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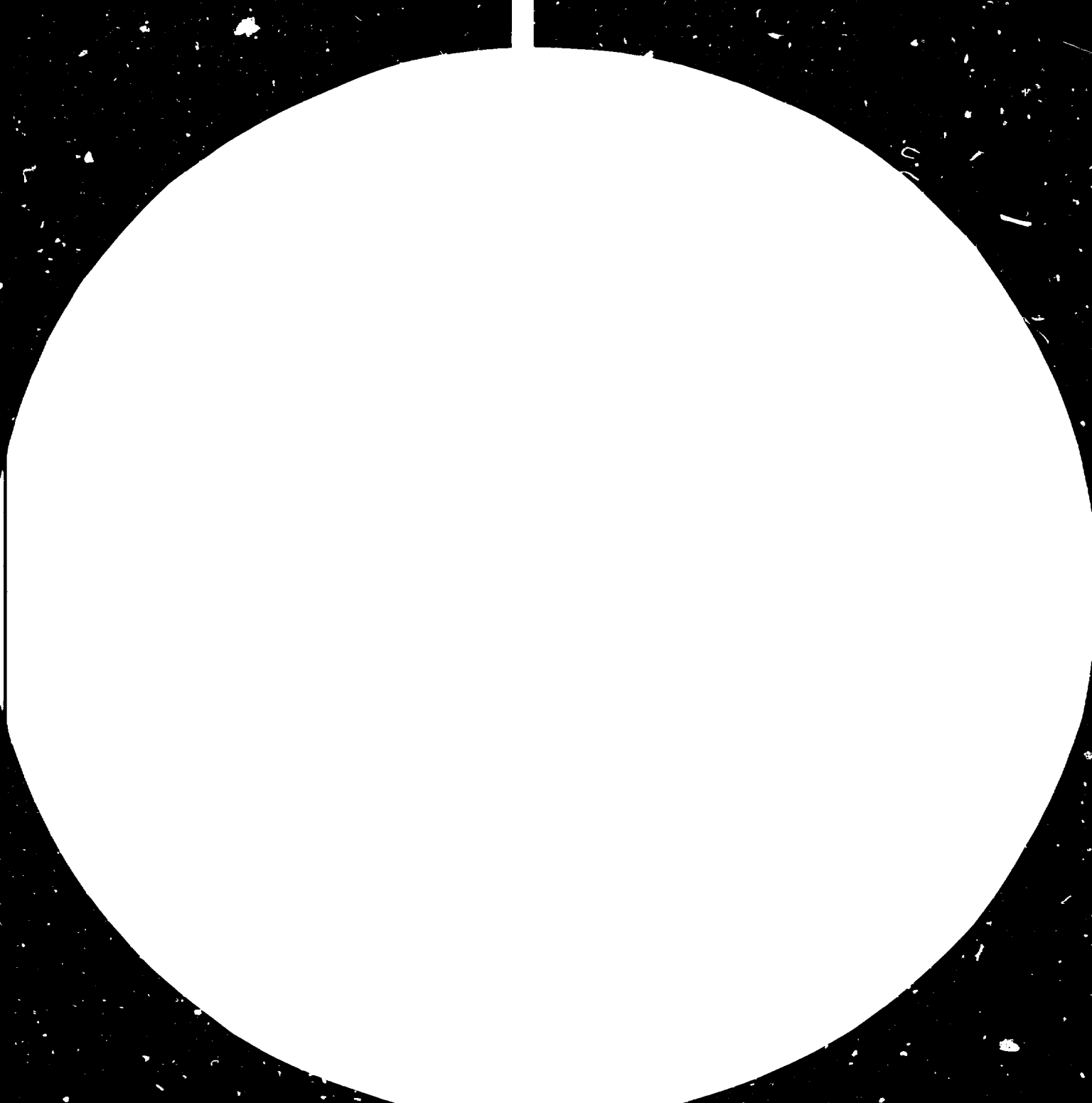

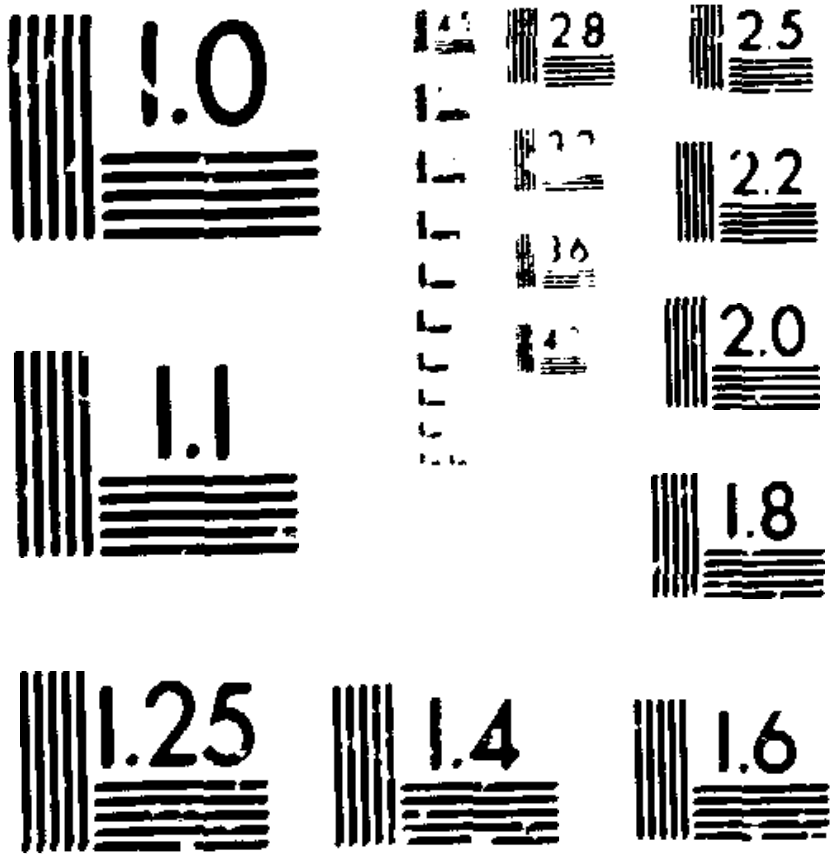

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GUIDELINES FOR THE FORMULATION OF A BASIC POLICY AND DEVELOPMENT PLAN FOR SCIENCE AND TECHNOLOGY*

by

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CONTENTS

Summary

Policy measures for a science and technology development plan are discussed in Section A. It is recognized that the strategy for a national plan depends to a great degree on needs and capabilities of the country. The pivotal problem is how to assess latent capabilities so that they can be translated into development programmes for implementation. It is, therefore, essential to provide necessary basic data by mobilizing talents in the country as well as abroad, prior to the formulation of a science and development plan.

Three types of guidelines are suggested in Section B for the formulation of a comprehensive plan for science and technology, outlining the preparatory work for planning and planning procedures.

The concluding remarks underline the need to create an awareness among the developing countries of the vast scope of technologies available and to encourage collaboration between countries. It is recommended that industrial research can be extremely useful in developing technological rapport with the changing pattern of industrial development. When science and technology are favourable a country's science can strike deep roots and grow adequately to contribute to national development and improve living standards, therefore, it is important that decision-makers and governments are fully aware of the socio-economic development brought about by the development of science and technology.

A. Policy Measures for Science and Technology Development Plan

It is not difficult to achieve a consensus among people of different backgrounds that the choice of technology development strategy depends to a great degree on needs and capabilities and we can go on to conclude that needs and capabilities must be identified before formulating any plan for technological or, on an even broader scale, any national development plan. The pivotal problem is not deficiencies in perception but how to ascertain needs and how to assess latent capabilities so that they can be translated into development programmes for implementation. What little experience we have had leads me to say that this is a task most difficult of accomplishment for most developing countries. In this regard, it is essential to provide necessary basic data by mobilizing talents in the country as well as abroad, prior to the formulation of science and technology development plan. With these thoughts in mind I will try to suggest policy measures for science and technology development plan using as appropriate some of the experiences I have observed, particularly in my own country, viz. the Republic of Korea.

I. Techno-Economic Study and Preparation of Basic Data

In order to formulate science and technology development plan, it is necessary to survey the present status and future prospects of their economy and identify country's needs and

potential capabilities. On the basis of this survey, it is able to determine the policy directions for development. In this regard, following guidelines are suggested :

(1) Identify the strategic industries and needed technologies for these industries, particularly through market survey of products which they aim to produce.

(2) Analyze the mechanism of technology transfer in the newly industrialized countries, in order to establish the technology transfer and development systems.

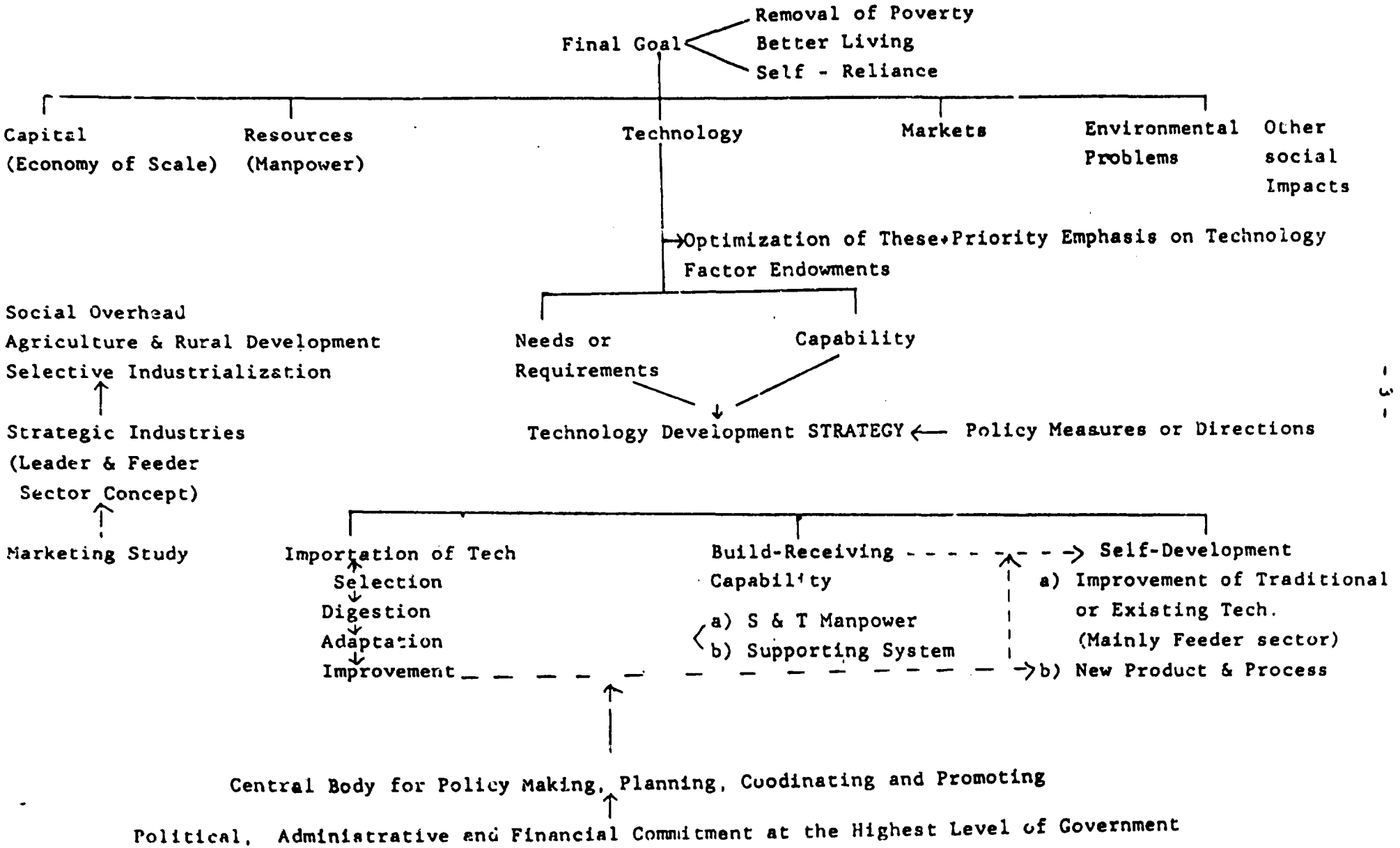
(3) Review country's potential capabilities and strengthen them to meet their national needs, particularly for economic development.

II. Formulation of Guiding Plan and Five-Year Development Plan

The government should decide to pursue a long-range plan for the development of science and technology as an integral constitute of the economic development plan. In this plan, they have to adopt what might be called a three-pronged approach, emphasizing manpower development at various levels, accelerated introduction of foreign technologies, and stimulation of domestic R & D activities. We believe that domestic R & D is a prerequisite for sound selection, efficient assimilation, and fruitful adaptation of foreign technologies. The Republic of Korean example on the relationship between industrialization plan and technology development strategy is shown in Diagram 1.

In this regard, the following measures are recommended:

Diagram 1. Industrialization Plan and Technology Development Strategy



II-1. Establishment of Bases for Promotion :

First, it is necessary to establish appropriate infrastructure conducive to the development of science and technology. I will introduce examples from the Republic of Korea for your reference. For the institutional framework, it included among other measures, the establishment of :

(i) the Ministry of Science and Technology (MOST) as the central policy-making, planning, coordinating and promotional body in the government ;

(ii) the Korea Institute of Science and Technology (KIST) by a special law as an autonomous multidisciplinary research organization ;

(iii) the Korea Advanced Institute of Science (KAIS) which serves as a special mission-oriented post-graduate school ;

(iv) a huge number of vocational training institutes for skilled workers and technicians ;

(v) the reinforcement of the technical information clearinghouse ;

(vi) the strengthening of quality control and inspection activities ;

(vii) intermediary for financial support and so on.

For the legal back-up, several very important laws are enacted. These include :

(i) the Science and Technology Advancement Law which defines the basic commitment of the government to support science and technology and to provide policy leadership ;

(ii) the Law for the Promotion of Industrial Technology Development to provide, among other things, fiscal and finanial incentives to private industries for technology development;

(iii) the National Technical Qualification Law which, through an examination and certification system, promotes an enhancement of status for professionals in technical fields, particularly for those who practice skills ;

(iv) the Assistance Law for Designated Research Organization which provides legal, financial and fiscal incentives for research institutes in specialized fields being given supportive emphasis by the government and private industry ;

(v) the Engineering Service Promotion Law to promote local engineering firms by assuring markets on one hand and performance standards on the other ; and so on.

II-2. Development of Scientific and Technical Manpower :

Considering the importance of technological manpower development for national needs, innovative measures in science education and technical training are essential. Particularly, those deep-rooted, tradition-bound value criteria which under-rate skilled occupations need to be corrected.

What the Republic of Korea has done for this purpose includes legal, financial and administrative measures. On the one hand, several laws have been legislated to step up education and training programs run by the government and, on the other hand, to obligate industrial firms above a certain size to undertake in-plant training programs to help accelerate the production of needed manpower.

Furthermore, the government enacted a National Technical Qualification Law not only to upgrade the quality of technical manpower but also to help bring about a consensus among the general public in favor of skilled occupations so that young talented people may with high morale and pride choose such an occupation as a career. In addition, those science and engineering students, who pass the entrance examination of KAIS and selected technicians who pass a national examination for skill proficiency are exempted from obligatory military service ... this is probably the single most prized incentive the government can provide... and full-scholarships are awarded to those who are undergoing education and training.

II-3. Industrial Technology Development :

In recognition of the need for an intermediary agent which would bridge the traditional and the contemporary, the domestic and the foreign, the establishment of an industrial research institute staffed with individuals who had had experience both in academic and in applied research and development activities, are desired.

This institute will be designed to create a non-conventional, problem-oriented, self-perpetuating research group which would become the center of R & D activities, and act as a breeder institution, helping in the formation of scientific and technological communities throughout the country. Such an institute was particularly needed to work over some difficult-to-assimilate advanced

technologies from abroad and adapt them to local situations. This task requires on the one hand capacity to appreciate indigenous problems, and on the other capacity to find answers to these problems in exogenous sources. In Korea, KIST was established for this purpose through special legislation, as a contract research organization so that marketing principles prevailed in the realm of R & D to make researchers problem-oriented and to impress the underwriters of such R & D with the importance of what they do with R & D results. To operate such an institute effectively and efficiently, autonomy of research, stability of establishment and a research environment conducive to attracting needed manpower become key features.

Following up on the institutional framework, the adequate legal back-up for the promotion of industrial technology development should be considered, particularly a parallel policy support for private industry to induce their research activities. Finally, for the policy-making and planning of technology development, it is necessary that not only all locally available scientists and engineers be mobilized but also experienced foreign talents be utilized effectively through international technical co-operation. In this regard, the tripartite co-operation system among the recipient country, the newly industrialized country and the help of the advanced country or UN organization is recommended.

II-4. Creation of Science and Technology Climate :

Science and technology development gain momentum when a suitable environment for its popularization is created. The

creation and promotion of such an environment is a prerequisite for science and technology development, particularly in a country where social and economic patterns and customs are tradition-bound. The Republic of Korea has launched a "Movement" for the popularization of science and technology as an integral part of its long range development plan. The movement aims at accomplishing a universal desire for scientific innovation among all the people in all aspects of their lives. It has been led by the Ministry of Science and Technology, the Korea Science Promotion Foundation and the Saemaul Technical Service Corps in cooperation with concerned government agencies, industry, academic circles, and the mass communication media. The basic goal of this movement is a re-orientation of the public's attitudes.

Thus far I have tried to suggest important policy measures for science and technology development by using some of the experiences of the Republic of Korea. However, I wish to emphasize that the process of science and technology development must be a long-term operation. There should be a gradual or modular approach to building up the capacity to maximize the latecomer's advantage as obstacles are being eliminated one by one so that the development can take place through synchronization of built-up capacity and elimination of obstacles to development.

B. Formulation of a Comprehensive Plan for Science and Technology

The comprehensive plan for science and technology (C.P.S.T) may contain three types of plans. The first type is a guiding plan (at least 20 years period). The second type is development plan (5 years) and each plan is associated with the national socio-economic development plan. The third type is implementation and management plan for each development plan.

I. Preparatory Work for Planning

I-1 Basic Studies and Basic Data :

In order to carry out the planning process, some basic data must be collected plus some basic analysis and studies must be carried out.

This may include the following :

(1) First : basic study- review and analysis of the current status of the country in terms of socio-economic, institutional and science/technology related factors, second : survey of the available data in the country in areas related to industries, science and technology, manpower developments. This includes population statistics such as (10-25) years of age, third : study and analysis of the existing educational system and a comparative analysis with other relevant countries, fourth : social studies regarding work habits, acceptance of technology, fifth : study of value system (religion, social, etc), sixty : science and technology inventory analysis, seventh :

a comparative study of science and technology experiences in different countries, finally : preliminary comprehensive techno-economic survey for the future prospects of the country, etc.

(2) Studies and basic data related to the Guiding Plan such as occupational analysis of existing manpower, forecast of the manpower requirement, socio-economic studies to determine the means of science and technology public awareness, socio-economic goals, forecast the socio-economic status of the country, and so on.

(3) Studies and basic data related to the science and technology development plan such as analysis of the previous Five Years Development Plan, functional relationship and requirements of the needs of different socio-economic goals from science and technology, study of manpower performance, motivation, table of technology input-output of the country (soft-hard technology), etc.

I-2 Guiding Plan

This plan will include the following :

(1) Review of long-term socio-economic development plan. Particularly identify strategic industries selected by market survey.

(2) Defining science and technology policies, goals and objectives (science and technology for long-term prospects in the country). These policies, goals and objectives must be part of the national development policies, goals and objectives.

(3) Identification of the country's priorities in science and technology. This includes identification of specific fields of science and technology to be developed and emphasized.

(4) Review and analysis of the science and technology needs of Government and Industries up to year 2000 and the identification of the countrys R & D needs.

(5) Basic guidelines of science and technology policy.

(6) Policies and priorities guidelines for R & D activities.

(7) Role of central body for promotion

(8) Strategy for technology acquisition and adaptation.

(9) Strategy and guideline for the un-packing of technology.

(10) Strategy and guidelines for self-development.

(11) Guideline and strategy for manpower development in the field of science and technology. This includes guidelines and strategy to develop general education, vocational education, higher education, training and national examinations for technicians and professionals. Motivation for manpower will also be considered. This includes policies to motivate inflow of science and technology manpower. Alternative policies for science and technology manpower development (institutional, programatic, administrative, etc.,) will also be developed in the plan.

(12) Strategy for public awareness of science and technology. This includes policies and concept to stimulate the public awareness of science and technology.

(13) Strategy for implementation including the stages at which the plan is going to be carried.

(14) The criteria and standards for the control of further planning and implementation.

(15) Science and technology policy and program management system including organization of a feed back mechanism so that the experiences gained from planning and implementation can be utilized in improving the guiding plan.

(16) Development of alternative policies and development plan for science and technology facility development : institutional, programatic, administrative and so on

I-3. Development Plan :

This plan is a detailed quantitative plan for the tasks which are going to be performed in order to achieve the goals of the first stage (5 years) as will be defined in the guiding plan. The plan will be geared to the current national five year development plan as well as successive five year development plans, which will be prepared in the near future. The plan may deal with :

(1) Developing a proper method for conducting technological assessment including the identification of appropriate technology :

(2) The creation of a mechanism and program for importation, assimilation, adaptation and improvement of foreign technology:

(3) The establishment of mechanisms to carry development of research results through the different stages upto its application :

(4) Provide extension services and techno-ecoromic study services to the industries :

(5) Science and technology system integration. This includes crystalizing the relation between central body (MOST) and intermediary agents (KIST) on the one hand and industry on the other so as to bridge the gap between them.

(6) Program for institutional set-up for science and technology development

(7) Formulation of a manpower development matrix including improvement of educational system, the creation of training programs and programs to motivate inflow of science and technology manpower.

(8) Development of science and technology capability and infrastructure in different government and public sectors and in industries.

(9) Establishment of legal support which will help to create suitable environment for science and technology development. This may include providing incentives to the industries to activate their R & D activities and to utilize locally developed technology.

(10) Promotion of engineering extension programs and consulting services (The un-packing of technology).

(11) Short and medium R & D plan and the creation of a technology self-development policy and program to achieve self reliance. Some areas of science and technology will be stressed.

(12) Science and technology awareness. This includes programs to stimulate public understanding of science and technology.

II. Planning Procedure

The planning procedure can be summarized in Diagram 2.

The planning process will start with the carrying of basic data collection and analysis and some basic studies. The basic studies and data collection will continue throughout the planning process. The mechanism of collecting the data and analysis may become permanent for the purpose of feed back of new information and experience and updating the plans. The guiding plan will be formulated as a result of these basic studies and analysis plus the extensive discussion which will be carried with different private and government sectors. The result of these discussions will be assessed by experts before adopted in the plan. Some aspects of the guiding plan can only be done by independent studies of experts. The development plan is more quantitative in nature. It is controlled by the present status, the guiding plan and the national five year development plans. The public and private sectors demands of science and technology and also their contribution towards achieving science and technology goals must be planned by them with the assistance of MOST. The final plans must reflect

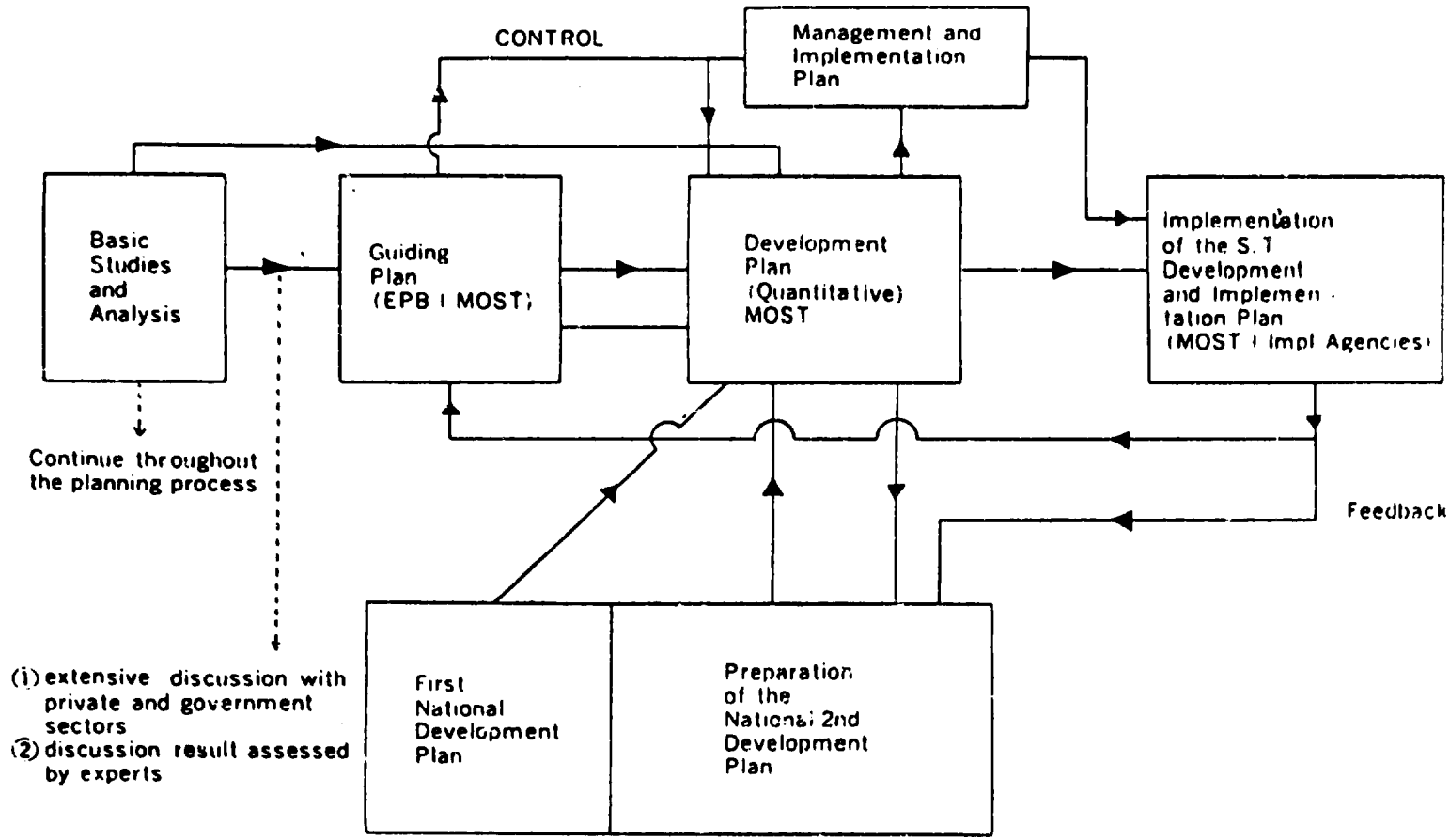


Diagram2 GENERAL FLOW CHART (Procedure of planning)

S.T Science and Technology

accurately the sectoral plans. The sectoral plans may be done within the exercise of formulating the five year development plan. This will help to put the science and technology plan in the fabric of their plan and not as a side exercise and a supplement to the five years development plan.

The implementation and management plan for each development plan will supplement the development plan. The guidelines for development of this plan are defined by the guiding plan. The national development plan will define the resources available for implementation of the science and technology development plan.

II-1 For Guiding Plan :

The following steps will be taken to prepare the guiding plan :

(1) Review of the basic studies.

(2) Discussions with sectors to identify future needs, targets, and priorities. A special studies by the sectors and by MOST to help identify those factors may be required.

(3) Set the criteria for the selection of the national targets and priorities for science and technology.

(4) Identify the national targets and priorities for science and technology at different areas.

(5) Identify the policies for science and technology which will help achieve the set of targets.

(6) Identify the strategies of development.

(7) Identify the criteria and standards for controlling the development plan and the implementation.

(8) Preparation of the final report.

II-2 For Development Plan :

The following steps will be taken to prepare the development plan :

(1) Review of basic studies, including technological manpower demand forecast ;

(2) Identification of technology demand for development :
In order to achieve this stage, the following aspects need to be handled in sequence :

(a) Survey of existing techno-socio-economic conditions of the country : in order to have a full and clear picture of where we stand.. This could be used as a base for future improvement on different aspects and needs. However, the results of such comprehensive survey for present conditionscan be presented among other things, by an input-output matrix.

(b) Projections of socio-economic needs during plan period : this however, has to be determined within the long-term projection for socio-economic needs. Given the existing conditions on various aspects of the economy and society and given future prospect and objectives, a technique need to be developed and extrapolated to quantify and indicate the future requirements, i.e., input-output techniques.

(c) Analysis and forecast of technology requirements in the country : this can be obtained through constructing a technical input-output table with rows showing the technologies supplied and used by various products (sectors)

indicated by the columns, and details should be specified in the course of the work. After constructing such an input-output matrix, accordingly, technical co-efficients will be derived and proportionalities of different technology-mix to produce one unit of given sector of the industrial production, be determined. Thus, with all that is available, integrating of various socio-economic objectives and needs for the future can be handled to forecast the optimal - technology-requirements in any given future time dimension.

(3) Identifications of capabilities for science and technology development :

(a) Analysis of existing condition of education and its systems : this can be done in line with the analysis of overall socio-economic existing conditions.

(b) Projection of education system, education structure, educational needs and requirements during plan period : again, this can be achieved, by carrying out such projection within the overall long term projection for various segments and sectors of the economy.

(c) Analysis of existing training programs.

(d) Projections of training programs and requirements during plan period : this, however, will be carried out as part of overall future prospect, as explained above. Nevertheless, this aspect requires special and

complementary techniques, such as occupational analysis and sectoral-occupational matrix and occupation-education (and training) matrix, for the country.

(e) Analysis of existing science and technology infrastructure and institutions. This has to be analysed as part of analysis of overall existing conditions on various aspects.

(f) Projections of science and technology infrastructure and institution required during plan period : again, this will be achieved, by considering it as a part of overall future prospect with a dynamic yearly and/or every five years requirements.

(4) Steps to upgrade the capability in order to meet the science and technology demand. This includes :

(a) Plans to improve the educational and training systems;

(b) Legal supports which will help the science and technology manpower development;

(c) Establishment of the required educational and training plans for the country;

(d) Plan for the establishment of an additional or new infrastructure to the existing one as required by analysis and forecast of technology requirements in the country.

(5) Identification of proper technology supply for development : In order to determine the supply of proper technology to satisfy the requirements in the country as illustrated above, the stages below have to be observed, analysed and quantified.

(a) Identification of technologies to be transferred as well

as technologies to be developed locally : the need to investigate the aspect of technologies required for the country, and whether it can be developed indigenously given the various resources and inputs availability. Then, what technologies to be transferred and adapted : this, has to be analysed and determined, taking into consideration the availability of required resources and the absence of the alternatives.

(b) Establishment of the strategy for the technology acquisition : this strategy should be directed so that it can determine :

i) what technology has to be transferred,

ii) who is going to transfer,

iii) from where it should be transferred,

iv) when it will be transferred, and

v) how it can be transferred, i.e. the form and method

(c) Establishing the strategy for R & D : this again should be able to give the right direction to what kind of R+D is needed, when should be started, how it can be carried out, who is going to do the research required. However, subjects, titles and time of research should be determined, and cost and management of R & D should be specified and identified.

(6) Facilitating the technology demand and supply balance : To achieve an equilibrium between demand on technology and needed supply to satisfy the existing demand over time, the following principles and steps are required :

(a) Establishment of procedures and mechanism for adaptation of technology transferred, such as identification of problem area and strategy formulation of projects;

(b) Establishment of procedures and mechanism for engineering consulting services .

This should contain, for instance, identification of common management and technical problems in industries and community at large, strategy formulation of projects and so on ;

(c) Establishment of mechanism for utilization of R & D results : this has the following aspects which have to be investigated and carried out : conducting a techno-economic feasibility study (technological assessment) for project selection, select the appropriate and feasible projects, select customer / partner for project formulation and implementation;

(d) Establishment of strategy for promotion of science and technology awareness and improvement of motivation of science and technology manpower;

(e) Establishment of an effective incentive system on various aspects.

(7) Establishment of macro-micro linkage for science and technology development.

(8) Formulation of framework of draft plan with investment plan.

(9) Finalizing the development plan.

C. Concluding Remarks

In concluding my recommendations and suggestions of policy measures for planning of science and technology development, I wish to convey the following specific messages.

First, the developing countries should not be swayed by the prevalent notion, held by some, that the generation of technology in developing countries is not economic, if not impossible. On the contrary, I believe that there is a vast scope for and an absolute need in developing countries for the generation of technologies by those countries themselves or perhaps in collaboration with countries where there are enlightened governments and people. To accomplish this requires the right people more than anything else as they are the only ones who can change the methods and the milieu.

Second, industrial research can be made extremely useful in developing technological rapport with the changing pattern of industrial development and it can, over time, act as the catalyst in changing the attitudes of entities within the contact domain of industrial researchers to enable them to cope with ever changing situations. Sustained economic development in many of the developing countries absolutely depends on how soon, how much, and what kinds of industrial research they can manage to undertake.

Third, the massive effort to mobilize in-country talent and bring it to bear on the problems at the grass-roots level, be they agricultural or industrial, is absolutely necessary to

realize the national industrialization goals.

Fourth, a country's science and technology can strike deep roots only when soil and climate are favourable to their growth, and only with deep roots can they grow adequately enough to countribute to national development and improve living standards.

Lastly, but probably most importantly, I would like to underscore the statement of Steven Decijer that positive involvement of a chief executive of a nation in the development of science and technology, is not merely desirable, but essential for developing countries, if they are to develop their science and technology and apply them efficiently to their socio-economic development.