of certain productive activities.

However, it is important that in all cases the importation of technical knowledge, even when it seems the most viable and convenient short-term solution, should be accompanied by an effective effort of assimilating it and adapting it to our needs. The process of technology transfer should not be viewed as a simple way of overcoming obstacles to the economic expansion of the country, but mainly as the acquisition of an input that will be further manipulated and utilized in the process of enabling the country for scientific and technological creation." (2, p.12)

"Scientific and technological development are particularly necessary in the mineral sectors, since the indiscriminate import of technology can be totally inadequate in this sector, due to the peculiarities of our minerals. On the other hand, obstacles to the internal development of technology, which reside in the acquisition of foreign processes, frequently carried out due to the urgency in the execution of certain undertakings in the sector and the lack of confidence in the internal capability of generating solutions, must be removed." (1, p.31)

Development of Human Resources

"To achieve capability in the area of technology, support will be given in the preparation and upgrading of the human resources necessary for the generation, absorption, operation and transfer of technology and the administration of this process at its diverse levels, making use of the system of higher education and especially of the centers of research and development. On the other hand, complementary actions will be taken with the objective of establishing an infrastructure of support for technological development. Efforts in this area will include the strengthening of the systems of industrial property, of metrology, standardization and certification of quality, services of support for and

protection of inventions, mechanisms for the collection and diffusion of technological information, upgrading of capability in the field of project engineering and in the domestic production of instruments and supplies for research." (1, p.41)

"Advanced Training of Human Resources:

To promote conditions of stability and continued improvement of the teaching and research personnel, encouraging full-time service, the establishment of career plans for researchers and for middle and upper level technicians, the effective integration of teaching and research, the introduction of sabbatical leave, and the exchange of individuals among the various institutions and regions of the country. At the same time, support will be provided for the expansion of specialized courses to respond to the needs and characteristics of the labor market and to increase the participation of research and development centers in the preparation of human resources." (1, p.23)

"Methods and nonconventional instruments of training and education, that can make professional preparation accessible on a large scale, will be studied. It will be emphasized, as well, the development of means to help create the spirit of research, particularly, in young people." (1,p.28)

"Emphasis will also be placed on the formation of human resources at the under-graduate level, in the health and nutrition fields, adapted to the real needs in these sectors, aiming at attending the needs of the population at the local level, as well as courses in occupational medicine, the creation and improvement of graduate courses and the training of researchers, particularly those connected to epidemiology and public health, nutrition, pharmacology and food technology." (1, p.29)

Financing Science and Technology

"Over the past several years there has been a decrease, in real terms, in the budgetary resources of the executing and funding agencies of the scientific-technological area. To guarantee the expansion of the

activities of science and technology, it is the policy of the Government to reinforce the budget allocations of the executing agencies to assure their financial stability, and of the funding agencies so they may provide adequate support to their promotion activities." (1, p.13)

"The decentralized action of the agencies and sources of funding will be maintained, while promoting improvements in communication and coordination.

Under the coordination of the CCT the following steps will be taken:

- assist in the elaboration of a budget for science and technology, in articulation with the Federal Government system of programming and budgeting, detailed at the sectorial level and involving the main sources of federal funds; and this budget will be monitored and published annually;
- make explicit and public the portion allocated from federal funds for science and technology, while making efforts towards the effective participation of the CCT in the programming of the resources destined for this sector;
- stimulate a greater participation of state governments and of private enterprises in the funding of science and technology and thereby complementing the resources of the federal area." (1, p.19)

"The fiscal and credit systems will be the objective of studies aiming at using them as effective instruments in the promotion of activities of research and development by business and industry either directly or through sub-contracts within the country.

The system of financing for national enterprise in this sector will be improved with the following aim: to achieve greater economic rationalization of the various subsidies; to consider the conditions of risk inherent in research and development activities; to broaden the basis of participation and the sharing of risks involved in research, particularly, with respect to small and medium enterprises in specific areas of production." (1, p.19)

Scientific and Technological Information

"The active and integrated functioning of the channels of information in science and technology is essential for the scientific and technological development of the country, providing the bases for its planning and follow-up.

It is necessary to sensitize the national conscience concerning the importance of the use of information about science and technology, with the purpose of improving its mechanisms of the access, storage and diffusion.

Given the multidisciplinary characteristic of this sector, it also becomes necessary the training of human resources of high technical level in the treatment and utilization of information." (1, p.18)

"The promotion of documentation and the systematization of scientific and technological information generated by the various executing agencies, the establishment of information systems which will interconnect the involved public and private organs, the collection and dissemination of scientific and technological information from foreign sources through an expansion of international agreements or through organizations specialized in this area and through initiatives directed at the effective functioning of the Patent Bank, will be incentivated.

On the other hand, the growing demand for bibliographical services available abroad has resulted in foreign firms marketing their services directly in the country. On the basis of the experience of other countries, the establishment of a specific legislation for regulating this type of service is recommended.

As a result, the implementation of a policy to meet the needs of scientific and technological information in the country is anticipated, considering its special characteristics taking into account the scarcity of resources and thus, the need for their rational use. This requires the strengthening of the Instituto Brasileiro de Informacao Científica e

Tecnológica (IBICT) (Brazilian Institute of Information in Science and Technology) of the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), as the central body having institutional and material conditions to carry out the functions of a decentralized coordination of the information activities of science and technology in the country." (1, p.18)

"Circulation of Information:

Dynamize the circulation of information through the organization of sectorial libraries, promote the publication of books and periodicals, support faculties and scientific societies, and undertake promotions of various kind for the divulgation and exchange of technical and scientific information." (1, p.23)

R and D Linkage to Productive Sector

"The enterprise is the agent for the adoption and dissemination of technological innovation within the economic system. Thus, the national enterprise, public and private, must be engaged in the effort to master the technology used, particularly with respect to assuring its power of decision at the technical and administrative levels. The actions in this area must take into account the size of the company, as well as the peculiarities of the sector in which it operates, while seeking the creation of instruments which will encourage the generation of technology within the firm itself. In cases in which the acquisition of external technology is indispensable, greater coordination between the acquiring company and project engineering firms, as well as centers of research and development, universities and independent scientific institutions will be encouraged, aiming to increase the bargaining capacity and enabling the effective absorption of the technology acquired." (1, pp.14-15)

"Given the importance of the energy problem, the Government considers an extensive and generalized effort in research and development technology to be expedient, complemented by technical-economic studies on sources, forms, uses and economy of energy, in search of rapid and efficient answers that lead to a progressive reduction of energy and

technology imports in this field. In the case of Brazil, this question takes on a particularly serious form in relation to petroleum fuel derivatives. The resources of science and technology will be mobilized in support of petroleum prospection within the national territory, as well as in support of research in alternative energy sources. Special effort will be dedicated to the technology for the efficient use of derivatives of biomass and coal, as to produce appreciable economies of petroleum." (1, pp.25-26)

"The priority given to agriculture by the III PND implies efforts in the field of science and technology to consolidate knowledge and its transfer to the producer through rural extension, as well as to innovate technology to increase production and productivity. These efforts will be accompanied by institutional changes and capital investment in a manner to assure better utilization of production factors and greater integration between agriculture and industry." (1, pp.26-27)

"The basic objective of the industrial technological policy is to increase the degree of national autonomy in the area. For this to occur it is necessary to strengthen the capacity of national enterprises to create and to absorb technology. The realization of this objective will result in an improvement of quality and an increase in productivity, contributing to the greater competitiveness of national enterprises in relation to foreign enterprises." (1, p.33)

"The projects contracted between a client enterprise and R+D centers should be used as technical and managerial instruments for the articulation between these institutions, and when necessary with the participation of project engineering firms, with a view to the practical utilization of the results of the research. Such centers will be encouraged to provide technical services, especially for small and medium size enterprises. Such services include analysis, tests information, and documentation, as well as technical assistance services with a view to equate and solve their problems in relation to productivity and improvement of their quality and technological innovation. The centers could even be used as technical agents of the Government and depositories of the technology acquired by Government organs. This technology could be

absorbed and disseminated in public and private enterprises and, in so far as possible, articulated with the universities and national consulting enterprises furnish a broad base for technical competence in the effort of development of the national enterprise." (1, p.35)

"The Science and Technology policy for the sector will stimulate basic research in areas of science for the production of basic knowledge, and research applied to the experimental development necessary for its industrial application. This policy aims at making the sector less dependent on the import of materials, components, services and engineering projects, developing its own capacity for the generation and absorption of technology and enabling industrial decision-making within the country." (1, p.39)

"Capital Goods:

To:

- support industry in the development of the necessary equipment for the full and efficient utilization of the new energy sources being developed in the country;
- promote the articulation between national manufacturers and users, in order that the technical knowledge accumulated by the latter may be incorporated in the improvement of designs of machines and equipment;
- stimulate measures which will increase the reliability and performance of equipment produced by national manufacturers, including the expansion of the system of insurance of contractual guarantees regarding these two items, the use of credit facilities to promote goods produced by national manufacturers which have performance guarantees, as well as the implementation of quality control practices between manufacturers and users." (1, pp.60-61)

"Informatics:

To:

- encourage, in a systematic manner, the activities necessary for the technological development of the sector, in accordance with the National Informatics Plan;

- employ the mechanisms and instruments of market protection and import controls in the range of micro, mini, small and medium computers and accessories, in order to ensure, in this way, the proper environment for national technological development;
- encourage the development of basic software, especially operational systems; of application software, in particular that of data bank management systems; of process control programmes; of distributed processing systems and of data communications networks;
- carry out technological evaluation studies of informatics, searching the potential economic, political and cultural consequences of massive automatic electronic information treatment." (1, p.63)

International Co-operation

"The multinational corporations, apart from bringing in external savings, technology and managerial capability, should promote the Brazilian exports and their diversification, and also contribute to the development of the industrial research in the country. In this vein, the multinational corporations should be induced to expend in Brazil part of their total outlays in research and development, and for this purpose, the Brazilian subsidiaries should be allowed to carry their own R+D budget and to sign contracts for project engineering with consultants operating in the country.

Furthermore, mechanisms will be created to improve the competitive position of the domestic enterprises vis-à-vis the multinational corporations. These mechanisms will cover the expansion of the financial and administrative assistance, the modernization of production processes, and the governmental action to supply and to promote the access to technology, both of domestic and foreign sources. In these lines, it is important to mention the financial activities of Investimentos Brasileiros S.A. (IBRASA), Empresa Brasileira Mecanica (EMBRAMEC), Financiadora de Industrias de Base S.A. (FIBASE) and Financiadora de

Estudos e Projetos S.A. (FINEP), as well as the Programa Nacional de Treinamento de Executivos (PNTE) (National Program for Executive Training) and the Centro Brasileiro para Assistencia Gerencial (CEBRAE) (Brazilian Centre for Managerial Assistance to Medium and Small Enterprises)." (2, p.11)

"International cooperation in the area of science and technology should be used primarily as a complementary instrument in the execution of the III PBCT.

The essential objective of the Government, through the efforts of the SNDCT, is to increase the degree of autonomy in science and technology, characterized by a greater capacity for generating local solutions and the capacity to select the foreign technology to be transferred.

Cooperation with developed countries should contribute primarily to a strengthening of the national scientific and technological structure. On the other hand, in the case of developing countries, it should seek the solutions for problems of economic and social development within the spirit of horizontal cooperation.

International scientific and technological cooperation will proceed and develop through integrated action among the various Brazilian governmental bodies, which are responsible for the establishment and implementation of the policy directives in the sector." (1, pp.19-10)

"In relation to industrial propriety there will be at least two objectives to be attained: the generation of technological information, and the organization of technological transactions within the country and with foreign countries." (1, p.34)

B. CAMEROON

General

"During the Fifth Year Plan,^{1/} action will be undertaken to consolidate the established structures and to implement projects that would permit us to master our technological and industrial development." (3, p.856)

In the last few decades, technological and industrial development has faced several bottlenecks among which could be mentioned:

- the lack of a technological research structure;
- the shortage of qualified technicians;
- the lack of a standardization and quality control structure.

During the Fifth Five Year Plan, action will be undertaken to consolidate the established structures and to implement projects that would permit us to master our technological and industrial development. There are provisions for:

- changing the National Committee for the Transfer of Technology into a National Committee for the Development of Technology - an advisory, studies, coordination, documentation and information body on the development and acquisition of technology;
- setting up a Technological and Industrial Research Institute comprising, among other things, a pre-extension service;
- setting up a workshop for the repair and maintenance of scientific and technical equipment;
- setting up a library and a National Scientific and Technical Documentation and Information Centre.

^{1/} From 1980-81 to 1984-85

The aforementioned measures will be accompanied by the execution of certain important projects such as:

- the establishment of a technological information system and the publication of a technological information bulletin;
 - taking an inventory of scientific and technical equipment in the various university and research institutions;
 - the assessment of technological requirements in Cameroon;
 - the dissemination of information on "appropriate" technologies."
- (4, p.306)

Science and Technology Infrastructure

"It is in the course of the Fifth Plan that the Delegation General for Scientific and Technical Research will, through its specialized bodies and institutes, implement Government's scientific and technological policy. At the national level, the Fifth Development Plan therefore best fulfils the conditions for the implementation of the country's scientific and technical research objectives." (4, p.298)

Development of Human Resources

"Human Resources:

The success of the actions thus described depends on the number and quality of available scientific and technical personnel. Consequently, it is necessary that measures be taken in order to considerably increase scientific human resources during the Fifth Plan.

If one considers that total needs in respect of national research workers in recognized research institutes will increase from 140 in 1980/81 to 472 in 1986, one has an idea as to the scope of these needs." (3, p.857)

"Human Resources - Personnel to be Recruited
and/or to be Trained During the Fifth Plan

Establishments	Category of Personnel			Total
	Researchers	Intermediate staff	Junior staff	
DGSTR and central services	35	45	20	100
I.A.R.	102	100	120	322
I.M.R.M.P.S.	73	59	65	197
I.G.M.R.	70	35	25	130
I.Z.R.	97	60	100	257
I.H.S.	99	50	48	197
M.A.B., etc.	51	40	30	121
Total	527	389	408	1,324"

(3, p.858)

Financing Science and Technology

"With the setting up of the Delegation General for Scientific and Technical Research, the publication of the Rules and Regulations governing Research Workers, the strengthening of and increase in the number of operational research structures in the field, research activities will develop significantly during the Fifth Plan. It is in consideration of these factors that the cost of scientific and technical research equipment will amount to about 18,400 million CFA francs."

(3, p.858)

In the past, blame for the apparent lack of funds for research could be put more on the inability of the research apparatus to judiciously use available funds than on the Government's unpreparedness to allocate adequate funds. A look at the table below which outlines the trends in the recurrent and capital budgets of the Delegation General for Scientific and Technical Research shows an increase of from 1,000 million francs in 1974-75 to 4,700 million francs in 1980-81. Thus, in seven years, the research budget has increased by 47 percent. During the Fifth Plan, emphasis should not only be laid on increased funds but rather on a wiser use of available funds." (4, p.299)

R and D and Linkage to Productive Sector

"Although the institutions constitute the framework of scientific and technical research in Cameroon, it must be recalled that research activities are also being carried out in the university, in some ministries and in other government, semi-governmental and private institutions. Lastly, it is useful to mention that individual researchers and foreign bodies which are not based in Cameroon are also contributing to the broadening of the country's scientific and technical knowledge." (4, p.298)

International Co-operation

"A regional and international co-operation agreement on the Gulf of Guinea was signed in Abidjan in March 1981. For Cameroon, it is necessary to draw up its national plan of action pursuant to that agreement, and to promote oceanographic research." (4, p.305).

C. GHANA

General

"The government has recognized that the prospects for achieving rapid economic recovery and social prosperity in Ghana will depend upon a national plan that includes the application of Science and Technology. It is further recognized that the hopes and aspirations of the people cannot be fully realised with a national development strategy that does not include a clear science policy objective." (5, p.55)

Science and Technology Infrastructure

"The need to organise Science and Technology to play a major role in the economic and social development was entrusted to the Council for Scientific and Industrial Research (C.S.I.R.). Government therefore expects the C.S.I.R. to co-ordinate research in such a way as to find expression in the nation's decision-making processes. In the conduct of its own research, the C.S.I.R. is expected to provide analytical studies that will enable it to collaborate with the Ministry of Economic Planning and other governmental and non-governmental organizations to identify priority areas in the national development where Science and Technology are specifically needed.

The establishment of the Science and Technology Planning and Analysis Group (PAG) within the C.S.I.R. is a major step forward for providing the required co-ordination and guidance which is currently lacking in the science communities in the country. The PAG will be expected during the plan period to analyse and to recommend assignment of identified projects to the institutes within C.S.I.R. and other research organisations in Universities and private institutions which can best deal with such specific problems.

Government supports the concept that both basic and applied research activities are needed to fulfil specific short-term projects to alleviate current economic difficulties, while concentrating at the same

time on medium and long range programmes that will have lasting positive effects on the social and economic development of the nation. Furthermore the government has observed that intensive multidisciplinary and inter-institutional research must be fostered and encouraged to result in fruitful exploitation of the country's scientific knowledge and know-how. Government will allocate funds to C.S.I.R. to pursue these objectives." (5, pp.55-56)

Choice, Acquisition and Transfer of Technology

"Appropriate Technology. - Government has acknowledged that a major constraint affecting the national development is the lack of appropriate technologies in all sectors of the economy. The institutes of the C.S.I.R. whose activities include substantial Research and Development (R and D) will be required to make the necessary input into the adaptation of known technologies to suit local conditions. Furthermore the institutes will contribute innovative technologies to help improve the production of local raw materials and the expansion of the nation's industrial output." (5, p.57)

Development of Human Resources

"Government has recognized that science at the Universities involves systematic investigations directed towards the development of new or fuller scientific knowledge with or without reference to any specific application. It is however expected that during the plan period science at the Universities will, in addition to their non-mission oriented research, lend the needed support and expertise to the C.S.I.R. and other governmental and non-governmental research organisations in the country's attempt to fulfill the objectives of the National development plan." (5, p.56)

Financing Science and Technology

"Allocation of Research Funds. - In order to make efficient use of all research funds and the available manpower, the C.S.I.R. will be requested to approve of all funds allocated for research and management within its institutes regardless of source, to ensure that research projects undertaken during the plan period are designed to support the specific objectives of the national plan." (5, p.57)

D. INDIA

General

"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." (6, p.3)

"The crucial role of science and technology as an instrument of social and economic change has been appreciated and the rapid development of science and technology and of its application, accepted as a major objective of planning. This trust in science is embodied in the historic Scientific Policy Resolution of the Government of India adopted in 1958. In the last thirty years of or so, 119 universities, affiliating about 1650 colleges, 5 institutes of technology, 150 engineering colleges and about 100 medical colleges and 350 polytechnics have been established; about 150,000 qualified scientific and technical personnel are produced every year. The total stock of scientific and technically qualified manpower is estimated at 2.5 million, ranking India as the third largest complement of such manpower in the world, occupying a unique position among developing countries. Simultaneously, about 130 specialised research laboratories and institutes have been established under the aegis of Indian Council of Agricultural Research (ICAR), Council of Scientific and Industrial Research (CSIR), the Indian Council of Medical Research (ICMR), the Departments of Atomic Energy, Science & Technology, Space and the Defence Research & Development Organisation, etc. In recent years, public and private sector organisations and undertakings, assisted by fiscal incentives, have established over 600 in-house research & development laboratories largely to meet their internal technological requirements. A relatively new but important development in the last fifteen years is the rapid growth of engineering consultancy organisations to provide design and consultancy services and act as the bridge between research institutions and industry. There are now over 150 such firms of varying size and capability employing over 20,000 technologists. The total expenditure on science and technology is now close to 0.6 per cent of the GNP." (8, p.1)

"Although scientific research has been a part of national planning process since the Second Plan, the extent of the Nation's scientific and technological effort which it has covered has been rather limited. Whether in terms of programme formulation or resource allocation, planning has so far been confined to a few major scientific research agencies and departments. More importantly, perhaps, the structuring of the effort has been such that the goals of Research and Development (R and D) programmes and projects have, often, not been derived directly from the technological needs of development projects, whether in industry or other areas. At the same time, the scope of "science planning" has not covered the whole of the "innovation chain". As a result, successful research results at the laboratory level have often failed to be linked to such elements as pilot plant work, design engineering, plant erection and commissioning and marketing, which are essential if the nation is to secure real and substantial, social and economic benefits from science and technology. The opportunity provided by a planning exercise to knit together competences relevant to a particular development task, which exist in more than one agency, has also not been adequately grasped in the science and technology area."

(7, p.216)

"It was this realisation which led the Government to decide to prepare, as an integral part of the Fifth Plan, a comprehensive Science and Technology Plan, covering particularly all the sectors of the economy. The National Committee on Science and Technology (NCST) was set up to undertake the task of formulating the programme content of such a Plan as also advising Government on the policy framework, organisational and managerial structure and other measures needed for its implementation. In undertaking this task, the NCST has adopted a combination of a sectoral approach, and an overview of the totality of the nation's scientific and technological effort. The actual planning and programming effort, has been largely undertaken by panels of scientists and technologists, not only from research laboratories and universities but from design engineering and manufacturing units, natural resources survey agencies, and extension organisations,, in collaboration with economists, administrators and other skilled groups. Most

importantly, these groups have taken as their starting point, the development profile for each sector, as formulated by "Tasks Forces" of the Planning Commission so that the scientific and technological projects are derived from committed development programmes." (7, p.216)

"Political independence has thus been matched by increasing technological independence in many areas. A range of industries, from the small to the most sophisticated, has been established covering wide areas of utilities, services and goods, and a large number of technologists are now familiar with their operations. There is now a reservoir of expertise well acquainted with the most modern advances in basic and applied areas, and equipped to make choices between available technologies, readily absorb new technologies and provide a framework for future national development. Scientists and technologists have distinguished themselves not only in class rooms and laboratories but also in factories and fields, in conceptual planning and formulation of strategies and in their implementation. Indian scientists and technologists have demonstrated on many fronts that given clearcut objectives and tasks and necessary support, they can fulfil national expectations. The relevance of a large part of the effort in Indian Science and Technology to, and its correlation with, national development can be well established." (8 p.1)

"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." (6, pp.3-4)

Science and Technology Infrastructure

"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." (6, p.5)

"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." (6, p.9)

"It is important to create on an urgent basis appropriate instruments relating to policy formulation for science and technology and for S&T planning. At the apex level, there will be a Cabinet Committee on Science and Technology which will consider all important issues related to science and technology. The Cabinet Committee will be supported by the Scientific Advisory Committee to the Cabinet. This Committee will critically assess the progress of S&T policies in relation to the aspirations of the people and in relation to the achievements of advanced nations and make appropriate recommendations to the Government." (8, p.4)

"Special cells for promotion of S&T for women could be set up in the University Grants Commission, CSIR, ICAR, ICMR, Departments of Atomic Energy, Space, Electronics, Science and Technology and Defence Research and Development Organisation. Specific programmed relating to technologies for rural women and warding off of occupational hazards, have to be structured. There is also need to look into the personnel policies for promoting greater involvement of women in S&T. The coordinating role in this regard has been entrusted to the Department of Science and Technology." (8, p.6)

"Environment and Ecology

A new Department of Environment has been set up. The activities in this important area will pertain to:

- (i) support for R&D programmes, developing and information system, monitoring network field action and demonstration schemes and matters relevant to planning and coordination on environment and ecology at the national and State levels;
- (ii) operational programmes such as establishment of biosphere reserves and centres of excellence for environment education and managements, and Eco-development force and Eco-development camp.
- (iii) programmes pertaining to pollution control measures (water, air, noise etc.)". (8, p.9)

"The S&T programmes in the area of housing and construction materials will concentrate on applied research and development covering building materials, soil engineering, building processes, rural housing, construction equipment and techniques and structural designs, marine structures, construction management and solar energy in buildings. The implementing organisations include Central Water Commission, Central Board of Irrigation and Power, Indian Road Congress, Defence Research and Development Organisation, National Building Organisation, Central Building Research Institute, Indian Institutes of Technology and other laboratories." (8, p.9)

"New research efforts envisaged in the Plan at the Tata Institute of Fundamental Research are in the areas of molecular biology, radio-astronomy, chemical physics and computer sciences. The research programmes of the Saha Institute of Nuclear Physics in the areas of bio-physics, cyclic accelerators, molecular biology, plasma and laser physics will continue. Grant-in-aid support to universities for basic research would be further augmented with a view to help strengthen the infrastructure capability of the university system and develop a national base for expertise in areas of interest to atomic energy development programmes." (8, p.9)

"These new initiatives will be in addition to the on-going S&T programmes such as those undertaken by the Khadi and Village Industries Commission, the National Institute of Rural Development, Centres for application of S&T to rural development and sponsored R&D in other institutions. S&T programmes which relate to improvement and development of implements and machinery needed for village industries, reduction of drudgery and increasing the earning capacity of the workers, will continue." (8, p.9)

"The use-oriented Science and Technology Plan emphasizes links between the generation and users of Technology. Some of the RDD (Research Design and Development) programmes formulated involve execution and implementation by production agencies alone, while in other cases, institutionally distinct RDD laboratories and production agencies have been brought together so that technology transfer can take place smoothly

and dependably. Every effort has been made to ensure that whichever route is followed, scientific and technical personnel with the relevant skills will be associated at each stage of the total innovation chain." (7, p.217)

"As regards the setting up of new institutions, the general approach has been to first reorient prevailing programmes in existing institutions towards the new priorities and needs of the Fifth Plan. Nevertheless, in quite a few areas new institutions, whether for applying known scientific and technological knowledge and expertise, or bringing about new technological innovations through R&D will need to be set up. The basic approach which will be followed in the case of these institutions, is to grow them organically out of groups set up initially in existing institutions. This approach will enable work to get off the ground faster because of the ready availability infrastructure in the mother institution. It will also help to ensure that the physical facilities at the new institution are set up in relation to well-defined programmes of work." (7, p.217)

"The S&T programmes in electronics are funded through the Technology Development Council and National Radar Council sponsored by the Electronics Commission. These institutional mechanisms are responsible for identifying, financing and monitoring R&D efforts in this sector, the projects are selected through national consultative processes and on the basis of a comprehensive definition linking all the elements such as technology gaps, technology competence, in-house R&D needs of industry, import of know-how, manpower needs, creation of facilities, appropriate applications etc. in order to ensure the establishment of a viable technology base for electronics development in the country. The development on micro-electronics on a major scale and its applications for microprocessors and computer systems, development of efficient and reliable systems needed for tele-communication, satellite technology, process control etc. will receive special attention in the Sixth Plan. Several schemes are also envisaged relating to spin-offs from space research, atomic energy research and defence research, which would cover video technology, telemetry and telecontrol, navigational systems, UHF/microwave communication systems, tethered ballon technology, infrared

and mm wave technology. Some of the application areas will be thyristor controlled industrial devices, digital switching, opto-electronics and control systems and systems engineering, production of electronic materials, components and equipment." (8, p.14)

"The focus of the research activities will be on evolving improved and economical designs, use of locally available materials, adoption of better construction practices and development of indigenous technology for new instruments and materials, identification of activities required for the optimum development and water resources by remote sensing techniques and promotion of studies in pure and applied hydrology." (8, p.9)

"The Science and Technology (S&T) programmes in meteorology are undertaken by the establishments of the Indian Meteorological Department, Indian Institute of Tropical Meteorology, Indian Institute of Geomagnetism and Indian Institute of Astrophysics. The programmes pertain to strengthening the infrastructure capabilities and competence to provide weather forecasts, warn against severe phenomena (like cyclones, heavy rains, snow, heat and cold waves), and for detection and location of earthquakes and evaluation of seismic risks. New programmes proposed relate to integrated weather service for agricultural operation and planning, application of remote sensing technique to agricultural meteorology, extension of soil moisture observational network, reconnaissance of cyclonic stores and development of instruments." (8, p.9)

"Institute of Petroleum Exploration (IPE) will be undertaking studies on basic issues connected with petroleum genesis and accumulation, by adopting an integrated and multidisciplinary approach. Institute of Reservoir Studies (IRS) will be concentrating on programmes for developing enhanced recovery techniques for different oil fields. Institute of Drilling Technology (IDT) will initially concentrate on solutions for problems of drilling deep wells. The developmental activities of the three institutes include import substitution and indigenisation of equipment in the field of oil refining, Indian Institute of Petroleum (IIP) will be the prime organisation to conduct

R&D programmes, it will be supplemented by Indian Oil Corporation (IOC - R&D Centre), Engineers India Limited (EIL) and others. The main areas of research would be thermal and fluid catalytic cracking, catalytic reforming, solvent dewaxing and deoiling, hydro-treatment and sweetening of various petroleum products. The Plan programmes envisage setting up a semi-commercial pilot plant next to the Koyali Refinery. Concentrated efforts will also be made to develop catalysts required for various refining programmes." (8, p.10)

"The Department of Science and Technology is concerned with promotional efforts in new areas of science and technology as also coordination of S&T activities in the areas in which a number of institutions and other Departments have interest and capabilities. The Department also provides support to some scientific establishments, science academies and societies and deals with matters concerned with international appropriate mechanisms to operationalize S&T schemes such as advisory Committees and steering Committees; which bring together various institutions, expertise and capabilities to help in implementing schemes and monitoring them in a coordinated manner." (8, p.13)

"In the Sixth Five Year Plan, the infrastructure facilities for the promotion of scientific and technological effort in oceanography and sophisticated instrumentation will be strengthened. The Ocean Science & Technology Agency would be acquiring oceanographic research vessels for undertaking scientific surveys and research for both mineral and biological resources; a marine research and development fund to intensify R&D work is envisaged. The four Regional Sophisticated Instrumentation Centres already set up would be strengthened by adding new equipment; a few more centres to serve the instrumentation needs of scientists in other regions are envisaged." (8, p.13)

Choice, Acquisition and Transfer of Technology

"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." (6, p.1)

"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." (6, p.2)

"The need to conserve foreign exchange and consideration of national security induced the application of domestic science and technology in the substitution of imports. With the increasing emphasis on cost effectiveness in establishing domestic production and exports, a new challenge is posed to the use of domestic scientific and technological talent." (8, p.2)

"The adoption of technologies that can promote decentralized production will be helped through the support to design, marketing, quality control and other services." (6, p.8)

"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." (6, p.12)

"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." (6, p.13)

"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." (6, p.14)

Development of Human Resources

"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." (6, p.2)

"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

sector 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." (6, p.6)

"The first priority must be to nurture talent by a substantial improvement in the general science and technology facilities in universities and research institutions. The University science system has been allowed to run down through lack of support in the recent past, a trend which, if allowed to continue, may result in an irretrievable situation. The current pressure to which the universities are subjected in terms of the enormous intake of science students needs to be reduced. The ten-plus-two-system of higher secondary education has to be effectively brought to use uniformly in all regions, taking note of the opportunities that it provides for filtration at successive levels of 10 to 12 years of school level education. This filtration will only succeed if the alternative channels for vocational training and, later, opportunities for gainful employment, are taken care of." (8, p.3)

"The higher education institutions with their research facilities are a unique base for the training of competent scientists and technologists. But with the rapid expansion of the number of institutions and students, without the corresponding inputs by way of facilities, the role of universities as advanced centres of teaching and research has been eroded, leading not only to the weakening of science teaching and research but also adversely affecting the climate so essential for higher learning. The need today is therefore to restore to the universities their proper image as centres of higher learning. Although it would be unrealistic to expect all the members of the academic community to take up research in addition to teaching, there is an urgent need to revive the concept of integrating of teaching and research so that in 10 to 15 years from now, our universities present a different image and are restored to their recognised positions." (8, p.3)

"Facilities available in universities are not adequate. That they should be increased cannot be over-emphasised. It is in the general interest of not only the universities, but also scientific agencies such as CSIR, DAE, ISRO, public enterprises and technical departments in the

Centre and the States, that the resources in the education sector are considerably augmented, since the manpower that they need comes from the University sector. Moreover, as the benefits of these researches will extend to several sectors of the economy, State Governments and industries should also share in funding research in universities." (8, p.3)

"There is greater need to develop appropriate technologies for those working in the small and unorganised sector. This is particularly applicable to women facing serious occupational hazards in several professions leading to avoidable health problems. There is also a need for a coordinated research project to find out methods to improve the production efficiency and reduction of drudgery in the occupations of women. In the field of information dissemination, mass media could play a useful role in spreading information on technologies relevant to home needs such as care and maintenance of household gadgets, electrically operated utensils etc." (8, p.6)

"Young Scientists: The involvement has to be at the following three levels:

- (a) development of the programmes of the institutions and organisations where the scientists are working;
- (b) interaction with the State Councils of Science and Technology; and
- (c) at the national level, there is a need for a proper mechanism for a continuous involvement of young scientists in the formulation and implementation of policies for science." (8, p.6)

"The University of Grants Commission has provided assistance to Universities to set up computer facilities, instrumentation centres, and centres for advanced study in science. Support is also provided by UGC to selected university science departments to develop accessory and infrastructure facilities for undertaking group research in selected subjects, strengthen and consolidate their teaching and research programmes and to identify an area of specialisation in which they would

ultimately strive to achieve excellence. With UGC support, specific time bound research projects are also undertaken by university faculty members and junior teachers in colleges and universities. These activities will continue in the Sixth Plan." (8, p.9)

"Science and technology programmes relevant for rural reconstruction would be designed to generate expertise and skills for using local resources and manpower, establishing structural linkages between national laboratories, institutions of higher education and state development agencies and programmes through a consortium approach, developing a corps of young professionals and stimulating action-oriented research for development and transfer of appropriate technologies. In this regard, special attention will be paid to the betterment of landless labour, marginal farmers, village artisans and rural women. The S&T programmes would be oriented to the plan programmes which are specially geared for rural development, such as the minimum need programme, village and cottage industries development, integrated rural development, national rural employment programme and special programmes for hill areas, deserts and tribal areas. Specific measures envisaged are the starting of an all India coordinated research project for technologies for landless labour, developing a corps of young professionals, promotion of S&T for weaker sections and women and involvement of younger scientists for solutions of local specific problems." (8, p.11)

"The principal objective of the space programme in India has been to develop indigenous competence in designing and building sophisticated hardware involved in space technology, including rockets and satellites for scientific research and practical applications, the use of the systems for providing point to point communications and the application of satellites for meteorology and for remote sensing of earth resources. During the last decade, substantial progress has been made in establishing a firm indigenous base for the development of space science and technology. More than a thousand rockets have been launched from Thumba and Sriharikota ranges for scientific, technological and meteorological studies. The technology for development and fabrication of satellite launchers, complete with solid propellants, rocket motor propulsion systems, control and inertial systems and electronics has been successfully established. The building up of the capability to construct

satellites indigenously has also registered a good advance. The successful launch and operation of the satellite Aryabhata was followed by the launching in 1979 of Bhaskara, both with the cooperation of the Soviet Union. In the area of applications, two major experiments were completed. The Satellite instructional television Experiment, which was conceived to test the feasibility of utilising satellite T.V. broadcasting for rural audiences, has led to the establishment of technical and organisational capabilities within the country for organizing a large scale satellite based rural T.V. system. Under the other experiment, the Satellite Telecommunication Experiment Project, the applicability of space technology for remote area communication and emergency communication, was investigated." (8, p.14)

Financing Science and Technology

"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." (6, p.9)

"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. (6, p.10)

"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." (6, p.10)

"During the Sixth Plan, the approach would be to fund the programmes under S&T agencies undertaking research, development and design up to the stage of competence building and data collection and to a more limited extent in terms of pilot plants or product and process demonstration units; the latter will be in areas where the application is clear and likely. The further requirements for application-oriented efforts in terms of upscaling of technology, extension and field trials etc. would be funded by the concerned ministries and departments. In addition, certain areas of work in S&T agencies such as CSIR, particularly those calling for large S&T expenditure, will be taken up only on the basis of a clear-cut indication of their need or priority in the concerned economic sector; the S&T agency will then take up its part of the programme on the basis of funding provided from the S&T allocation of the concerned economic ministry or department. This would ensure both the rationale for the programmes and their need and also utilization of the technology developed. Suitable mechanism is being evolved for such complementary funding of programmes in the agencies or research institutions." (8, p.16)

Scientific and 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, p.14)

"A strong information base is a prerequisite for a S&T plan with self-reliance as one of its principal objectives. Since information is utilised not only for the understanding of current status but also for anticipating the shape of things to come, a strong base for the pursuit of intellectual efforts in the direction of technological forecasting, information analysis, R&D management etc. has to be created. Computerised net-works for handling of information would have to be

institutionalised to meet the requirements of policies trends of research, monitoring on a global level, resources availability, industrial, technological and market intelligence." (8, p.5)

"Four sectoral scientific information centres (drugs, leather, food and machine tools) were set up as a first step for developing a National Information System for Science and Technology (NISSAT). The plan envisages setting up four more such centres, as also training in information acquisition, storage and retrieval and bringing about linkage towards developing the national system. Support for seminars and symposia in selected areas would continue." (8, pp.13-14)

R and D and Linkage to Productive Sector

"Council of Scientific and Industrial Research:

The national laboratories under CSIR have undertaken turn key projects and provided basic designs for processes to various industries. Up to 1979-80, more than 1200 processes have been released to industry of which over 500 have gone into commercial production. Design and consultancy capabilities have been developed in several specialised area e.g. optics, electronics, instrumentation, geophysical surveys, pollution control, chemicals, food processing, leather, glass, civil engineering structures etc. For taking science to the grass roots level, CSIR has also pioneered a programme of adoption of districts." (8, p.12)

"The Telecommunications Research Centre will take up R&D schemes in the switching and transmission areas and creation of support facilities e.g. telephone instruments, digital telephones, key telephones, micro-wave and line systems, UHF/VHF and environmental laboratory facilities. The major areas in the plan of Indian Telephone Industries relate to digital and rural communication hardware e.g. Telephone subscriber apparatus and instrumentation, telemetry. RTs and powerline carrier communication systems and integrated communication systems. Hindustan Teleprinters propose to set up functional laboratories and facilities such as pilot production shop, prototype machine shop, PCB

facilities, technical library etc. The programmes of Wireless Monitoring Organisation pertain to formulation of interference criteria, simulation studies, channelisation plans in VHF and UHF bands etc." (8, p.15)

"In the Information and Broadcasting sector, S&T programmes have been taken up by the Research Department of All India Radio. Studies and projects catering to immediate needs of AIR and Doordarshan in the areas of VHF/UHF, TV studio equipment, TV translator, multi-lingual attachments, scale model measurements of antenna and colour TV systems have been taken up. New programmes will include MF/HF propagation, stereophonic broadcasting, TV transmitting and receiving aerials, TV transmitting equipment, digital TV, audio and accoustic engineering studies, development of MF/HF equipment and FM transmitting equipment." (8, p.15)

"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)." (6, p.5)

"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." (6, p.6)

"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." (6, p.8)

"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." (6, p.11)

"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." (6, p.11)

"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, pp.14-15)

"When we consider the magnitude and dimensions of India's problems of economic and social development, associated with the vast and increasing population and immense poverty, especially rural poverty, it becomes clear that massive application of science and technology has to be an essential component for their solution. Science and technology must now be considered a vital input in all investments on par with capital and trained manpower although it has a longer gestation period; the latter implies advance planning beyond the normal five year framework. Science can and must establish new heights for achievement and endeavour, which are big enough to provide the challenge and excitement for the country's best talent. This will generate pride and self-confidence, as well as new innovative ideas and solutions which go beyond mere import substitution. With the much lower costs at which S&T activities can be carried out in India, compared to that in other countries, science and technology is the one resource, which more than any other, provides the greatest advantage and it is, therefore, only logical for us to base our strategy for economic and social growth on this important resource." (8, p.2)

"Linkages between academic institutions on the one hand and national scientific agencies, laboratories and public sector enterprises on the other, have to be strengthened. This can be done in several ways such as through increased mobility of scientific personnel between education and research organisations, joint research projects, and insistence on a minimum percentage of the R&D budget of government scientific agencies and public sector enterprises being spent in the academic sector. Universities and colleges should also be encouraged to undertake applied research, useful for several regions of the country. Since the problems of a particular region are unique and intrinsic the best way that the S&T thrust could be made in finding out solutions to those regional problems would be to make use of the local resources- people, the scientists and community at large." (8, pp.3-4)

"It is only in recent years that a number of enterprises and a few departments of the Government have set up in-house R&D organisations. Their efforts have been mostly confined to providing assistance in establishing process and product standards, substituting imported raw materials and intermediates and towards bringing about product improvements based on feed back from the market or users. A major initiative in the Plan would be to induce the public and private enterprises to enlarge their nascent R&D capabilities to grow rapidly with a view to engaging them in the task of promoting technological innovations. These would also need to be facilitated through appropriate institutional mechanism to enable the managements of such enterprises to have R&D advice in the pursuit of technological innovations as a part of corporate planning." (8, pp.4-5)

"The thrust of the research effort in the energy sector will be on improving the efficiency of production, distribution and utilisation of all forms of energy, improvement of energy efficiency in processes and equipment, recycling of waste for augmenting energy supply and development of new and renewable energy technologies. As the energy problem has emerged as the most critical problem which the world has to face in the coming decades and as investments on this sector are growing increasingly massive, the S&T effort in the energy sector is being intensified over the entire range from atomic energy at one end to animal energy at the other." (8, pp.9-10)

"Coal: The Coal R&D projects are coordinated and monitored by the Central Mines Planning and Designs Institute, Ranchi. Under the Department of Coal, an inter-ministerial Standing Committee on Science and Technology has been formed. The programmes include those of the Central Fuel Research Institute, the coal companies and Research sponsored in academic institutions like Indian School of Mines, Central Mining Research Station and Indian Institute of Technology and Banaras Hindu University. In the Sixth Plan two new techniques of mining, viz. shield mining and hydraulic mining will be tried on an experimental basis. Other S&T schemes include the introduction of geophysical methods for the estimation of river sands, monitoring of environmental conditions, underground communications and technologies for Coal beneficiation, conversion, agglomeration etc." (8, p.10)

"The R&D programmes will be carried out by the public sector units, such as Bharat Heavy Electricals, Hindustan Machine Tools, Bharat Heavy Plate and Vessels, Bharat Pumps and Compressors, Heavy Engineering Corporation Mining and Allied Machinery Corporation, and institutions such as Welding Research Institute, Central Machine Tool Institute and Automotive Research Association Institute. The main objective of in-house R&D units will be to develop competence to provide engineering services bring about improvement in product design and efficiency import substitution and technology absorption, as also for a steady flow of new products, processes and services." (8, p.11)

"In the case of textiles, the R&D programmes will be looked after by industrial research associations for jute, cotton textiles, silk, man-made fibres and wool. The R&D programmes identified in the Plan cover jute fibres, jute re-inforced plastics, energy and water conservation in textile mills, improvement in technologies of yarn and fabric preparation in the decentralised sector, open and spinning technology, machinery development and instrumentation." (8, p.11)

"Chemical Industries: It is proposed to set up facilities for in-house R&D under Indian Drugs and Pharmaceuticals and Hindustan Antibiotics for carrying out development work and improving productivity in the field of drugs and pharmaceuticals. Hindustan Organic Chemicals

intend to establish multi-purpose pilot plant facilities. A central complex for R&D in the field of insecticides is planned by Hindustan Insecticides." (8, p.12)

"A National Institute of Fertilizer technology under the administrative control of the Department of Chemicals and Fertilizers is proposed to be set up during the Sixth Plan. Some of the R&D areas identified for special attention in the field of fertilizers are fuller exploitation of pyrites resources, recovery of sulphur from gypsum, production of nitro-phosphate with use of nitric acid to reduce dependence on sulphur, methods of making tailor made nutrient mixture for specific requirements, miniaturisation of ammonia plants and simplification of process routes to encourage decentralised production units and biofixation of nitrogen. The thrust in R&D on drugs will be on the development of processes for drugs like anti-leukaemic, anticonvulsant, antifertility, anti-malaria, anti-tumor and anti-tuberculosis drugs. Work on development of technology for drugs from indigenous plants would be continued. A coordinated programme is envisaged on development of fermentation technology covering drugs, pharmaceuticals, food and industrial raw material particularly aimed at replacing petro-chemicals." (8, p.12)

"Steel: The Research and Development Centre for Iron and Steel under Steel Authority of India is engaged in undertaking in-house R&D projects of the steel plants. The Sixth Plan programmes will cover areas such as raw materials for producing iron, direct reduction steel making rolling mills, refractories, instrumentation control etc. Amongst the important projects, mention may be made of the partial briquetting of coal charge which aims at utilisation of about 20 per cent non-cooking coal in the existing coke oven batteries, installation of coal dust injection facility at Bhilai Steel Plant, development of alternate routes for production of iron and steel using non-cooking coal by rotary kiln sponge iron pilot plant, improvement in the LD lining life, pilot plant at Durgapur for development of bottom blow oxygen steel making process, development of technology for removing alumina from iron ore on a commercial scale and commercial scale production of cold bonded pellets utilising steel plant wastes. An Information and Documentation Centre is being set up at Ranchi." (8, p.12)

"The R&D programmes are implemented through a network of national laboratories and institutes, regional field stations, extension centres and polytechnological clinics. The S&T programmes of CSIR are reviewed, monitored and managed through a multi-tier system involving the governing body, the executive committees of the laboratories and coordination councils of Directors of laboratories. The CSIR also supports extra-mural research in universities, IITs etc." (8, p.12)

"During the decade 1980-90, there will be three major missions in the space programme. The first is to develop and launch an Indian remote sensing satellite in 1984-85 for effective utilisation of remote sensing technology and the promotion of a national natural resources survey and management system. The second major objective will be to develop by 1986-87 a launch vehicle capable of launching satellites of the class 500-600 KGs in the equatorial orbit and more importantly in the polar orbit. As an intermediate step, launch vehicles capable of placing 140-150 Kg. satellites in near circular orbits will be developed by modifying the SLV-3 system. The third major programme is geared to the commissioning in the early years of the Seventh Plan period, of the prototype of a multi-purpose satellite so that the country could eventually utilise indigenous satellites to meet its needs of space communication. Subservicing these three major objectives, launch vehicle development facilities, satellite development facilities, tracking, telemetry and command network will be augmented and R&D programmes in the area of advanced communication techniques, geodesy etc. intensified." (8, pp.14-15)

International Co-operation

"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, p.15)

"Collaborative efforts through multilateral programmes such as those of the various agencies of the UN system or bilateral technical assistance programmes have emerged as significant vehicles for inter-country cooperation in S&T. It is, however, important that such programmes of technical cooperation are enmeshed with the indigenous S&T capability and linked to the S&T plan.

In devising programmes of technical cooperation with other countries, aid as such should not be the primary objective. Since the basic infrastructure of S&T is strong enough in the country, it would be advantageous to look for programmes which call for collaborative effort between our scientists and those of the advanced countries. It should be the endeavour of R&D institutions to see that, as far as possible, the emphasis in the collaboration is on exchange of specialised knowledge on both sides and procurement of specialised equipment from advanced countries. Certain scientific areas in which we have advantage could be considered for offer of training facilities for the scientists of other developing countries. In this regard, the Centre for S&T for non-aligned countries and Regional Centre for Transfer of Technology (under ESCAP auspices) will be supported and developed. It may also be possible to offer proven technologies to neighbouring countries faced with development problems similar to ours." (8, p.7)

"Under international science collaboration, the support for the Regional centre for Technology Transfer in collaboration with ESCAP would continue. The setting up of a Centre for Science and Technology for non-aligned countries is envisaged, as also coordination of programmes under Technical Cooperation among Developing Countries (TCDC)." (8, p.14)

F. INDONESIA

General

"General policies are intended to create a favourable climate for the viability of a labour intensive growth and the necessary decision making framework for economic agents to adopt labor intensive methods and products in production and consumption. General policies include investment policies, technology policies, education and training policies, labor market and labor protection policies." (9, p.19)

"Industrial development will continue to play a major role in Repelita III. The major objectives of industrial development are to create employment, to fulfil basic human needs in sufficient quantities at reasonable prices, to produce finished and semifinished goods to meet domestic demand as well as for the foreign market, to process raw materials to meet domestic industrial requirements and to produce goods needed by other sectors. In addition the Plan stipulates that industrial development should contribute to a more balanced regional development and a more efficient use of natural resources without endangering the environment." (9, p.35)

Science and Technology Infrastructure

"In order to achieve these objectives the Plan provides for programmes of government support through the introduction of a more clearly defined incentive system coupled with straightforward licencing procedures, financial assistance through the government banking system, and technical extension services for marketing, management and production planning. The incentive system involves among other things, taxation policies, tariffs and credit facilities. The Plan does not elaborate the

specifics of these policy instruments but indicates in general terms government commitments to the policy. This will enable the government to make the necessary adjustments and improvements during the Plan period.

The Plan calls for an improved climate for industrial development. For this purpose the following non-monetary nonfiscal steps are contemplated. The licencing procedures, which have been a major bottleneck in the past, will be simplified. This will be done after a thorough review of existing regulations. Special attention will be given to the speed of processing and the number of levies. Speedy processing and reduction of levies will induce investments in the industrial sector. In addition, procedures of the Investment Board will also be simplified. A priority Scale List which indicates priority industry groups will be issued regularly." (9, p.35)

"...the role of the government in industrial development is the development of infrastructure, in the form of roads, power, harbours etc." (9, p.36)

"The marketing of the output and the input delivery system in the past seems to have been a major bottleneck. To mitigate this problem, cooperative development will be encouraged. Through cooperatives, economies of scale can be obtained for input procurements and marketing of the output. A more difficult problem is to encourage small-scale industries to use opportunities in the export market. For this purpose the assistance of the government through the existig agencies will be enhanced." (9, p.37)

Choice, Acquisition and Transfer of Technology

"Various steps will be taken in the promotion of appropriate technology. Capital intensive technology that has to be used will be modified as far as possible to conform to appropriate technology characteristics. In this respect careful evaluation will be made before a decision is made to use a capital intensive technology. Other steps include the improvement of traditional technology by means of improving

the technique and process of production, improving the design and quality of basic goods in the field of food, housing, health, transportation and others which already command a ready market domestically." (9, p.20)

"The choice of technology is crucial in determining the amount of labor which can be absorbed through industrial development. Priority is given to labor-intensive technology. However, imported and new technologies are in general capital intensive. Therefore a policy of technology adaptation will be followed to ensure a more widespread use of labor-intensive technology. Research activities to support this objective will be enhanced. In addition, existing labor-intensive technology will be promoted for wider use. Research activities to improve productivity without sacrificing labor intensity are also envisaged in the Plan." (9, p.36)

Development of Human Resources

"The objective of training and educational policies is to achieve a greater balance between the demand and supply of educated manpower. To this end efforts will be made to overcome shortage of manpower. Training will be available for those who are self employed or for those who work as wage or salary earners. In university education, emphasis will be given to improvement of quality. Senior high vocational schools will be expanded to cater to the needs in various sectors for skilled manpower. But development of new junior high vocational schools will be limited. Vocational training centers however will be expanded. Activities of non-formal education to cater to the needs of illiterate or semiliterate members of the labor force will be significantly increased. Curriculum of high schools and universities will be improved to include not only the needs of appropriate technology development but also to give sufficient emphasis to proper work ethics, discipline, hard work and excellence. Businesses and private organizations will be given incentives and guidance to conduct their own training programmes. (9, pp.20-21)

Scientific and Technological Information

"The Plan calls for increased efforts on the promotion of government supporting services to improve management through a provision of training facilities. In addition lack of information on markets and export potentials, on the part of new industrial managers and potential investors, limits the growth of the industrial sector. To meet these needs the Plan envisages the establishment and expansion of a trade information network, and of product development and sales promotion activities. In addition, regularly available inputs are required for efficient industrial production. To ensure continuity of supplies of input, marketing organizations will be established which will also serve as information and communication centers." (9, p.36)

R and D and Linkage to Productive Sector

"A favorable climate will be created for innovation. Policies in this context include the granting of patent rights to those who develop appropriate technology, the granting of incentives to research workers and to businesses that adopt appropriate technology, the improvement of curriculum in high schools, universities and academies to conform to the needs of appropriate technology development, and the redirection of activities of research institutes." (9, p.20)

"The Plan also envisages the stepping-up research activities to find ways and means to utilize non-conventional energy sources and to develop the technology required. To build up research capabilities the Plan emphasizes manpower development and strengthening of research institutions." (9, p.41)

"Based on the national strategy policy, the Plan undertakes a series of actions consisting of short, medium, and long term programmes. The short term programme is to intensify exploration and production of conventional energy sources especially oil and natural gas. The medium term objective is to diversify energy consumption through efficient use of energy, utilization of coal in power development, utilization of hydro

power, increasing the production of firewood and utilization of the waste products of forest industries as a source of energy. Research activities for the utilization of solar energy and nuclear energy will be encouraged." (9, p.41)

F. IVORY COAST

Science and Technology Infrastructure

"The effort to adapt research to the specific development problems of the Ivory Coast should be pursued and intensified. In particular, there should be better coordination of research centres (institutes, faculties, etc), so as to insert their activities into the frame of the programmes implementing the broad development options chosen at national level." (10, p.34)

Choice, Acquisition and Transfer of Technology

"The availability of factors of production at competitive prices is a source of comparative advantage which can stimulate the creation and development of activities.

In this context, it should be stressed that the high cost of foreign management personnel, which is still indispensable, is a burden on Ivorian industry, whether its production is directed towards the home market or to export. Correspondingly, rapid Ivorianisation of management is one of the most efficient means to foster the country's industrial development. This is further justification, were any necessary, of Ivorianisation as an objective for industrial development." (10, p.311)

Financing Science and Technology

"This objective will be achieved by the establishment research Agreements with universities and colleges, companies and individual researchers, professional and scientific Associations etc. Partial corporate tax exemptions for research expenses incurred is also possible. These actions will be completed by campaigns to increase awareness and information about research and innovation." (10, pp.41+42)

"Contracts for research, experimentation and the use of new processes will be drawn up between the authorities and enterprises, which would commit themselves to include new local products in their standard manufacturing processes, to find new applications for local products, and to market new products based on local resources.

State involvement in operations of this kind could take the form of soft loans, subsidies, availability of basic products, guarantees of foreign borrowing by firms and guarantees of completion." (10, p.314)

Scientific and Technological Information

Strategies for the achievement of this objective are:

- creation of a national technical and scientific information center
- creation of an office entrusted with the adaptation and development of technologies and innovations." (10, p.41)

Research and Development and Linkage to Productive Sector

"On the structural side, closer relations should be developed between research institutes and university, and between the public and private sectors. Students writing theses should have access to the facilities in research institutes, where they would be exposed to alternative methods of approach to problems.

An objective should be the establishment of a duly constituted body of national research workers, who would gradually come to fill the roles presently played by foreign researchers. For this purpose, pupils and students should be made aware of the problems of their surroundings and the directions in which progress might be sought. This has as a particular corollary the reform of the educational system and more especially of the university, which at present is just a copy of the French model." (10, p.34)

International Co-operation

The means for the achievement of this objective will be the diversification of partners and foreign assistance for Research on the one hand and the determination of research programmes in cooperation with other African countries on subjects of common interest (agriculture in the savannah regions, health, nutrition, forest preservation and exploitation, pharmacopia and traditional medicine) on the other.

The realization of these six main Scientific Research objectives will incur costs, but it is not easy to assess them completely for the 1976-1980 five year period. However 5.58 billion investment is projected (with 5.49 borne by the State) and 25.65 billion in operating costs; note also that there will be, in addition to these expenditures 10.285 billion in foreign assistance." (10, p.42)

"At the present stage in the Ivory Coast's development research activity should be subordinated to development objectives. While research without immediate application may prove fruitful in the long-run it is essential, here as elsewhere, to avoid a dispersion of resources in view of their scarcity and the sheer scale and immediacy of needs. A further consequence of this lack of resources is that the Ivory Coast must draw on the research of other countries, especially the industrialised nations, and where possible seek international cooperation. Promoting greater participation of Ivorians in the research effort will go some way towards enlarging the resource potential. Lastly, by concerting research and development the effectiveness of the resources allocated for research will be yet further enhanced." (10, p.111)

"Research activity, like other measures such as documentation, should be designed in the framework of regional cooperation with neighbouring countries." (10, p.368)

G. KENYA

General

"The national science policy of Kenya has a two-fold character. Firstly, it is concerned with the development and, secondly, with the use of the scientific and technological potential of the country. This also includes the support for science as a cultural activity. In practice, it is the identification of the scientific requirements, the use of technological advances and the allocation and management of the concomitant financial and manpower resources in supporting and pointing the way to cultural, social and economic development that constitutes the national science policy." (11, p.184)

"The productivity of the nation and the income-earning opportunities associated with it depend crucially on the application of modern scientific knowledge to the identification and generation of improved technologies, and the use of the technologies in production processes. In this Plan, therefore, high priority is attached to scientific development and to the use of technology for the social and economic development of the nation. Because the resources available in Kenya for scientific research and technological development are limited, our planning efforts in this regard must be first, to design our research programmes on the basis of clearly identified national priorities, and second, to co-ordinate these programmes so that no effort is wasted in unnecessary duplication of research." (12, p.55)

Science and Technology Infrastructure

The Development Plan 1970-74 proposed that a science policy-making body should be established and close consultations between the Government and the scientific community have now resulted in a proposal to establish a National Council for Science and Technology (NCST) as a statutory body with the following main functions:

- (a) to determine priorities for scientific and technological activities in Kenya in relation to the economic and social policies of the Government and its international commitments;
- (b) to advise the Government on a national science policy including general planning and the assessment of the requisite financial resources;
- (c) to ensure the application of the results of scientific activities to the development of agriculture, industry and social welfare in the country;
- (d) to ensure the scientific conservation of the human and natural environment in the country;
- (e) to ensure co-operation and co-ordination between the various agencies involved in the machinery for making the national science policy; and
- (f) to promote public confidence in scientific expenditure and an atmosphere conducive to scientific activities.

Legislation to set up the proposed Council will be enacted early in the new Plan period." (11, p.186)

"The amount of institutionalization will be reduced to the minimum consistent with good administration, so as to release the maximum funds for the research projects themselves. This investigation will also take into account the need to create the maximum mobility for scientists within and between research establishments to facilitate the reorientation of programmes for research and experimental development and the administration of the careers of scientific and technical personnel involved." (11, p.188)

"The responsibility for expanding on these policies and co-ordinating their implementation lies with the recently created National Council for Science and Technology. Under its aegis, the

Government will establish several government research institutes whose research programmes will require approval by the Council. In addition, research programmes at the University of Nairobi and at private centres, such as the Medical Research Centre, will be referred to the Council for its consideration and all research work in Government ministries will be co-ordinated by the Council." (12, p.57)

Choice, Acquisition and Transfer of Technology

"There will be an early review and evaluation of the efficiency and effectiveness of the machinery involved in technological innovation, particularly that concerned with the transfer of technology, such as the extension and public information services. Considerable sums are spent on these, the justification for which depends on the use the public make of these services." (11, p.188)

"There is now an early prospect of a surplus of scientific manpower and action must be taken if serious over-production in relation to job requirements in certain fields is to be avoided. Over-production of specialists can be as much a constraint as under-production where full employment is a national objective. This potential situation will be modified by Kenyanization of the present jobs in science and technology. However, this may be slower than in many other fields, because extensive experience in addition to formal training is a characteristic need for competent scientists and technicians." (11, p.189)

"Those national priorities must be assigned to specific technological needs in Kenya whether these needs are met by the transfer and adaptation of research results and modern technologies found elsewhere in the world or by original research and new technologies designed in Kenya. With regard to technological transfer, we will develop our scientific capacities to the point where the results of such research can be readily assimilated in Kenya, and more importantly, modified and adapted to our needs. In this way, transfer of technology

will be used as a stimulus leading to further development of technology. To facilitate this, basic supporting facilities, including standardization, patent control, documentation, and information, will be developed." (12, p.55)

Development of Human Resources

"The manpower bottleneck is serious at each of these levels- research, translation to the Kenyan setting, and maintenance. The Government will relieve these shortages as quickly as possible by continuing its emphasis on science subjects in the school system, supporting polytechnic training, expanding the Science Teachers College, and increasing research talent through advanced degree programmes at the University of Nairobi and abroad. In addition, the primary and secondary schools will disseminate more information on the role of technology in the lives of students and develop their mechanical aptitudes so that those who emerge understand principles of maintenance." (12, p.57)

Financing Science and Technology

"The financial and manpower resources devoted to science and technology, as estimated in 1971, are given in Table 8.1. In this table, Research and Experimental Development (R/D) includes all types of research from basic to pilot-plant operations; and, Scientific and Technical Services (STS) includes all those non-research activities involved in teaching, public services and the production of goods in science-based industries which are necessary for the transfer of knowledge and technology. The numbers of scientists refer to high-level manpower with a university degree, or recognized equivalent, and includes engineers and technologists but excludes all foreign financed personnel. The numbers of scientists in research and experimental development are calculated as full-time equivalents. The numbers of technicians include middle-level manpower with at least Form IV education plus a minimum of three year's vocational training in a field applicable to science. The expenditure does not include projects financed by foreign aid or the cost of imported research.

Financial and Manpower Resources Allocated to Science and Technology

Table 8.1

Resource	Expenditure (1971)		Manpower (1970)			
	(KL mill.)		Research and Development		Scientific and Technical Services	
	Research and Development	Scientific and Technical Services	SC*	TECH.	SC*	TECH
Natural and Exact	0.53	2.01	68	65	99	316
Agricultural	3.57	10.33	371	525	228	4,300
Medical	0.56	6.03	55	382	988	2,219
Industrial	0.40	0.92	30	62	1,070	1,000
Social	0.08	0.42	45	-	22	-
TOTALS	5.14	19.71	569	1,034	2,407	7,835

*Full-time equivalent: SC-scientists, engineers and technologists;
TECH- technicians.

Sources: Compiled from various external and Government sources."

(11. pp.184-185).

"As the task is largely a technical one, the Advisory Research Committees, which are scientific forums for the discussion of research requirements, will be composed, primarily, of research scientists. Their advice to the Ministries concerned will show what research projects are needed and their estimated cost, and with which research establishment the work should be contracted-national, regional, international, governmental, university or private. The sum total of the research programmes of each Ministry will constitute its budget for research and experimental development, the review and approval of which will be part of the task of the Council." (11, p.187)

"The Government intends to increase its expenditure on research and experimental development from 0.91 per cent in 1971 to 1 per cent of the Gross Domestic Product by 1978. To achieve this, expenditure on Research and Experimental Development will have to reach KL 11 million by 1978; representing an annual growth rate of 11.5 per cent over the 1971-78 period." (11, p.189)

"The Government has adapted as a long term national target that 1 per cent of Gross Domestic Product should be devoted to research and development. In this Plan, the total provision for funding publicly supported research institutions in both the development and recurrent budgets is KL 9.6 million in 1978/79 rising to KL 15.0 million in 1982/83. In addition, the National Council for Science and Technology will have a Research Fund rising from KL 200,000 in 1979/80 to KL 1 million in 1982/83. Finally, the private sector will be encouraged to expand its expenditures on research and development." (12, p.57)

R and D and Linkage to Productive Sector

"When priorities for research and experimental development are established by the council, they will generally be described in terms of social, economic or environmental problems. These must then be redefined in terms of research programmes and projects needed to find solutions to these problems. For this task the Act will establish, as advisory bodies in their own right (i.e., they are not part of the Council), four

Advisory Research Committees (ARC) in Agricultural Sciences, Medical Sciences, Industrial Sciences and the Natural Environment Sciences. Each Advisory Research Committee will be required to advise, within its sector of responsibility, the Ministries concerned on-

- (i) the details of the research programmes required to implement the research priorities arising from the national science policy;
- (ii) the concomitant budget requirements;
- (iii) the encouragement, promotion and co-ordination of all types of research; and,
- (iv) the application of the results of research through the technical and development services of the Government." (11, p.187)

"The technological needs of off-farm activities will also be addressed. Technologies are required in all industries, but especially in agricultural processing, capital goods-including machine tools, and export industries, which are both efficient and labour intensive. Moreover, improved technologies are needed in the provision of basic needs such as nutritious foods, housing, water, sanitation, and health care. Finally small scale technologies are needed which will make a variety of small industries viable in both the rural and urban settings. These needs will absorb much of the nation's remaining research capacity." (12, p.56)

"The normal lag between the development of appropriate technologies and their widespread adoption in the field often exceeds five years. Therefore, much is to be gained from making this lag as short as possible in Kenya. Hence, the Government will devote more resources to the development of pilot models, testing and demonstration in order to shorten the period between the identification of promising technologies and their employment in production." (12, p.57)

International Co-operation

"The Government recognizes that the constraints on the rapid expansion of scientific expenditures are leading to the need for increased international and regional co-operation in science and technology. For several years now it has worked closely with its Partner States in the East African Community, as shown by its contribution to the maintenance of East African based research institutes for agriculture, forestry, fisheries, veterinary, pest and disease control (both animal and human), and medical and industrial problems. These institutions have enabled research and experimental development to be carried out with less costs and unnecessary duplication than would be likely if each of the Partner States set up its own national institutes for the same purpose."
(11, p.189)

H. REPUBLIC OF KOREA

General

"Advancement of science and technological innovation of a nation depend largely on the availability of scientists and technicians as well as on the level of their ability and creativity. Korea has been making special efforts to train and secure scientists and technicians as well as to improve their capability under medium-and long-term policies and programmes for the development of such manpower." (13, p.59)

Science and Technology Infrastructure

"Sixteen government-funded science and technical research institutes were merged to form 9 institutes which have been made responsible exclusively to the Ministry of Science and Technology. Prior to the mergers these institutes were under the control of various government ministries.

The mergers are expected to permit a more rational operation of these institutes with regard to exchange of researchers, joint utilization of facilities, joint research undertakings, and administrative support. In order to improve research efficiency as desired, it is necessary to establish appropriate systems for research activities and management." (13, pp.64-65)

Choice, Acquisition and Transfer of Technology

"In order to facilitate imports and domestic absorption of advanced technology and thus reduce the nation's technological gap with advanced industrial countries, an automatic approval system for imports of technology was adopted in July 1980. Under the system, imports of all types of technology, except for nuclear and defense technology, are

approved immediately by the Bank of Korea when a contract calls for a royalty of 10 percent or less for the duration of 10 years or less. Imports of nuclear and defense technology with similar contract terms are given immediate approval by the appropriate government ministries." (13, p.66)

"Between 1962 and 1979, a total of 1,467 items of technology were (see Table 6) imported. Of these, 477 items, or 32.5 percent, were for machinery and shipbuilding; 273 items, or 18.6 percent, for oil refining and chemical industry; and 136 items, or 9.3 percent, for metals. Of the total royalty payments, \$113.79 million, or 32.5 percent, were for oil refining and chemical industry; \$66.10 million, or 18.8 percent, for machinery and shipbuilding; \$43.40 million, or 12.4 percent, for metals; and \$34.60 million, or 9.9 percent, for electronic and electrical devices." (13, pp.66-68)

"Japan represented the largest source of technology imported by Korea. Other major sources of imported technology were the United States, West Germany, and Spain, in that order. Japan accounted for 57 percent of technology imports in terms of number of items and 34 percent in terms of royalties. Thus the sources of Korea's technology imports have been skewed toward Japan.

About 70 percent of imported technology consisted of know-how plus patent. The patent portion was as high as 83.7 to 88.7 percent in the case of machinery and electronic technology." (13, pp.68-69)

"In order to develop skills required for domestic manufacturing of nuclear power plants, a number of Korean technicians have been sent abroad to participate in atomic power plant engineering. In addition, a testing station for atomic power generating equipment and supplies is scheduled to be set up." (13, p.70)

Foreign Technologies Imported and Royalties Paid

Table 6

Type of Industry	Number of Cases			Amount of Royalties Paid		
	Approved by Gov't			In thousand dollars		
	1962-79	Ratio	1979	1962-79	Ratio	1979
	%			%		
Agriculture and Livestock	9	0.6	2	4,407.3	1.3	1,157.8
Sub-total	9	0.6	2	4,407.3	1.3	1,157.8
Foods	24	1.6	9	3,631.7	1.0	506.4
Pulp and paper-making	13	0.9	-	7,325.1	2.1	117.5
Textile	22	1.5	1	4,100.0	1.2	1,425.3
Synthetic fiber	40	2.7	12	20,652.0	5.9	4,100.2
Ceramics & cement	38	2.6	7	5,678.5	1.6	2,261.2
Petroleum refining & Chemical	261	17.8	54	113,792.6	32.5	29,970.3
Pharmaceutical	31	2.1	-	1,663.6	0.5	05.8
Metal	136	9.3	26	43,447.7	12.4	2,459.5
Electronic & electrical machinery, apparatus and appliances	273	18.6	43	34,639.7	9.9	8,605.1
Machinery	445	30.3	100	56,184.5	16.0	24,959.3
Shipbuilding	32	2.2	3	9,922.2	2.8	2,309.4
Others	56	3.8	14	11,564.3	3.3	6,403.2
Sub-total	1,271	93.5	269	312,601.9	89.2	83,183.2
Electricity	33	2.2	6	19,116.7	5.4	4,263.7
Communications	38	2.6	8	9,876.8	2.8	3,865
Construction	16	1.1	2	4,595.3	1.3	1,453.8
Sub-total	87	5.9	16	33,588.8	9.5	9,583.1
Total	1,467	100.0	287	350,598.0	100.0	93,934.1

Source: Economic Planning Board

Development of Human Resources

"...steps are being taken to expand the Korea Advanced Institute of Science and to bolster graduate schools of universities in order to secure a greater number of much-needed high-level "brains." At the same time, short-term programs have been set up to invite overseas Korean scientists and technicians to come to Korea to teach or engage in researches in their respective fields of specialty. These programs, conducted on a selective basis, were initiated to fill shortages of such specialists as are needed for the nation's economic and social development.

Measures have been taken to enhance the quality of education at engineering schools of colleges and universities with emphasis placed on the study of major theories of advanced science and technology. The enrolment quotas for various fields of study at these schools have been adjusted in response to the demand for scientists and technicians.

Access to four-year colleges and universities has been broadened for junior vocational college graduates, while programmes designed to train technicians needed by industry have been established.

Changwon Vocational College, set up to train high-skilled manpower for supervisory work, was inaugurated in March 1980 and has since been operating as planned. Recently, the demand for skilled workers has tended to decline because of prolonged business recession. Nevertheless, emphasis is being placed on training an adequate number of skilled workers and on improving their level of skill who will be in increased demand when the economy resumes its growth momentum." (13, pp.59-60)

"The Korean Advanced Institute of Science (KAIS) currently has an enrolment of 931 and a faculty of 85 professors. The institute, set up to train high-grade scientists and technicians, produced 306 masters of science and 13 doctorates in 1980. The Engineering School of Seoul National University is scheduled to increase its enrolment to 2,100 by

1987, a three-fold expansion. A detailed plan has been worked out under which the KAIS and the Korea Institute for Science and Technology (KIST) will be merged in order to increase the utilization of facilities and reduce operational costs." (13, p.61)

"Changwon Vocational College in March 1980 accepted 240 persons to enrol in three departments--machine operation, machine maintenance, and metal processing. Of these, 200 are currently enrolled. A second group of 280 persons entered the college later. They are attending either day courses or night courses in the three departments and another newly established department of electronic machinery and appliances." (13, p.61)

"At present, 6,500, or 66.2 percent, of the total number of high-grade scientists and technicians are employed by schools and research institutes. State-operated enterprises and public service account for 7.6 percent and technical service industry 5.0 percent. Thus a relatively small proportion of such scientists and technicians are engaged in industry (see Table 5).

Table 5

Sectoral Distribution of Technical Manpower

	Number of persons	Composition Ratio (%)
Schools	4,352	44.29
Research institutes	2,152	21.90
Mining industry	77	0.78
Chemical industry	338	3.44
Metal industry	159	1.62
Machinery industry	144	1.47
Electrical & electronic industry	161	1.64
Transportation & shipbuilding industry	206	2.10
Other industry	1,004	0.22
Technical services	491	5.00
State-run enterprises & public service	742	7.65
Total	9,826	100.00

Source: Ministry of Science and Technology." (13, pp.63-64)

Financing Science and Technology

"A financial reserve system for technical development was introduced in order to expedite technical innovation by businesses themselves. However, this system has not worked very well due largely to lack of initiative on the part of businesses.

The government is now studying measures to provide financial support for businesses to spur technical innovation and facilitate commercial application of newly developed technology." (13, p.65)

"In order to provide and administer such financial support, a technical development corporation will be established. Funds to be provided through this firm will be financed largely by the private sector, together with IBRD loans and government credit. The corporation will provide funds directly to businesses to help finance research on specific types of technology they choose to develop either by themselves or through research institutes and to assist in commercial application of such technologies. The corporation, however, should also be able to assume a major role in facilitating coordination between businesses and research institutes and to meet demand for funds needed to assist technical researches for businesses. Moreover, it should closely cooperate with the Small and Medium Enterprises Promotion Corporation in providing technical guidance for small and medium industries." (13, p.66)

"Financial support and tax benefits are provided for selected service firms to help develop the technical service industry and promote exports of technical services." (13, p.69)

Scientific and Technological Information

"A consultation service center has been set up at the KAIST in order to provide information on imports of technology, especially with regard to the sources and import terms of foreign technology." (13, p.66)

International Co-operation

"Under overseas technical training programs, researchers, industrial technicians, professors, and business managers will be sent abroad to acquire advanced knowledge and skills. These state-financed programs will eventually emphasize enrolment in degree courses at schools in advanced industrial countries. About 200 selected trainees are to be sent abroad during 1980. By 1991 a total of 5,000 persons will have been trained abroad under these programs.

In the meantime, a short-term program has also been established under which foreigners, as well as specialists from the Republic of Korea living abroad, are invited to teach at colleges and universities in the Republic of Korea where specialists are in short supply. Under this program, 60 such specialists came to the country during 1980 to teach, 38 of them on a permanent basis and the others on a temporary basis."

(13, p.61)

Table 7

"Technical Personnel Trained Under Foreign Assistance Programs

Programs Sponsored by	Number of persons				
	1951-77	1978	1979	1980	Total
Advanced industrial countries	3,811	207	260	314	4,592
United Nations	3,750	391	491	504	5,136
Colombo	3,298	157	162	158	3,775
AID Loans	3,948	18	-	50	4,016
Total	14,807	773	913	1,026	17,519

Source: Ministry of Science and Technology

Table 8

Number of Specialists Invited

Financed by	1951-77	1978	1979	1980	Total
Advanced industrial countries	205	44	11	24	284
United Nations	935	71	43	61	1,110
Colombo program	509	39	34	44	626
AID loans	1,893	-	-	-	1,893
Total	3,542	154	88	129	3,913

Source: Ministry of Science and Technology" (13, p.68)

"Of the 112 contracts (see Table 10), 31, or 27.7 percent, were for machinery and metals; 21, or 18.8 percent, for construction; 20, or 17.9 percent, for chemical industry; 17, or 15.1 percent, for electricity and electronics; and 7, or 6.3 percent, for atomic power. Of the total value of the contracts, \$2,178,000, or 25.4 percent which represented the largest ratio, was for atomic power. Construction accounted for the second largest proportion, machinery and metals the third, and electricity and electronics the fourth.

Table 10

Foreign Technical Service Contracts

	1972-76	1977	1978	1979	1980	Total
Number of contracts authorized	205	94	105	131	112	647
Value of contracts (In thousand dollars)	18,496	9,190	9,685	14,345	8,565	60,281

Source: Ministry of Science and Technology". (13, p.72)

I. MEXICO

General

"The development of basic engineering and information services is indispensable for a country seeking technological self-determination, again defined as the capacity for making independent decisions which will determine our future development. Future economic growth of the oil, petrochemical, and mining industries requires the rapid expansion of basic engineering services." (14, pp.40, 41)

Choice, Acquisition and Transfer of Technology

"Ninety percent of technology adaptation and development in electronics has been directed toward industries which produce goods such as radios, televisions, toys, etc. At the same time, sufficient support has not been forthcoming for the development of production tools and research instruments." (14, p.42)

"Research will be carried out in the textile, leather and shoe industries for the benefit of the local labor market and local consumption. Adaptation, knowledge and mastery of technology already imported will be furthered and new processes and techniques in tanning will be developed." (14, p.42)

Scientific and Technological Information

"Industrial information services have grown slowly. In order to strengthen these services, equipment for data processing and for the dissemination of information will be increased, information subsystems by industrial areas will be developed, and the technical advisory system for small and medium-sized industry will be enlarged." (14, p.41)

"A computer program will be written to develop a uniform design and optimize the performance of transformers. A method will be developed to evaluate the assembly and testing of transformers. Studies will also be made on the improvement of structural materials." (14, p.48)

"Thermohydraulic circuits for nuclear generation of electricity:

The purpose of this program is to build and operate thermohydraulic circuits for nuclear plants, as well as to test the design and its components.

This project will provide the necessary information for building a cooling circuit for a low power reactor." (14, p.48)

"The industrial information service network has not been developed according to any overall plan. There are no available statistics to evaluate development and growth.

Information sub-systems will be designed according to the needs of each type of industry. Research will be done on the establishment of technical assistance centers for small and medium-sized industries." (14, pp.57-58)

R and D and Linkage to Productive Sector

"Research on models and scales of production, in partnership with the producing enterprises, will continue to receive support, as allowed by the local market structure. Public sector requirements will also be used as a priority indicator for developing prototypes. The work will be initiated with the design of drilling equipment for oil and water wells, and of locomotives and high power generators.

Expenditures in applied research and experimental development in the mining industry have grown considerably in recent years. However, there is still no integrated research program for the exploration, withdrawal, and transformation of minerals using manufacturing processes. Research will be planned and coordinated in support of mining development." (14, p.41)

"Scientists will be trained in designing, building and operating a zero power reactor, to acquire experience in technology. A zero power reactor will be designed using natural uranium processed locally as fuel, with heavy water as a moderator and a graphite reflector. The reactor will be used to support basic theoretical research and identify neutron parameters.

"Various projects deal with the utilization of wind energy which can benefit isolated areas of the country. An experimental station will be built applying Mexican technology for designing and developing wind converters which are based on local meteorological conditions. A station will be built to test wind-powered engines, pumps and generators." (14, p.51)

"Research will be done on total flow systems to take full advantage of geothermal resources for generating electricity. A model of a total flow turbine will be built in order to be tested and evaluated under operating conditions in the Cerro Prieto geothermal fields." (14, p.52)

"The electronics industry has emphasized production of recreational products, i.e., television sets, radios, record players, tape recorders, etc., because they show the most profit. The production of industrial electronics represents only about 10 percent of the total output.

Research will be carried out on component technology and on the utilization of materials available in Mexico to produce industrial electronic equipment for quality control, development of agriculture, medicine, oceanography and scientific research.

Studies will be made on raw materials and such semi-conductor components as electronic ceramics." (14, p.60)

International Co-operation

"The large government investments already made and those projected for the future in petroleum, mining and metallurgy will cause a growing demand for capital goods. These goods now account for approximately 40 percent of our total foreign purchases, and of the Mexican companies producing capital goods, some 64 percent still buy foreign technology. Basic engineering is highly scarce, but equipment to begin producing at sufficient scale is indeed available." (14, p.41)

"Research will be carried out to coordinate and combine national mining development programs and research. Once the present situation is evaluated, an outline will be made of the industry's future prospects. The technological levels of unintegrated and rolling mill industries will be identified and studies will be made to improve the efficiency and quality of products to meet export standards." (14, p.61)

J. TURKEY

General

"Research, development and technical progress constitute the guiding and driving force of socio-economic evolution. It will therefore be a basic policy to direct the research and development activities to pre-set targets and give them a dynamic structure." (15, p.176)

Science and Technology Infrastructure

"A scientific and technological master plan will be worked out, which would conform to the plan's long-term targets and strategies and to the economic, industrial and social development objectives of the country. In the preparation of the subject master plan, the study called, Turkey's Science Policy, 1983-2003, which was completed in 1983 will be taken as a starting point." (15, p.177)

Development of Human Resources

"Funds allocated to scientific research and development with respect to basic researches as well as to applied researches will be focused on research bodies endowed with suitable infrastructure, thereby creating thoroughly developed centres of attraction in various fields and sectors, and encouraging specialisation on certain lines where universities are particularly dominant and also promoting an effective co-operation between universities and the industry." (15, p.177)

"It is of vital importance that computers should be programmed in accordance with the target so that they may perform the work expected from them. The objective will be to train an adequate number of qualified system analysts, computer maintenance and repair personnel who play a vital role in getting the productivity expected from computers. The acquisition of computers will be conditional on the prior employment of computer operators." (15, p.178)

"Companies developing computer software will receive encouragement, in view of the fact that the accumulation of qualified manpower and knowledge in Turkey has reached such a level as to enable the production and development of software at home and to export it to the regional countries in the future, rather than to import it." (15, p.178)

Scientific and Technological Information

"Starting from the viewpoint that a loss of productivity caused by an improper use of the products of information technology (computer hardware and software) would surpass the funds allocated for the operation of this technology, the target aimed at will be to evenly spread the most rational operation and exploitation of this technology all over the country." (15, p.177)

"The basic policy will be to give importance to the adoption of every measure and therefore support the necessary institutionalisation in order to develop the data processing technology and prepare conditions for the training and employment of the manpower needed in this field, with a view to speeding up the economic and social development and stepping up productivity in the agricultural, industrial and service sectors." (15, p.177)

"The principle adopted for the development of a viable data flow system in Turkey is that enterprises owning or likely to own a computer should make best use of it by setting up a data bank related to their respective operations and that a computer network should begin to take shape for interconnecting these centres for data exchange, and to developing to this end in priority the quality and volume of the telecommunication infrastructure." (15, p.177)

International Co-operation

"Principles and Policies:

In policy implementation pertaining to international cooperation and technical assistance the following principles will be observed:

International co-operation and technical assistance constitute an important tool in the transfer and production of know-how and technology.

In the utilisation of technical aids, it will be a basic principle to back up those projects and programmes which are aiming at concrete objectives and results in economic and social fields, provide for the consolidation of existing enterprises, are autonomous in context and which aim at becoming self-supporting in the long run.

With the knowledge that Turkey has attained the level of contribution to international technical cooperation, technical aid will be extended especially to developing countries and emphasis laid on the improvement of relations with these countries in various fields.

Attempts will be made, in the context of foreign oriented activities, to increase the number of Turkish experts working on projects conducted at international institutions as well as in countries which aols, and export industries, which are both efficient and labour intensive. Moreover, improved technologies are needed in the provision of basic needs such as nutritious foods, housing, water, sanitation, and health care. Finally small scale technologies are needed which are developing through the technical aids being issued by said bodies."

(15, p.178)

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