Centre for Science and Technology for Development

TRENDS AND PROSPECTS
IN PLANNING AND MANAGEMENT OF
SCIENCE AND TECHNOLOGY FOR DEVELOPMENT

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Edited by M. Anandakrishnan

Editorial Committee: A.F. Ferrari, S.V. Tsukanov,
A.I. Rogov and V.K. Pavlov

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FOREWORD

The Vienna Programme of Action, adopted by the United Nations Conference on Science and Technology for Development in August 1979, defined three broad objectives: namely, strengthening scientific and technological capabilities of developing countries; restructuring the existing pattern of international scientific and technological relations; and strengthening the role of the United Nations in the field of science and technology and provision of increased financial assistance. For the fulfilment of these objectives, a number of specific recommendations were incorporated in the Programme of Action. These were further elaborated by the Intergovernmental Committee on Science and Technology for Development, established after the Vienna Conference, through the framework of an Operational Plan in terms of eight major programme areas. These programme areas covered various intersectoral policy and programming aspects which were critical for the development of endogenous technological capability and for developing the necessary environment for rapid scientific and technological progress. The programme areas extended from science and technology policies and plans to the strengthening of technological infrastructure; the selection and acquisition of technology; the development of human resources; the financing of science and technology; the provision of scientific and technological information; the strengthening of research and development and its linkages to the production system in developing countries and the strengthening of scientific and technological coopration between developing countries and between developing and industrialized nations.

The Vienna Programme of Action and the Operational Plan represent a broad-based blueprint of policies and institutional objectives and programmes which prescribe the parameters for planning and management of science and technology. While sectoral priorities are different from country to country because of varying factor endowments and levels of development, the broad inter-sectoral spectrum of activities incorporated in the Vienna Programme and its Operational Plan provide the overall framework for technology planning and management.

The Vienna Programme of Action recognizes "a clear need to adopt measures to create, stimulate and promote the demand for endogenous scientific and technological activities" and sets forth a number of requirements as well as proposals for specific action on the national, regional and international levels. The Operation Plan for the implementation of the Vienna Programme recommends that the United Nations system support activities designed to assist developing countries in improving their policy making and planning through international cooperation, support in methods and analytical techniques, diffusion of appropriate information on methodologies and techniques for planning and programming through different channels, including seminars and training courses.

In the process of identifying specific ways and means of implementing the Vienna Programme of Action and its Operational Plan, the United Nations Advisory Committee on Science and Technology for Development (ACSTD) in accordance with the decision of the Intergovernmental Committee for Science and Technology for Development (IGCSTD) has identified a number of key topics for in-depth examination through its Adhoc panels of specialists. One of the Adhoc panels was organized in Kuwait in 1983 which dealt with the topic on "Human resources development for the planning, management and implementation of science and technology programmes in developing countries". As a follow-up to the suggestions and recommendations, an Interregional Seminar was organized in Moscow, whose proceedings constitute this volume.

The objectives of this seminar were:

1. To assess, through the meeting and its background material (reports, national papers and case studies, etc.) the needs of interested countries regarding the whole range of organizations and functions associated with policy-making, planning and implementation of Science and Technology programmes;

2. To evaluate with the assitance of participants and experts concrete situations in selected countries with a view to arrive at definite recommendations for strengthening endogenous capacities;

3. To prepare coherent set of training material and documents on the subject of science and technology policy and planning for further dissemination in developing coutnries.

The purpose of this Seminar was also to assess the overall planning and management functions and institutional arrangements with regard to policy-making, planning and implementation of programmes related to science and technology. In this regard, a discussion of concrete situations and experiences in different countries, was of special importance and relevance. There is still relatively limited knowledge and experience of comprehensive science and technology planning and management in developing country conditions. Various aprpoaches have been initiated with respect to policies towards development of endogenous capability in different developing countries.

The effective management of science and technology constitutes one of the critical pre-requisites for rapid growth of endogenous capability. While national priorities and policies may differ, all developing countries have the same basic goals of rapid scientific and technological growth and self-reliance.

These goals can best be achieved through careful policy choices and appropriate planning and management of science and technology and to their integration with the process of overall socio-economic development objectives. This is undoubtedly a very difficult and challenging task but one which necessarily has to be tackled.

Often, sectoral economic development alone may not meet the goals of rapid socio-economic and technological progress in most developing coutnries. Similarly, the development of science and technology, by itself, may not necessarily result in adequate or desired patterns of economic growth. The need for effective integration of the two processes is the important message of the Vienna Programme of Action.

The objective of technology planning and management in this context is to develop the necessary institutional and human infrastructure for appropriate technological choice, acquisition and application and for adaptation and development of improved techniques and processes. This necessitates the rapid growth of national capability in various aspects of technology planning and management. It is initially necessary to identify technological needs and priorities in each economy. These would obviously differ from country to country and over periods of time. It is also necessary to develop the technological infrastructure in terms of human skills and resources and institutional capability for specialized education, training and research. The selection of technology must be appropriate and closely related to local resources. Comprehensive research programmes need to be undertaken at institutional and enterprise level and related to technological changes in each sector.

The development of such capability is a formidable and challenging responsibility. It requires new directions in perspective planning with respect to scientific and technological developments and their potential for application in national economies. It necessitates adequate resource allocations and planning of technical manpower resources and institutional capability in various specialized fields. It implies increased use of indigenous technologies which must be suitably upgraded through applied research. It requires careful evaluation of technological alternatives and the selection and acquisition of technology and services on suitable terms and conditions. Such technologies must also be rapidly absorbed and adapted to local conditions so that they serve as foundations for technological innovations in future. Endogenous research capability must be not only expanded but linked directly to the production system as far as possible. Such capability has to be developed at the level of technological use and application in different production and service sectors. The development of such capability must be viewed as a basic and integral feature of socio-economic policy. It is only then that the application of science and technology would effectively reduce or eliminate various obstacles to development.

Planning and management of science and technology must, in fact, constitute the core of policies and programmes. While the extent and coverage of socio-economic and sectoral planning differs considerably from country to country, it is fully recognized that developing countries must undertake steps towards fostering and accelerating socio-economic and technological progress in accordance with desired goals and priorities. This is particularly necessary with regard to planning for science and technology, which should be designed to strengthen the basic foundations for economic and technological growth in each economy.

The papers presented at the Seminar reflect the range of situations and directions in planning and management of science and technology in a rather representative group of developing countries from different regions. Some are in initial stages of examining their options while some others are in a comprehensive process of implementing their policies and plans. The papers by the Soviet participants provide a detailed description of the experiences of USSR in this area.

The collection of the experiences represented in these papers would be of valuable assistance to those interested in the approaches to managing science and technology for development without necessarily prejudging the merits of the various opinions and direction. It is for this purpose that this volume was brought out for wider dissemination.

I wish to thank the Government of USSR for their support in organizing the seminar and for the various Soviet institutions who contributed to its preparation and management. I am grateful to the participants for the presentation of the papers contained in this volume. I wish to acknowledge the assistance of the Department of Technical Cooperation for Development of the United Nations Secretariat for assistance in all phases of the Seminar. I deeply appreciate the interest and enthusiasm of the staff of our Centre in the successful organization of the Seminar and in the preparation of this volume.

I sincerely hope that this volume would help to stimulate further interest in other parts of the world in articulating the effective management of science and technology for development.

Amilcar F. Ferrari
Executive Director
Centre for Science and Technology
for Development, United Nations Secretariat

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INTRODUCTION

The Vienna Programme of Action, adopted by the United Nations Conference on Science and Technology for Development in August 1979, constitutes a principal basis for national, regional and international action in strengthening the endogenous scientific and technological capacities of developing countries.

The Intergovernmental Committee on Science and Technology for Development (IGCSTD) of the United Nations General Assembly provides the guidance and the directions for the implementation of the Vienna Programme of Action.

The Advisory Committee on Science and Technology for Development (ACSTD) assists the IGCSTD through identification and analysis of critical issues governing the effective use of science and technology for development.

Under the guidance of the Director-General for Development and International Economic Co-operation, the Centre for Science and Technology for Development of the United Nations secretariat, in co-operation with concerned organisations in developing and developed countries, as well as in the United Nations system, is engaged in promoting worldwide efforts relating to the objectives of the Vienna Programme of Action and its implementation. In-depth discussion of the salient features of the Vienna Programme is facilitated through panels, seminars and other small gatherings of knowledgeable and experienced persons to focus attention on specific steps which can be accomplished with reasonable efforts. This publication is the outcome of an interregional seminar in this process.

PART ONE

TRENDS IN DEVELOPING COUNTRIES

SCIENCE AND TECHNOLOGY IN ANGOLA

INTRODUCTION

Angola was a Portuguese colony up to 1975. Usually the main goal of the investment during the colonial period was to exploit the natural resources, resulting in the establishment of a few Research Institutes, in such fields as fisheries, construction, geology and agriculture. Most of the researchers and technicians of those institutes left the country and even the Agriculture Institute was partially destroyed during the invasion of Angola in 1975.

CURRENT STATUS OF S & T

Inspite of continuous stresses and strains in the post-independence period Angola has managed to launch major efforts in such areas as education, health, agriculture, energy and industry. Emphasis has been laid on creation of educational facilities and establishment of medium level institutes and science facilities.

There has been a steady growth in the number of students in the University. For example, in the Faculty of Engineering there are now around five hundred students, and most of them are in the first three years of the undergraduate programme.

Most of research and development in the near future will be centered around the programmes of the University. The major constrainst facing the growth of science and technology in Angola are lack of adequate human and financial resources.

Development of special research programme and facilities within or outside the University will be based on the social and economic objectives determined at the national level. Some of the current research efforts, for instance, are directed towards indentification of sources of new construction materials for housing programmes, development of health programmes, provision of safe drinking water and development of fuel resources for rural population. There has been a significant increase in the

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Presented by Carlos A. A. Sereno

production capacity in the textile industry. Special attention will be directed towards strengthening national capacities in development of areas such as agriculture, fisheries and mineral resources.

FUTURE PROSPECTS

The growth of S & T activities in Angola would be based on specific projects conceived in the context of national perception of priorities to be implemented by the concerned ministries with the approval of the planning ministry . In addition to the resources provided by the government, these efforts would, in many instances require the support of other countries or international organizations. As an active member of the Southern African Development Coordination Council (SADCC), Angola would also benefit from cooperation with other member countries of the Council in the promotion of the development programmes.

Thus, while there are no explicit policies and plans for science and technology in Angola, future projects would implicitly incorporate the development objectives besides aspects of coordination and cooperation at the national, regional and international levels.

IMPORTED TECHNOLOGY AND DEVELOPMENT OF LOCAL SKILLS: A CASE STUDY FROM ARGENTINA

TWO ARGUMENTS

Much of the economic literature which started in Latin America in the 1960s has developed the theme of technical change, emphasizing one of its phases: the commerce of technology. Most of the attention has been focussed on the choice and acquisition of technological assets. By using a profusion of empirical data it has been possible to assess the cost of transfer by looking at both its explicit and implicit costs (i.e. royalty payments on the one hand and restrictive clauses attached to the transaction on the other)(1). For the most part, this approach departs radically from the neoclassical assumptions which considered technical change as manna arriving in the firm at no cost(2).

This argument has also conceptualised the type of technical development experienced in economies similar to those of Latin America, inspite of the fact that technical transfer is a phenomenon intrinsic to all economies. Of course, its importance has varied according to the level and type of development. For the Latin American case, this has led to the assertion that the assimilation of technical knowledge is above all imitative and does not tend to instigate new systems and products(3).

Presented by Guillermo Vitelli. The author is grateful to A. Canitrot, J. Fidel, K. Hoffman, J. Katz and J. Lucangeli for comments and discussions

1. For an exhaustive study of this theme, reference may be made for example to the works of UNCTAD (1970), Diaz (1971), Vaitsos (1973), INTI (1974), Sercovich (1975) and Teece (1977).

2. The neo-classical framework implies essentially zero cost for any movement along an isoquant. There are no expenses in creating new technology, nor in research or adaptation, since technological change is exogenous to the firm and apparently appears like manna from heaven.

These assertions only consider major advances in scientific knowledge as generators of technical change. New directions in economic theory, however, are currently rejecting or broadening this focus by incorporating a new type of innovation, <u>the major change</u>, which is seen to play an active part in modifying the long-term technical profile(4). Some authors believe that the accumulation of minor innovations over time can lead to relatively important technological modifications(5). Any engineering modification, however slight, can be considered as a minor change and therefore an element allowing domestic capability to be identified.

This wider theoretical approach leads naturally to the consiusion that the actual process of production can in practice be used acquire capabilities.

Without going into each concept in depth, it is easy to show that there are two arguments, both presenting analytical positions on the existence of domestic capability (and whether it leads to major or minor advances). They differ on the role of technology assimilated from abroad, and the entry of transnational corporations as to whether they are a substitute for local effort and exclude it (the first argument) or whether they act in a complementary way and give rise to local innovation later (the second).

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3. Herrera (1973) says that "for countries underdeveloped today - i.e. those which did not take part in the phases of creation and expansion of the industrial revolution - technology has become an exogenous factor in whose creation they have not part". Merhav (1972, pg.62) states that "advanced technology is transplanted into a backward economy (because) it is incapable of producing it endogenously", and he ads, in his turn that "the underdeveloped countries depend for their growth on techniques from the advanced countries". Monza (1972 pg. 265), says that "the economy does not create technology but uses methods of production designed in the central economies, that is in those whose pattern of consumption it imitates". D. Arango (1972 pg. 36), states that "scientific-technological dependence is a consequence of the poor countries" inability to develop their own technology, so they have to resort to foreign technology to promote their development". On the same lines, we can also include the works of O Donnell and Link (1973), Herrera (1971), Halty C. (1970), Teitel (1973), Patel (1972), and Jaguaribe (1971).

4. The most representative works are, among others, those of: Arrow (1962), Nelson and Winter (1977), Rosenburg (1965), Hollander (1965). Although they are subjects which we will not examine here, as well accepting minor innovations, the actual concept of technical change was modified so that its roots are considered to be endogenous rather than exogenous. The works above also demonstrate this concept.

5. Rosenburg (1965 pg. 37 and chapter 3).

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In both arguments, because of the nature of local economies, the level of foreign investment is considered as a factor influencing technical change(6), since subsidiary companies clearly dominating a particular sector of the economy may define the type of technology used in the different productive processes and the way in which they are assimilated. However, the role and ifluence assigned to foreign investment may vary significantly in each approach.

The first argument has tried to show that foreign subsidiaries tend to be a substitute for local capability and to exclude it, becuase of the way in which they are assimilated into the local market. Technology is included as part of an initial package and reproduces - often identically - processes either currently being used by the parent company or rejected by it. The process of import substitution based largely on the entry of transnational corporations, is said to have conditioned local research and development, since absorbed technology does not employ special R and D expenditure, nor major adaptation to local conditions(7). That is, it is an argument, which tends to emphasise the minimization and exclusion of local development. What is more, various authors have shown that because of the integration of transnational firms, bringing their own technological assets, national firms have had to obtain foreign licences as the only viable way of competing in markets where codes of conduct are fixed by the behaviour of foreign subsidiaries. The clearest demonstration of this would be the high percentage of sales under licence, and it would also explain the reduced level of local research and the imitative conduct of national firms.

On the other hand, the opposite point of view has gone beyond merely questioning the lack of domestic capability. It has not only drawn attention to it (almost always including minor innovations), but has also tried to demonstrate a reversal of the process, assuring that in some Latin American countries a phase has begun which is characterised by a) export of manufactured goods; b) sale of technology through licensing and "turnkey" plants; c) direct investment and d) assistance in the development of basic infrastructure(8,9).

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6. Fajnzylber (1972 pg. 146-7), Monza (1972 p.277), O Donnell and Link (1973, caps. 3 and 4), Hymer (1972 pages 22-24).
7. Garcia (1974 pg. 295).
8. Katz and Ablin (1976), Katz (1978) and Lall (1979). A statement by Jaguaribe (1971 p. 16), from what we might call the substitutive stand point, guesses that the opposite may be true: "there is still insufficient motivation, and scarcely any institutional facilities, for the new demand for technology in Latin America to lead to an effective and sustained effort in the application and local production of science". That is, the argument takes a quite different view: it not only maintains that expanding abroad is impossible, but sees fewer possibilities of developing local technological capacity capability.

This approach accepts implicitly the existence of a technological gap between countries allowing expansion abroad, even though the expansion may be due to technology previously licensed or due to policies of the transnational companies to establish themselves in wider regional markets. This is why foreign licensing has been seen differently, complementing and also developing local learning.

This description is probably an extremely simple version of both arguments, although its basic conclusions include two opposite views on the viability of non-dependent capitalist development. In other words, its results go beyond the mere conceptualization of technical change, and it is relevant. to investigate the partial or total validity of both approaches.

If for instance, the exclusive argument were confirmed, and it was established that the entry of foreign technology, particularly that developed by transnational corporations, conditions the behavious of local firms, the statistical results would show that the propensity for local firms to buy foreign technology is similar to that of the subsidiaries operating in the same market (at product level). That is, imported technological assets would prevail over the creation of local technical knowledge when a foreign firm is acting under licence in that particular market. Confirmation of this relationship has been mainly based on the sectors recently integrated into the market, or those which are often called "dynamic" (10).

But the exclusive effects of imported technology should be verified not only by looking at dynamic branches of industry, but also at sectors which were part of the stage called easy import substitution and saw a substantial change in the type of product they manufacture. More specifically, at the level of the firm it is necessary to examine old-established branches of industry with a degree of technical dynamism, and where local firms coexist with foreign subsidiaries; and analyse whether imported techniques have given rise to as much substitution of local capability by foreign imitation, also in industrial branches not recently established.

These points lead to two questions, which are defined by the capability or lack of it to break a dichotomy which sets imported technology against the development of local skills.

These questions allow us to investigate the validity of the two opposing approaches defined in the first paragraphs.

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9. As we understand it, the STPI programme can be considered from a stand point somewhere between the two arguments. See Sagasti (1978)

10. Analysis about the development of major innovations can be found in Cooper and Chasnais (1970) and Freeman (1974)

In this paper, some of the assertions made by both sides, are analysed. In many cases, this will only be partial, and for this purpose, a sector of the manufacturing industry in Argentina, namely, construction materials, has been chosen. It is difficult to give reasons, a priori, to justify this choice. However, they are branches of industry which make comparison easier since dynamic and traditional industries are both included and allow us to incorporate time variables.

The points which we will analyse (without giving a very precise description) can be divided into four areas:

I. The propensity of the firms to take out licences: whether the size of the firm's capital is one factor or whether the existence of foreign technology produces a chain reaction of other firms in the sector;

II. Whether the age of the industry and of the firm explains differences in the degree to which licensing is prevalent;

III. Some features of technological behaviour in local firms;

IV. Description of the restrictive clauses in licensing agreements, which will give an outline of the possibility of improvements developed at the local level being used locally when the original stock of technology was imported.

I. THE TENDENCY TO TAKE OUT LICENCES

It is extremely difficult to use a single indicator to show the existence of domestic capability, although a split of markets as regards the origin of both the firm's capital and technology can allow a first evaluation of the complementary and substitutive approaches.

Analysing a group of building materials (Table 1) it is possible to unravel three different facts which define in this particular universe the level of utilization of foreign technology:

(i) only one product is manufactured completely under licensing agreements (e.g. product number 1). The studies which have anlaysed transfer at a global level reflect a similar situation, for there are few branches of industry which are totally dominated by foreign technology (11). Ignoring for the moment the licensed sales and also the characteristics of the recipient firm (12), it is possible a priori to assume that these

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11. For the Argentine case, see: INTI (1974, pp.49-51); also a study by F. Almeida Trito, E.A. Guimares and M.H. Poppe (1977) where similar situations are seen.

12. Among these the different levels on the scale of industrial plant may be mentioned. 2650

goods can be produced without incurring payment of royalties. It is also possible, perhaps, to talk of domestic capability, of the existence of technologies which are freely disclosed, of agreements made simply to differentiate between products, or of the possibility of direct imitations. Although a second question remains, namely, whether the drawing up of a licensing contract brings a real transfer of technological assets.

(II) If we now separate the market structure of each product identifying the degree of involvement of foreign subsidiaries, we can state that the level of sales under licence is directly linked to the share of foreign firms (13). In fact, this feature has been observed in all market structure (and specially. In products numbers 2 to 6 and 8 to 13) regardless of the supply concentration and foreign capital involved.

(III) Linked with the former point but now identifying producer firms it is possible to establish at production level, a very significant point: that is, foreign subsidiaries which are most likely to take out technological licences, preferably obtaining them from their parent company. This behaviour can be detected not only in markets dominated by foreign subsidiaries (as the products 2 to 8), but also where local firms (not acquiring practice), have an important share of sales (numbers 9 and 13 in practice, in a sector where foreign and national firms coexist, it is the foreign ones that are most likely to take out licences, while the national ones tend not to do so (or to do it to a lesser extent). This happens with products like paint, surface coverings, water-proofing, galvanized material, polyester and glass fibre sheeting where local firms have most of the market. The subsidiaries, in spite of only accounting for 20-30% of total production, obtain licences for all their sales, nearly always from their parent company. Here, it is only foreign firms which buy technology from abroad. In other words, a close correlation exists between licensing and foreign capital involvement.

The former three points permit the development of a first group of preliminary conclusions explaining the segments of the markets where the substitutive effect have a great validity:

(a) Whatever the level of local participation in the market, almost in every sector, firms acting with or without licences coexist, whilst the cases of total exclusion are rare. The presence of licence argrements, do not necessarily substitute the use (or development) of local capabilities.

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13. For simplicity's sake, we have decided not to distinguish between firms according to the level of involvement of foreign capital. It is true that firms whose sphere of operations is completely controlled by a foreign firm cannot be considered alongside firms with a small degree of foreign involvement. But from our point of view, the way in which we have worked does not invalidate the partial conclusions we have reached.

(b) the origin of the firm more than the presence of licences tend to define the substitutive effect. In the cases analysed, it is possible to observe that the greater the transnational corporation presence in the market, the greater the substantive effect over local capabilities.

These two conclusions pose a second question: if the foreign subsidiaries' greater tendency to buy foreign technological assets (whether formally or not) varies according to the age of the firm or the industrial branch. That is, whether techniques are bought as often in old-established firms (or whether the foreign subsidiaries work in new branches), a point which could explain its greater propensity to contract technology abroad. The question is a valid one also because if there is no relationship between age of firm and licencing, we can infer that with the passage of time firms have freed themselves of contractual ties. This would to same extent confirm the complementary nature of technical import.

II. AGE OF THE BRANCH OF INDUSTRY AND LICENSING.

A simple observation of table 1 (column (a)) shows that there is no correlation between the age of the branch (or the firm) and the propensity to purchase foreign technology. Very old industries show a significant degree of its sales made under foreign licences, in some cases higher than in the new branches, as can be clearly seen in several products of table 1. In fact, well established firms in their particular industry still involve foreign technology contracts in all or part of their sales. For instance, two firms founded more than 60 years ago and without having changed their product lines significantly act under licences, as well as 18 others aged 30 and 50 years old. In fact the information shows that it is not necessarily the new firm, manufacturing new products, which tends to take out licences abroad. Also firms which have been in the branch of industry for a long time and had a long period in which to adapt and assimilate the processes in use in their own sector do it.

This lack of correlation between age of the industry and licensing cast doubts about one of the main points of the complementary approach: the internalization of learning and the subsequent elimination of licences ties. The fact that they keep up a licensing contract probably tells us nothing about the level or type of local capability because we may be faced with a contract made to open a channel for liquid assets abroad.

III. TECHNOLOGICAL BEHAVIOUR OF LOCAL FIRMS

The two former sections show that the different propensity of the firms to take up licences expressed, in terms of its capital origin, is associated with long term contractual relationship.

Table 2 shows the reasons used by national firms to justify importing technological assets. It shows that the substitutive character of technical imports is more prevalent in cases where a local entrepreneur may be faced with technical risks (associated with his research costs), if he develops a process in order to undertake local production. It also exists in a situation of constant technological changes which are difficult to generate internally at the same rhythm. In other words, their development would place the firm at a competitive disadvantage and the need for a permanent and stable position in the market could encourage the local firm to take out foreign licences. Certainly it is possible to state that in these cases it is not technology transfer per se which limits or discourages local creativity but the actual outlook of the entrepreneur. In fact, the substitutive effects over local developments is implicit more in the structure of the market than in the transfer of technology per se. The substitutive nature is a factor related to the source of capital of the firm.

A firm's capability of generating its own technological developments over time is inversely proportionate to the market share of transnational companies, who, in their particular area exclude the possibility of producing or assimilating innovations which come from a store of imported technical knowledge. This exclusion is seen in branches of industry where subsidiaries control marginal sections of the market. In these cases, it does not have a direct effect on local firms, but on the use of technologies developed internally. That is, it has an effect not only on sectors where there is no local technical capability, but also where firms are working with their own techniques, as we can see in branches dominated or directed by local firms.

What is more, the exclusive effect of transnational firms tends to be accentuated over time, since their licensing contracts are maintained for long periods without a logical assimilation process of imported techniques. This exclusion occurs more frequently in branches where local production is instigated by a transnational company, since the structure of a sector tends to develop on the lines of its origins. That is, it is in the early development of a particular industry that the potential to develop technological capacity lies.

IV. THE CREATION OF LOCAL TECHNOLOGY AND LICENSING AGREEMENTS.

Up to this point, much of the attention has been devoted to a retrospective analysis of the interaction between technological licensing and local creation. There still remains a question as to whether it is possible to achieve a break from the dependency model starting out with foreign technological assets, or whether the actual formation of the model derives from the terms under which the technology was bought.

This question is analysed on the basis of the clauses incorporated into the licensing agreements.(14)

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14. In this section, technology contracts drawn up by local firms and also by foreign subsidiaries have been considered.

By analysing the clauses defined in technology contracts, it is easy to establish that transnational corporations or the licence-purchaser have foreseen that a licence-holder may launch innovations based on the technology he receives. There is implicit agreement that while the techniques are being used the licensee has an underlying potential for innovation and after a certain period may operate independently of the licensor. The restrictive clauses themselves incorporate this possibility, since we find examples where the ownership of knowledge generated is made explicit.

The restrictions are very significant and can be arranged in four groups:

1. Restrictions on the firm's continuing in the market;

2. Restrictions on the possibility of carrying out improvements; (or restrictions on the rate of local innovations)

3. Restrictions on the local appropriation of the new techniques.

4. Restrictions on staff divulging the technology to other staff within the recipient firm (or to third parties).

The first type of restriction shows what is probably the essential characteristic of licensing agreements: technological assets are almost always transferred in a temporary way and under hiring contracts. That is, the licensee does not acquire ownership of the technology - this continues to belong to the firm granting the licence. The actual texts of the contracts are very explicit and specify that:

" (the licensee) (15) is granted no property rights, as the rights are only licensed and cease when the agreement ends"(16)

and for this reason the information obtained must be returned at the end of the contract, and in some cases "as soon as it is reclaimed"(17).

There is no doubt that these restrictions on the ownership of knowledge can handicap a firm's position in the local market, especially when the contractual relationship is not parent company/subsidiary.

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15 The brackets in the original text contain the name of the firm or product

16. This is a clause found in contracts for manufacturing refractories, piles, parts for concrete mixers, wires and cables for concrete, glass, electrical goods for construction and chemicals for construction, among others.

17. Text from a contract for the manufacture of refractories.

This is all the more true since generally firms are not allowed to refer to alternative sources.

At the end of the contract, there is a stated embargo on all activities with alternative technologies(18).

> "The national party to the agreement will not be able to devote himself to the same activity nor one competing with (the licensor) for 10 years after the contract has terminated"(19). Or in other cases:
> (The licensee) is committed to refrain from manufacturing or selling (the product) after the contract is rescinded. If he breaks this agreement, for each (product) sold he must pay US$20,000 (to the licensor)" (20).

There is no doubt that in some cases, preventing the company from continuing in the market can lead to the sector being denationalized. This is not only because he can buy back the equipment he sold at a negligible price:

" (the local firm) will not be able to use the machinery when the patent expires. (The licensor) will be able to buy it at the end of the agreement, under the following conditions:

If the patent expires within a year: at the price at which it was bought;
If the patent expires - in the 2nd year: at 25% less than the price at which it was bought;
- in the 3rd year: at 40% less than the price at which it was bought;
- in the 4th year: at 70% less than the price at which it was bought;
- after the 4th year : at no cost at all(23,24).

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18. This is true of contracts referring to the manufacture of: wood for construction, parts for concrete mixers, premoulded items, electrical materials for construction, refractaries and plastics for building.
19. Contract referring to wood for construction.
20. Contract for manufacture of premoulded items, drawn up in 1970.
21. Contract for the manufacture of elements for perforated pipes.
22. As an example another text states for the same clause that: once the contract is sold(the licensor) can buy the machinery from (the local firm) at the invoice price less depreciation, at a reduction of 15% of the value in the first year and 10% in successive years, or at the depreciated value of the machines, plant and equipment which figures in the manufacturer's accounting, whichever is the lower". (Contract for manufacturing metal floors). In a contract relating to plastics, it is stated that machinery must be bought back or destroyed.

This is clearly very restrictive since the local firm, whether or not it has increased its innovative capabilities, is confronted with a dilemma, which leaves it exactly where it started: either it loses its position in the market, or it continues paying royalties to maintain a contractual relationship which under these circumstances becomes a necessary condition to assure its permanence and stability. That is, it belongs to the first category of restrictions and has a clearly exclusive effect.

The second type of restriction does not prevent the future action of the firm but limits its capacity for modifying the techniques during the period when the licence is being used. The restriction is called a restriction on possible movements:

"During manufacture, (the licensee) agrees to follow the drawings submitted by the licensor, and will not be allowed to deviate from them without his consent"(23); also:

"The concessionaire is committed not to modify or improve the said (product) nor the machines using it, without a written authorisation for this procedure from (the licensor)(24).

It could be said that this type of restriction is laid down by some firms to stop their national counterparts moving away from the original designs as they use the technology and start a process by which they will eliminate the contractual relationship (25). But such restrictions are not generally used, since most contracts contain clauses which have a specific, distinct aim: to appropriate possible innovations which may develop during the use of the licence (not to restrict them). So we come to the third type of restriction: that which applies to new techniques developed locally.

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23. Contract for the manufacture of paints and plastic coverings

24. Text from a contract referring to the manufacture of equipment

25. Another way of limiting local creative effort is by restricting information e.g. "the firm granting the license is not obliged to divulge to the licensee plans of the parts or sub assemblies that he (the licensor) will himself assemble or buy within his own country". (Agreement for the manufacture of parts for concrete mixers). Another restriction limits actual manufacture:" the (licensee) is committed to using the licensor's drawings or other documents once only i.e. he can only make one piece or the corresponding part indicated or the drawing for each design and will not be able to manufacture or re-use other equipment or machinery which derives wholly or partly from the (licensor's) designs. Should extra items be needed, a new special agreement will be drawn up". (Contract for expanding a cement plant).

In all cases, the clauses accept that innovations may come from a licence and be developed by the recipient. They do not try to prevent this, since they consider it a logical step. Thus interest is concentrated on possible ownership: on the one hand control of the activities of the firm which will exploit the improvements in the future and on the other hand the new rate of royalties (or in other words the future rent that the licensor will obtain).

In the first case, the clauses are explicit:

"in the case of a patent registered by (the licensee), (the licensor) will have the advantage of a free licence of exploitation, exclusively, and will be able to grant sub-licences freely to its subsidiaries(26).

There is no possible doubt (for the clauses are quite explicit) that any product of the innovative capability of a firm acting under licence ceases to belong to it at the moment when the innovation appears. What is more, given that technology bought from abroad is always a risk and faces restrictions on its later use, it is logical to think that when the contract is renewed, the licensee will begin to pay royalties not only for technology already assimilated but in addition will be paying for processes which the licencee initiated. There are clauses which consider this possibility:

> " if the national firm modifies (the product) increasing its value, the licensor will be able to demand a reasonable increase in royalties for (the product) where this modification occurs"(27).

This situation also occurs when improvements are brought from third firms:

"the licensor has the right to receive the usual engineering fees that apply to plant or machinery acquired from or improved by third parties"(28).

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26. Contract for the manufacture of articles of fibrocement

27. We also found these clauses in agreements for the manufacture of chemical products, electrical materials for construction, parts for concrete mixers, building wood and construction equipment. Another excerpt we can quote is the following:"The granter of the licence will hold an exclusive,divisible and continual licence covering all improvements patented by the licensee and not communicated by him to the licensor. This licence may be used for the licensor's profit, both in his territory and in the rest of the world". (Agreement for the manufacture of construction glass).

28. Contract for the provision of a patent to install an expanded clay plant.

These are clear methods of appropriation, and are found in most of the contracts, which lead to the following reflections:

If it is a local firm which has such a clause incorporated in one of its contracts, it is logical that during the period when it is in force it will not invest in research and development, or will minimise investment in the area of the licence, since the results can be appropriated by the licensor and/or the original royalties will be increased especially when the total sales are subject to the contract, and the overall operation of the firm is included. The consequences of this sort of situation are quite obvious: internal innovative activity is discouraged and the licensing agreements begin to have a markedly exclusive effect on it. The same thing happens when the restrictions on branches of industry or old firms which have longstanding contracts are analysed.

There are of course, hypotheses about behaviour which need more exhaustive analysis. However, the exclusive characteristics of technology agreements can hardly be desired. The important conclusion is that the three types of restrictions above interact and lead to the same results.

Finally, there is a fourth limitation also stipulated in licensing contracts, which tends to prevent members of staff disclosing technology to one another and restricts their joining competing firms. This limitation which is perhaps difficult to implement in practice but is found in many countries similar to the following:

" (the local firm) must use all the means at its disposal to prevent its staff from entering the service of another company making the products licensed, for five years after termination of the contract"(29).

" confidential information will only be accessible to those employees whose work requires their knowing it, and (the licensee) must be sure that they do not reveal it to unauthorized third parties"(30).

These clauses are undoubtedly difficult to implement since they usually contradict legal measures in force in the recipient countries. At all events, when the contract is drawn up the firm granting the license creates some mechanism whereby it can restrict the possible development of future competitive firms, thus achieving a market structure wihin which it can enjoy monopolistic revenue.

It may be thought, a priori, that not only clauses referring to a firm's staff are difficult to implement. The clauses

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29. Contract for manufacture of fibrocement articles.

30. Text from contracts for production of paint and parts of stairs.

described under the four types of restrictions may be equally difficult. Thus technology contracts may lead to legal conflict, and firms granting licenses have tried to protect themselves against this. The way they have approached this has been by defining in the actual agreement the arbitrator to which violations of a contractual agreement must be referred. Many authors have analysed this type of clause(31) which naturally tends to protect the interest of the firm granting the license. In the 86 agreements analysed, nearly 90 percent of contracts state that arbitration will be carried out in the licensor's country, while in only 2 agreements (2.3% of the whole) arbitration will be carried out by a tribunal independent of the recipient.

Certainly all our earlier analyses were based on legal clauses which may, in practice, be superceded and be no more than intentions to restrict firms taking out licenses, with a much less rigid effect than would appear. In any case, returning to the two opposing points of view described in the introduction, there can be little doubt that the types of restrictive clause incorporated in licensing agreements lead to question the possible appropriation of improvements achieved locally. Imported techniques and the entry of transnational firms may complement and provide an incentive to local creative effort. The crux of the matter is not only whether or not it is possible to generate innovations at the local level - the agreements themselves anticipate this - but whether the recipient is able to appropriate and commercialize the improvements he mayh achieve while he is assimilating and using imported techniques.

If we restrict ourselves to clauses in the contract, it is difficult to be optimistic about the future of the recipient firm, and even more so about the appropriation of local capabilities. But the technology is only part of the picture.

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31. e.g., among others C. Vaitsos, Commercializacion de Tecnologia en el Pacto Andino, op.cit., p.76; UNCTAD Control of Restrictive Business Practices in Latin America, ST/MD/4,1975 p.96 and the legislation in force around 1976 in Argentina, Mexico and the Andean Pact, where the licensor was forbidden to choose foreign courts.

TABLE 1

MARKET SHARE FOR BUILDING MATERIALS IN ARGENTINA

(A : Purchaser of foreign licence. B: Not purchasers of foreign licence)

Product; year of first production; first producer	Firm	Source of capital (and number of firms)	Market share	Contrct between parent company and subsidiary	Object of contrct
1. Prestressed wires and cables (1960s)	A	foreign (1) local (3)	35-45% 65-55%	yes no	technical assistance patents assistance
Foreign	B				
2. Additives for concrete (1945)	A	foreign (1)	85%	yes	Technical assistance
local	B	local (3)	15%		
3. Expanded Clay (1966)	A	foreign (1)	95%	yes	Technical assistance
Foreign	B	local (1)	5%		
4. Fibrocement (1937)	A	foreign (2)	52% 39%	yes yes	technical assistance accounting advice and expansion of brands
Foreign	B	local (1)	9%	-	-
5. Floors and plastic coverings (1960s)	A	foreign (2)	30%	yes	patents,trademarks and tech.assistance
Foreign	B	local (1)	7%	-	-

6. Glass (for construction except tempered) (1938)	A	foreign (1)	82%	yes/no	(a)
Foreign	B	local (1)	18%	-	-
7. Refractary materials (1924)	A	foreign (3)	74%	yes(both)	tech.information,ind. designs,trade-marks, patents and equipment designs
Local	B	foreign (1) local (1)	17 9% -	-	-
8. Tiles (1924)	A	foreign (1)	95%	yes	technical assistance
Local	B	local (2)	5%	-	-
9. Polyester and glass fibre sheets (1960s)	A	foreign (1)	46%	yes	technical consultancy
Local	B	local	54% (severals)	-	-
10. Surface coverings (plastic coatings) (?)	A	foreign (1)	35%	no/yes	patents, technical assistance
(?)	B	local	65%	-	-
11. Surface water proofing (1930s)	A	foreign (3)	35-45%	yes	trade-marks,patents & technical assistance
Local	B	local	65-55%	-	-
12. Tempered glass (?)	A	foreign (1)	65%	yes	patents,designs and drawings

13.PUC tubes (1960s)	A	foreign (1)	15-20%	yes	technical assistance trade-marks
Local	B	local(many)	85-80%	-	-
14.Tapes for concreté joints	A	foreign (1)	45%	yes	patents and technical assistance
Foreign	B	foreign (1) local (1)	50% 5%	- -	-
15.Galvanised materials (1918)	A	foreign (1) local (1)	27% 18%	yes no	technical advice patents and tech. assistance
Foreign	B	local (many)	55%	-	-
16.Paint, lacquers and varnishers (1880s)	A	foreign (3)	27%	yes	trade-mark, patents and stocking equipment
Local	B	local (1) foreign (1)	69% 4%	- -	- -
17.Lime (1880s)	A	local (1)	16%	no	patents
Local	B	foreign (1) local (many)	7% 77%	- -	- -
18.Aluminium bars and sections (?)	A	foreign (1)	45%	yes	technical assistance
(?)	B	foreign (2)	55%	-	-

19. Cement (1880s)	A	-	-	-	-
Local	B	foreign (1) local (many)	14% 86%	- -	- -
20. Round reinforcing bars (1943)	A	-	-	-	-
Local	B	foreign (1) local (many)	8% 92%	- -	- -

TABLE 2

REASONS USED BY NATIONAL FIRMS TO JUSTIFY IMPORTING TECHNOLOGICAL ASSETS

Nature of contract	Reasons given for contract	Product for which agreement drawn	Number of agreements
Setting up new industrial plant or extension of existing plant	Technical assistance derives from a tie with the supplier of the equipment who was approached: a) because of lack of sources b) because it owns patented processes which had been used earlier in the recipient firm (i.e.for technical continuity) and c) due to the high costs and risks implied by local development (assessed in terms of a very limited market)since new innovations or extensions in plant in the sector are sporadic	Cement and fired ceramics	9
Integration of new products into the firm	1) To deal with obstructive patents	Suspended glass	1
	2) Acquisition of brands and patents in a system with high R&D costs in a market supplied by a foreign subsidiary	Glass fibre	1
	3) Acquisition of brand names to capture a greater share of the market	Plastic products used in doors and windows	
	4) Rapid launching on to the market of a product which was beginning to be be manufactured by two foreign subsidiaries	Wires and cables for reinforced concrete	2
	5) To lessen costs and time needed for local development	Mechanical stairs	

Assistance for products developed before the agreement	1) Acquisition of patents (not obstructive) (no concrete reasons given)	Lime	1
	2) Acquisition of brand names and patents	Electrical switches	2
	3) Purchase of a patented process to reduce manufacturing costs	Galvanized materials	4

Source: Sworn declarations studied at the Nationsl Register of Licence and Technology Transfer Contracts; and own research

BIBLIOGRAPHY

Aranjo David (1972), Tecnologia y Dependencia, Seminar on Transfer and Innovation of Science and Technology, Instituto de Integracion Cultural, Colombia.

Arrow K. (1962), On the Economic Implications of Learning by Doing. Review of Economic Studies, June.

Cooper Charles and F. Chesnais (1970), La Ciencia Y Tecnologia en la Integracion Politica y Economica, O. Sunkel (ed), Ed. Universitaria, Santiago de Chile.

Diaz Pedro Leon (1971), Analisis Comparativo de los Contratos de Tecnologia en el Pacto Andino, mimeo, Lima.

Fajnzylber Fernando (1972), La Empresa Internacional en la Industrializacion de America Latina, in Stanzick and Godoy (ed), Inversiones Extranjeras y Transferencia de Tecnologia en America Latina, Ildis Flacso, Santiago, Chile.

Freeman Christopher (1975) La Teoria Economica de la Innovacion Industrial. Allanza Editores. Espana.

Garcia Antonio (1974) Desarrollo Industrial Latinoamericano, series of lectures in El Trimestre Economico No.12, Mexico.

Halty Carrere Maximo (1970), Produccion, Transferencia y Adapcion de Tecnologia, Department of Cientific Affairs of the OAS, Washington D.C.

Herrera Amilcar (1971), Ciencia y politica en America Latina, Siglo XXI Editores, Buenos Aires.

Herrera Amilcar (1973), La Creacion de Tecnologia como Expresion Cultural, Nueva Sociedad, 8/9 Costa Rica, Sep-Dec.

Hollander S. (1965), The Sources of Increased Efficiency. MIT University Press

Hymer S. (1972), Empresas Multinacionales y la Internalizacion del Capital. Ed. Periferia, Buenos Aires.

INTI (1974) Aspectos Economicos de la Importacion de tecnologia de la Argentina. Documento Inti. Buenos Aires.

Jaguaribe H. (1971), La Dependencia Politica-Economica de America Latina, various authors, Siglo XXI, Mexico.

Jaguaribe Helio (1971), Ciencia y Tecnologia en el Contexto Sociopolitico de America Latina, Universidad de Tucuman, Argentina.

Katz Jorge and E. Ablin (1976), De la Industria Incipiente a la Exportacion de Tecnologia: ľa Experiencia Argentina en la Venta Internacional de Plantas Industriales y obras de Ingenieria, IDB/ECLA Monograph No.2, Buenos Aires.

Katz Jorge (1978), Desarrollo Economico y las Relaciones Intra y Extra Regionales de America Latina, CIEPLAN, Draft, Chile.

Lall Sanjaya (1979), Developing Countries as Exporters of Technology and Capital Goods: The Indian Experience, Oxford University - Institute of Economics and Statistics, June.

Merhav Meir (1972) Depemdencia Tecnologica, Monopolio. y Crecimiento, Ed. Periferia, Buenos Aires.

Monza Alfredo (1972) La Teoria del Cambio Tecnológico y las Economias Dependientes, Desarrollo Economico, IDES, No.46, July - September.

Nelson R.R. amd S. Winter, (1977), In Search of a Useful Theory of Innovation, Research policy Vol.6

O. Donnell and D. Link (1973), Dependencia y Autonomia Amorrortu Editores, Buenos Aires

Patel Surendra J. (1972), La Transferencia de Tecnologia a los paises en esarrollo, Foro Internacional, Vol. XII No.1, El Colegio de Mexico

Rosenburg Nathan (1965), Perspectives on Technology, Cambridge University Press

Sagasti Francisco (1978), Science and Technology for Development: Teh Main Comparative Report of the Science and Technology Policy Instruments Project, International Development Research Centre, Ottawa.

Sercovich Francisco C. (1975), Tecnologia y Control Extranjero en la Industria Argentina, Siglo XXI, Buenos Aires.

Teece D,J. (1977) Technology Transfer by MUltinational Firms: The Resource Cost of Transferring Technological Know How, Economic Journal Vol. 87 No.346 June.

Teitel Simon (1973) Tecnologia Industrializacion y Dependencia, El Trimestre Economico, Vol, XL (3) No.159, July-September, Mexico.

Trito A., E.Guimaraes and M. Poppe (1977), A, Transferencia de Tecnologia no Brasil, IPEA, Series of Monographs.

UNCTAD (1970), The Transfer of Technology, Journal of World Trade Law, Vol.4 September-October

UNCTAD (1975), Control of Restrictive Business Practices in Latin America ST/MD/4.

Vaitsos Constantino (1973), Commercializacion de Tecnologia en el Pacto Andino, IEP Lima.

PROGRESS OF SCIENCE AND TECHNOLOGY IN CHINA

INTRODUCTION

Half a decade has passed since the United Nations Conference on Science and Technology for Development was held in Vienna in 1979. The Vienna Programme of Action adopted then stands as an important historical document and has created a positive climate for the development of endogenous scientific and technological capabilities in most developing countries. For China, 1979 also marked a beginning that led to a period of prosperous development of science and technology. Late in 1978, a National Conference on Science and Technology had been convened, at which science and technology was once again conceptually established as a positive, productive and social force. Efforts were made to create a favourable environment for scientific research and to improve the social status of scientists and technologists. On the other hand, the Vienna Conference also generated much international inputs to our national efforts. Many new concepts were introduced and new cooperative contacts have been made since then.

NATIONAL GUIDELINES

However, 1981 was the time of a great historical turning point in the orientation of science and technology development in China. During October of that year, Chinese Premior Zhao Zhiyang put forward and elaboratd a new guideline that science and technology must serve economic development while economic development must rely on the advances in science and technology and the two should develop in a coordinated manner. This new guideline incorporates five major aspects: 1. science and technology must develop in harmony with social and economic development and regard the latter as the key objective; 2. priority should be given to the research relating to production technology; to the correct selection of technology; and to create a rational technology mix; 3. efforts must be made to strengthen the development and extension of technologies that have a direct bearing on industrial and agricultural development; 4. steady and gradual development of fundamental research must be ensured; 5. the study,

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Presented by Yao Erxin

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digestion and assimilation of foreign technologies should be taken as an important means for developing China's endogenous science and technology.

In the light of this new guideline and drawing on the important concepts of the Vienna Programme of Action, a better linkage has been fostered between social, economic and political sectors and the scientific circle. Science and technology is now regarded as of strategic priority in the national economic development.

PROGRESS ACHIEVED

The People's Republic of China was founded in 1949. At that time, China only had 30 to 40 research institutes and some 50,000 scientific and technological research personnel, of whom only a few hundred were actually engaged in scientific research. There was a serious shortage of research facilities, and research funds.

As soon as new China was established, the Government of China devoted much efforts to the development of science and technology. First, many scientific and technological research institutes were set up, such as the Academy of Sciences and many of its affiliated research institutes. By 1950, there were 840 research organizations and over 400,000 persons engaged in research. At the same time, the first five-year plan put much emphasis on the importance of science and technology. In 1956, over 600 scientists, economists and planners were organized in a joint effort to draw up China's first plan for the development of science and technology, namely, the National Plan for Long-term Development of Science and Technology from 1956 to 1967. According to the requirements of the country's economic construction and national defense, the long-term plan ocvered 57 projects, including basic and applied research. Among them were research projects in semi-conductor and computer, electronics, automation technology, atomic energy and jet propulsion. However, overreaching attempts towards rash progress which came about in 1958 and 1959, disrupted the normal order of research. By 1961, the State Science and Technology Commission formulated a new ten year plan covering 374 priority research items, of which 333 were urgently needed in economic development and 41 in basic sciences. By 1964, more than 3,000 research achievements were registered with the Commission.

The ten years of the "Cultural Revolution" brought a temporary stop to all research undertakings, with facilities destroyed and research personnel driven to the rural areas into forced labour. The disaster came to an end in 1978 with the downfall of the leftist political line and then came the spring for sciences and technology.

Since then, much progress has been made in the development and application of science and technology, particularly in the policy and management field.

After the National Science and Technology Conference in 1978 the S & T infrastructure was vigorously restored and new ones established. By 1979, the number of research institutes and support organizations in natural sciences across the country had reached more than 6,000.

Since 1979, China has readjusted the composition of the research institutes and gradually created a number of new ones in the field of emerging technologies and their support organizations such as computing centers and testing centers.

SCIENTIFIC AND TECHNOLOGICAL MANPOWER

By 1979 the total number of natural scientists and technicians in state owned institutions amounted to 4.705 millions, of which there were 1,667,000 engineers and technical personnel, 324,000 agricultural technicians, 1,396,000 medical personnel, 317,000 scientific research personnel, and 1,001,000 teaching staff.

For every 10,000 persons, there were 48.5 scientists or technicians i.e. 17.2 engineers and technical personnel, 3.3 agricultural technicians, 14.4 medical personnel, 3.3 scientific researchers and 10.3 teaching staff.

FINANCIAL RESOURCES FOR SCIENCE AND TECHNOLOGY

China's total expenditure for science and technology in 1978 was 5,333 million yuan, 1.8 percent of its national income. It increased to 7.4 billion yuan in 1983. Yet this only accounts for the government's budget allocation and does not cover research expenditures spent from education budget in institutes of higher learning or raised in production enterprises, which did not enter national economic statistics.

INTERNATIONAL SCIENTIFIC AND TECHNOLOGICAL COOPERATION

China's international scientific and technological cooperation had developed markedly by the end of the seventies. Intergovernmental scientific and technological cooperation agreements, or industrial, economic and science-technology cooperation agreements were signed between China and many other countries. These include the Democratic People's Republic of Korea, Argentina, Pakistan, Bangladesh, Thailand, the Philippines, the Libyan Arab Jamahriya, Mexico, Zambia, Chile, Romania, Yugoslavia, Hungary, Poland, Czechoslovakia, Bulgaria, the German Democratic Republic etc. Since 1978, similar agreements have been signed with France, the United Kingdom, the Federal Republic of Germany, Italy, Sweden, the United States, Greece, Denmark, Finland, Belgium, Luxembourg, Australia and Japan.

Under these agreements, over 200 joint projects have been executed either in basic research, industrial-agricultural production technologies, or emerging technologies. According to incomplete statistics, some 4200 international experts came to

China in 1979 for scientific or technological exchange and cooperation while over 7300 Chinese experts went abroad.

DEFICIENCIES

Before presenting the achievements, it would be useful to discuss some of the problems we had in the institutional arrangement and management system of science and technology.

(1) A serious deficiency in the research management system was the absence of research capabilities and technological development in the enterprises. Among the existing 380,000 enterprises in China, with the exception of a few, designated as key enterprises, most did not have their own research and development capabilities; lacked expert personnel; were short of funds; and most important of all, lacked incentives to use new technologies and develop new products.

(2) Enterprises had little autonomous decision-making power and their responsbility, power and interests were not combined in a rational manner. Workers got the same pay no matter how well they performed. Eenterprises consumed the same share from the "Government Big Pot" regardless of the amount they contributed. All profits were passed on to the government while all deficits were absorbed by the government. As a consequence, product quality remained low and their variety was small. There was no initiative to develop new products.

(3) Many of our economic policies did not respond to the requirement of technical progress. These included policies relating to taxation, credits, incentives, etc. Some even posed obstacles to the adoption of new technologies. Since many new products required high cost and produced little profits in the initial stages, such endeavours could lead to troubles and losses rather than gains and interests for the enterprises.

(4) Research institutes received their operational and research expenditure from the government budget but were not accountable to the government. In other words, their research achievements were not evaluated in economic terms and they had no vested interest in the application of their research results to production. Essentially, this means that problems in production technology would not be reflected in the research institutes while what was accomplished in research institutes would not be transferred to production systems.

(5) Little technology transfer was going on among the various organizations involved in the same field. This was due largely to the fact that transfer of technology was basically free and there was no technology trade or market or competition. Technology owners had no enthusiasm or reason to transfer their technologies.

(6) In terms of the composition of research areas, too much emphasis was given to basic research, laboratory research while applied research, pilot experiment and industrial demonstration had

been greatly neglected. As a result, research was not translated into production and commercially applied. We could develop high technology projects in certain areas, such as satellites and atomic bombs while simple things as razor blades would have quality problems.

(7) The full potentials of science and technology personnel was far from being tapped. Once a scientist or expert was assigned to work in an organization, he or she became the "real estate" of that organization. He or she could not go elsewhere even if his or her expertise is not useful in that particular place. There was little mobility of personnel and hence knowledge and experiences were mostly confined to a restricted area.

(8) Our national economic and S & T plans were not connected closely. Economic plans were drafted without taking advantage of science and technology and the development of science and technology were not fully incorporated in the national economic plan, thus creating a gap between planned activities and their execution.

These represented some of the typical problems we had in the past and may exist in other developing countries as well, even though they may not originate from the same causes.

NEW CHANGES

Despite these serious problems, encouraging changes have come about over the last few years. These can be summarized in ten aspects.

(1) Government officials and enterprise management personnel at different levels, from the Premier of the State Council to the ministers, from provincial governors to mayors of various cities, enterprise managers to factory directors, are all taking direct responsibility for science and technology for development. Some provinces have designated certain years as the year of science and technology for development. On the basis of comprehensive surveys of its respective resources, and taking into account its economic development potentials, each province has proposed its plans and programs for the overall exploration and economic development through the advances of science and technology. Within each province different sectors have also formulated detailed plans for the coordinated developoment of science, technology and economy.

(2) Chinese scientists and technological personnel now have a clearer orientation in what they do, and a higher sense of responsibility towards society, to the well being of their people and are happier more than ever to contribute their knowledge and experience to economic benefits. In the light of the new guideline for science and technology, more efforts are now being devoted to the applied and development research. Over 90 percent of research funds are spent in this regard, while fundamental research is being developed on a steady and selective basis. A lot of research institutes have readjusted their research projects, to gear to the needs of the specific requirements of the production sectors, or more directly, to sign contracts with or receive orders from production sectors.

By opening their doors to the society, these institutes not only discovered their own social potential, but also receive more research expenditure for their programmes.

(3) The position of intellectuals in China now is much improved, both in terms of working and living conditions. Their role in developing national economy is being recognized to a high degree. This is in sharp contrast with the old concept that the intellectuals do not constitute part of the working force. Scientists, technical experts and engineers are now invited to participate in the policy and programming process and their views are highly regarded and reflected in various national and regional plans. For example, Chinese energy experts, on the basis of studying the existing energy resources and consumption patterns, proposed 13 suggestions regarding energy development. These suggestions were studied seriously and incorporated into the overall national energy plans. Another example is the proposal by Shanghai scientists to harness and develop the Yangzhe River Delta, to solve resource and pollution problems in a comprehensive way. This suggestion has now been adopted by the authority after careful consideration and is now one of the biggest construction projects.

(4) We have adopted a policy of four shifts, i.e. shift laboratory research to production, shift technology from advanced areas to backward areas, shift defence technologies to civilian application and shift foreign technologies to domestic utilization. Among the 2600 items obtained in 1980, 50 percent were applied in production in 1981, and have already been turned into concrete products. Many production enterprises have begun to feel the power of technological innovation and its economic benefits and leading to close connection with research institutes through contracts, exchange of experts and providing expenditure for product related research. For example, China was famous for its textile products. Yet, because of low quality and backward processing techniques, they were not competitive in the international markets. Through the application of organic silicon, which makes textile products extremely ripple-free and easy to wash, these products have opened a new door for export. We have also started technology trade fairs, consulting agencies, training centers, etc.

(5) With the expansion of autonomous decision power of the enterprises and the establishment of a sound and independent cost-benefit accounting system, enterprises are forced into research and development of new products, to improve product quality and increase variety so as to find necessary markets and customers. Old enterprises, or those with deficits and still using backward technologies, would run into troubles without making their own research and development. Individuals in the enterprises would also feel the pressure to initiate new ideas, new proposals and work with greater efforts, since a system of floating wages have been adopted in many enterprises.

(6) The most encouraging phenomenon has emerged in the vast rural areas, where a large number of farmers, having tasted the fruits of applying agricultural technologies, launched a movement of scientific farming. Many small research or experimental stations, both at country and cooperative levels, have been established. And a large number of agricultural technology extension centers are in operation to offer services and consultancies. In some places, farmers started their own demonstration centers, seedling corporations, fertilizer departments, etc. All of this resulted in the ever expanding production capacity despite severe natural disasters.

(7) The sources of investment in science and technology have increased. In the past, it is only the Government that allocates budget for research. But, now the production sectors are encouraged to make separate investments in research which may substantially improve the competitiveness of their products. They can also sell their rsearch results in the form of licence, consultancy services, etc. This has become an important part of the overall investment for science and technology. According to statistics from Sichuan, some 20 to 30 percent of the province's research expenditure comes from this source. In 1981, the State Science and Technology Commission and the Ministry of Finance jointly issued a regulation for the use of sales and turnovers for research and technical innovations, whereby the enterprises would gain economically through such ventures.

(8) The problems of personnel mobility have been improved to a great extent. Scientists, technological and engineering experts today have much greater freedom than in the past to move or transfer from one institute to antoher in order to find the kind of work more suited to their specialization. In certain areas, they are permittted to resign from their job and start their own research contracts with farming communities, factories or other business undertakings. There are also agencies which specialize in the transfer of technical personnel, identification of employment for college graduates, etc. Higher pays are offered to scientists who are willing to go to remote or isolated areas by the local govenments and better living conditions are provided to these people.

(9) A large number of medium and small cities have developed rapidly through concentrated efforts on the development and application of science and technology. These cities are characterized by their deep understanding of the economic and productive aspects of R and D and innovations. Some of them, such as Wuxi, Xiangfan, etc. have increased their industrial production by a large margin, of which 60 to 40 percent is due to technical advances and development efforts. Xiangfan used to be a city without any industry before 1949. Its industrial development was very low during the sixties, mainly small scale manufacturing of low level products. Over the last few years, however, with top priority given to science and technology and development research, it has emerged as one of the more industrialized city in China, producing many high technology

items, over a hundred of which are exported to more than 20 countries in the world. The industrial output in 1981 reached beyond one billion yuan, ten times over 1970, with per capita income around 1,000 yuan, twice as much as the national average.

(10) Research on "Soft Sciences", such as science policy, development forecast, and management, has been strengthened. At the same time, many research institutes, both at the national and local levels, have been established in the field of policy and management of science and technology. For example, China National Research Center for Science and Technology for Developmentwas set up two years ago under the State Science and Technology Commission undertakes research in policy and operations and formulates policies in general as well as for specific technical areas. Over the last few years, thousands of experts were mobilized by the center to propose technical policies for priority economic development areas, such as energy, agriculture, transportation and communication. China has also sponsored a number of international conferences and symposiums such as the Beijing International Conference on Science Policy and Research Management held in 1982 and International Roundtable on Science and Technology Policy held this year. These gatherings have not only provided excellent opportunities for people from various countries to exchange experiences, but also fostered closer co-operation among various institutions in this field.

PLANS

Since 1983, according to plans of the State Council, the State Science and Technology Commission (SSTC), in conjunction with the State Planning Commission (SPC) and the State Economic Commission (SEC), has been engaged in the deliberation and formulation of specific technical policies for the major industrial and economic sectors. Participating in this effort are some 2,000 experts. By now, policies have been formulated for agriculture, energy, material, building construction and material, consumer goods, computer and integrated circuit, urban and rural development, telecommunication, environment, etc.

With regard to science and technology planning, the Chinese government formuaited in 1980 a science and technology priority project plan for the 6th five year plan (1980-1985). This plan is characterized by its close link with economic development with emphasis on the role of science and technology in socio-economic development, and on the key technological issues in agriculture, energy, transportation and comprehensive utilization of natural resources. 38 priority projects were indentified at the national level.

Since 1983, SSTC, SPC and SEC have been engaged jointly in the formulation of a longer term science and technology development plan to the year 2000. The part that deals with priority science and technology programmes in the major sectors has now been completed. 19 priority areas have been chosen: agriculture, energy, transportation and communication, iron and steel, non-ferrous metal, petro-chemical industry, wood industry, health and medical care, environmental protection, electronics, machine building, textile industry, biotechnology, computers, computer software, optical fibre communication, new material, nuclear technology, basic research, etc. The general objective os the plan is to apply extensively in China before 2000 those technologies that are widely used in developed countries in the seventies and early eighties, which also comply to China's specific conditions. Meanwhile, R and D on emerging technologies will be developed to create new industries.

INSTITUTIONS INVOLVED IN SCIENCE AND TECHNOLOGY POLICY-MAKING

At the national level, the State Science and Technology Commission is the agency responsible for the overall science and technology policy formulation. It is a coordinating department of the State Council in charge of science and technology development in China. A major mandate of the Commission is the formulation of S and T policies. It has a department of S and T policy, a National Research Center for Science and Technology for Development that conducts extensive research and studies in S and T policy. In case of important S and T policies proposed by the Commission, approval from the State Council or the National People's Congress will be needed before they are implemented. Involved in the S and T policy making process are also the State Economic Commission and the State Planning Commission. The three commissions cooperate with each other and elaborate jointly on policy measures that are of concern to all before submitting to the State Council for approval.

In addition, the Chinese Academy of Sciences, the various ministries of the state council also participate actively in the formulation of policies specific to their own areas.

Within their terms of reference, the provincial and municipal governments are responsible for the formulation of regional science and technology policies.

FRAMEWORK FOR IMPLEMENTATION

Once approved by the State Council or the National People's Congress, science and technology policies and plans must be implemented by the various ministries and local government. The science and technology departments under the ministries and the commissions of the local ogvernments have direct responsibility to organize and monitor the implementation of such policies and plans.

PROBLEMS AND SHORTCOMINGS IN THE IMPLEMENTATION

From these developments, it is clear that China has accomplished a great deal of work in the formulation and implementation of science and technology policies and plans, and achieved remarkable progress.

Yet, from a nation-wide viewpoint, our new S and T policies are still in the initial implementation stage, and experiences are yet to be accumulated. There are departments or organizations which lack an adequate understanding of the importance of science and technology policies, leading to ineffective implementation. Furthermore, our policies as such should also undergo the test of practice, so as to be assessed, improved and to be more comprehensive.

SCIENTIFIC AND TECHNOLOGICAL INFRASTRUCTURE

Science and technology research institutions :

According to 1983 statistics, China has over 4400 independent research institutes in the field of natural sciences at or above municipal or prefecture level. About 10 - 15 percent of these are in basic research, the rest in R and D. Most of these institutes were established before 1979.

Since 1979, China has strengthened its S and T infrastructure in five aspects: (1) establishing a number of "soft sciences" research institutes, specialized in S and T or techno-economic policies, such as the National Research Centre for Science and Technology for Development; (2) establishing technology development consulting and service corporations to undertake technology development and transfer; (3) establishing supporting organizations such as national or provincial computing centers, testing centers or pilot plant bases, etc; (4) establishing a number of institutes in emerging technologies: Beijing Institute of Informatics, Biotechnology Development Center, Software Development Center, etc; (5) strengthening of S and T information, publication, management training institutes.

There is no adminisitrative relation between policy making bodies and research institutes in industrial and agricultural sectors, the latter being responsible mainly for research as such. However, experts and scholars are sometimes invited to participate in policy assessment and formulation, and planning. Their views and opinions often receive full attention and consideration by the authorities and are often incorporated in the policy making, either partially or wholely.

Professional organizations, associations and societies :

In China, there are trade unions at various levels, from central to local; and professional or research societies in the major ministries and industries. These are non-governmental organizations established by scientific and technological personnel with common professional interests. For example, there are Chinese Agricultural Society, Chinese Forestry Society, Chinese Hydraulic Society, Chinese Metallurgical Society, Chinese Chemistry Industry Society, etc. The biggest organization of this kind is the Chinese Association of Science and Technology, with over 100 professional or research societies under it, covering large number of industries and specialized disciplines. These societies frequently organize professional meetings, which give full expression to academic research and are creating a strong impact on the development of science and technology in China. They also offer to conduct research, consulting and technical assessment services, and make recommendations to the government, all of which contribute greatly to economic benefits of the country. In 1982, the Chinese Association of Science and Technology organized more than 2000 symposia with the participation of over 300,000 Chinese and foreign experts, and 938 science and technology training courses with 50,000 trainees.

Standardization, metrology and quality control :

The State Bureau of Standarization is the agency responsible for standardization across the country. In 1982, the Chinese Institute of Standardization and other institutes specialized in the field were established in 15 industrial sectors including machine building, chemical industry, post and telecommunication, transportation and communication, etc. There is also a China National Association on Standardization, with 26 provincial affiliates, responsible for research on and popularization of standardization. By the end of 1982, China had introduced 4462 standardizations, among which 390 are in industry and agriculture and 554 in engineering. To promote the development of science and technology, China also adopted in 1982 the "Regulations on the adoption of international standarizations", and is now planning to gradually matching a standardization with international ones.

In metrology, China has a State Bureau of Metrology as a national specialized agency, and corresponding metrology institutes in the various industrial sectors. The 20,000 large or medium enterprises also have their own metrology units with over 200,000 specialized personnel working on enterprise metrological management, methodologies, energy metrology and so on. In terms of metrological research, there is a Chinese Institute of Metrological Sciences, with a number of counterparts in the provinces.

In the field of quality control, the responsible government department has set up quality control agencies in over 100 cities with over 100 specialized institutes and more than 1260 quality control stations involving products from some 26,000 enterprises. In addition, the ministries of light industry, chemical industry, electronics, construction material, post and telecommunication, public security, etc., have also established over 60 quality control centers with the participation of large numbers of monitoring and control groups consisting of scientific and technological personnel forming a national network.

Science and technology periodicals and publications :

In 1982, the number of scientific and technological journals, not including social sciences, reached 1745, with 277.89 million copies printed, which amounts to an increase of 10 percent over 1981. During the same year, over 7500 scientific and technological books, again excluding social sciences, were published, with more than 186 million copies printed, a 28 percent increase over 1981, and 116 percent over 1978.

Programmes for popularization of science and technology :

Popularization of science and technology has received great importance and attention in China. Many departments and organizations concerned with science and technology are engaged in varying degrees in such activities. It is also one of the major mandates for the Chinese Association of Science and Technology and their provincial affiliates. It focuses mainly on children, young people, enterprise employees and farmers. At present, priority is given to the rural areas where such activities have developed rapidly. By 1982, the number of commune-run science and technology popularization associations in the rural areas had increased from 3,820 in 1981 to 15,598, with a total of 1.5 million members. These associations consist of rural science and technological personnel, skilled craftsmen, local experts, etc., and have undertaken the following activities during the past year:

(1) large scale rural technology training, for example, the Shanxi Provincial Science and Technology Association organized in 1982 some 1200 rural technology training courses with the participation of 130,000 farmers. The National Agricultural Broadcasting School sponsored by the Chinese Association or Science and Technology, the Ministry of Agriculture, Animal Husbandry, the National Agricultural Society and the Central Bradcasting Station has turned out over 400,000 students and is now training another 400,000: (2) science and technology popularization markets in which popularization lectures, technical consulting services, science films, slides, publications etc., are offered. Very often such a market would be frequented by over 5,000 people in one day; (4) distribution of science and technology journals and newspapers in the rural areas. By 1982, there were 54 agricultural science and technology newspapers. The number of distribution rose from 3.5 millions in 1981 to 5.55 millions in 1982, a 63% increase. (5) compiling and printing urgently needed popular science books and materials, such as picture books, slides, films, video-tapes, hanging picture presentations, etc. These are much welcomed in the rural areas. For instance, once, a "Fish Breeding" calendar was announced and there were 350,000 immediate subscriptions. (6) popular science exhibitions are directed to children and young people; some competitions were organized over the recent years, such as National Youth competitions, etc. Science camps were also organized by scores of scientific societies, which drew thousands of young people. In addition, young people participated in large scientific study tours like tropical biology study tour, Shennongjia biological studies, etc.

2650 Popularization aimed at the general public is done through books, newspapers and periodicals, films, television broadcasts, museums, lecture tours and street presentations. The government has set up a popular science publishing house for the purpose.

Weaknesses in scientific and technological infrastructure :

In infrastructure, the following organizations are to be strengthened in China: (1) "software" research institutions specialized in S and T policy management, legislation and techno-economic policies; (2) comprehensive statistical agencies specialized in S and T indicators and statistics; (3) computing and testing centers; (4) pilot plant and industrial systems; (6) supporting institutions providing research facilities and chemical reagents; (7) agencies specialized in promoting technology transfer; (8) S and T education and training institutions, particularly for periodical continuing education and professional training; (9) research institutes in emerging technologies, such as microelectronics, biotechnology, optical fibre technology, new materials, etc.

To improve China's S and T infrastructure, the following inputs must be increased: (1) financial expenditures, including necessary foreign currency; (2) improved management capability; (3) S and T personnel training; (4) necessary physical and advanced research facilities.

CHOICE, ACQUISITION AND TRANSFER OF TECHNOLOGY

Policies and guidelines on technology choice :

Technology grows out of certain socio-economic conditions and produces benefits only under a favourable environment. In other words, not all advanced technologies, regardless of the environment, can create positive results. In choosing technologies in China, the following factors must be taken into overall consideration: (1) the needs of China's socio-economic developments; (2) natural resource conditions; (3) technical capabilities and employment opportunity; (4) economic competitiveness; (5) effect on the environment; (6) compatibility with cultural tradition and value concepts. In short, what we need is technologies that make full use of our natural resources, save energy and raw materials, provide job opportunities, reduce environmental pollution, improve labour productivity, and are conducive to entering international markets. These we call as appropriate technologies.

China's science and technology information system supplies such information, whether Chinese or otherwise, to the various sectors and enterprises through professional journals, periodicals and other publications.

Regulations with regard to choice of foreign technology :

In addition to the criteria indicated above, the following points must be observed: (1) technology importation must be closely integrated with domestic enterprise technical transformation; (2) technology importation must be conducive to the improvement of indigenous S and T capabilities, rather than initiating dependence on foreign technologies; (3) priority must be given to the importation of "software", i.e. patent, technologies, blueprints, etc. The importation of equipment particularly turn-key plants must be reduced; (4) adopting flexible forms such as joint venture, purchasing of production licence, etc.; (5) under normal circumstances, importation should be limited to purchasing samples, single units, which are to be digested and assimilated. The same item should not be imported repeatedly.

Organizations responsible for technology imports in China are located at different levels. In general, such importation is organized and coordinated by the State Economic Commission, while important items at the national level, such as nuclear power technologies, are under the joint responsibility of the State Science and Technology Commission, the State Planning Commission, and ministries concernd. The ministries, provincial and municipal governments, including the special economic zones, are authorized to import technologies needed for their own use within their terms of reference. A small number of large, key enterprises can also import technologies needed for themselves.

Institutions involved in transfer of technology :

China has established a State Patent Office to register patents from domestic and foreign sources. Yet, it is not an agency concernd with domestic technology transfer or technology trade in a normal sense. So far, no center or organization at the national level responsbile for technology transfer have been created. Such activities are carried out by the ministries, local governments, and so on. Many S and T exchange, consulting, service or development centers have emerged across the country, which are actively promoting technology transfer. At the national level, technology transfer is administered mainly by the State Science and Technology Commission and their provincial affiliates.

Characteristics of foreign technology inflows :

Since 1979, our policy towards technology importation has undergone a significant change, emphasis shifting from turnekey plants to specific technologies, key components, licence trade, joint production, technical consultation and service. From 1979 to 1982, over 440 technology importation projects were signed under the government's plan, amounting to 4.5 billion US dollars. Among these, some 50 percent are licence trade, technical consultancy, service, co-production etc, in which licence trade makes up 75 percent.

Training of personnel handling technology choice :

Technology transfer was not given adequate importance in the past, and there was a serious shortage of trained personnel to deal with internal and international technology transfer. At present, more attention has been given to the training of economic, trade, including foreign technical trade, and management personnel in the various institutes of higher learning. By 1982, over 3,000 students in foreign trade were registered in relevant institutions. The State Economic Commission and the Ministry of Foreign Economic Relations and Trade have organized a large number of training courses in economics, trade and management, including some intended for those responsible for foreign technology importation and domestic transfer. Some of these training course are co-sponsored with other countries. Such training courses are also offered by the ministries and local governments according to their needs and requirements.

Impact of foreign technology inflows on endogenous science and technology development :

In general, foreign technology inflow has created a positive impact on the development of science and technology in China. Chinese scientific and technological personnel are usually mobilized to digest, assimilate and master important foreign technologies and to improve such technologies. This approach not only accelerates technology transformation in the enterprises and improve productivity, but also enhance the endogenous science and technology development, and has been quite successful.

Imported technologies, however, do sometimes impede endogenous R and D. The obvious advantage of some imported technologies such as favourable price and better technical performance, could present an obstacle to domestic R and D and discourage the initiatives of the domestic R and D personnel. To counterbalance such effects, the Chinese government has adopted a policy that the importation of advanced foreign technologies and their assimilation must be expanded and be regarded as an important means to develop China's own science and technology; meanwhile, limited but necessary protection should be given to domestic R and D. The latter, however, must not lead to the "protection of backward technologies", which are against the national interests and endogenous technological progress.

Constraints related to choice, acquisition and transfer of technology :

Constraints relating to domestic and international technology transfer in China are summarized in the following points: (1) lack of rich expriences in international technology transfer (2) lack of flexible information systems; (3) discriminative constraints from outside.

DEVELOPMENT OF HUMAN RESOURCES FOR SCIENCE AND TECHNOLOGY

Current potential of science and technology personnel :

In 1982, there were some 6.26 million science and technology personnel in public research institutes. Among these, about 50,000 are senior scientists at or above the level of associate professors, associate research fellows, senior engineers; about 1 million are lecturers, engineers, assistance research fellows; about 5 million are technicians, assistant engineers, assistant lecturers, etc.; 45.1 percent of them received higher education and 31.7 percent are women. In terms of professions, about 2.4 million are engineers and technicians; 361,800 are agricultural technicians; 1.8 million are medical personnel; 371,800 are scientific researchers; 1.9 million are teaching staff. By 1983, the total number had risen to 6.85 million, an increase of 590,000 over 1982.

Policy for human resources development :

China regards education and human resources development as a strategic priority. The number of university and college graduates increased from 85,000 in 1979 to 335,000 in 1983; and that of students registered in universities and colleges from 1.02 million in 1979 to 1.207 million in 1983. Meanwhile the number of graduates majoring in natural science theories, engineering, agriculture, medicine and other natural sciences rose from 51,000 in 1979 to 270,000 in 1982; the number of registered vocational school students from 800,000 in 1979 to 1,143,000 in 1983.

In 1982, the Ministry of Education sent 3,410 students abroad while 2,567 returned after studying overseas.

Women in China are entitled to the same educational opportunity as men. Among some 6 million science and technology personnel, 31.1 percent are women.

In some cases, science and technology personnel leave China because of job dislocation or working conditions. However, most of them are overseas Chinese who still have family members in other countries. Such phenomenonshould be regarded normal. On the other hand, many overseas Chinese science and technology personnel return to motherland to work. Basically, braindrain has not been a problem.

Adult Education

In 1982, 640,000 people received adult education in China, among which 258,000 through television, 208,000 through either correspondence or evening schools, 144,000 through workers or farmers colleges, and 34,000 through schools or colleges of continuing education for secondary school teachers. By 1983, students registered for adult education rose to 926,000.

In addition, there are 3,264,000 students in adult vocational schools and 6,350,000 adults at secondary schools.

The figures indicated above show significant increase over 1979.

Post-Graduate education and training system :

There existed no post-graduate education system in China. Since 1981, China adopted academic degree system, whereby university or college graduates become M.A. candidates through examinations plus a period of studies varying from one to three years. Once they passed their thesis, they are awarded M.A. degree. Students with M.A. become doctoral candidates also through examinations. If they pass their doctoral thesis and oral defence within a defined time period, they are granted Ph.D. degrees. From 1981 to 1983, more than 18,000 people were accorded M.A. degrees and 29 Ph.D degrees in China. In 1983, over 37,000 people were under either M.A. or Ph.D programmes in research institutes and institutes or higher learning.

Bottlenecks in development of S and T human resources :

Major problems at present are (1) the development of education, including expenditures and facilities, is incompatible with modernization programmes. The total number of Science and technology personnel in all fields is small and the percentage in the total population is very low - one out of every 62 in 1982; (2) irrational composition of specializations - there is a big demand for personnel in agriculture, light industry, textile industry, etc.; (3) over-specailized disciplines and curriculum, resulting in students' narrow scope of knowledge and lack of basic theoretical and comprehensive analytical abilities as well as flexibilities; (4) absence of a system for continuing education, thus providing no formal learning opportunities or updating knowledge in science and technology after university education.

To overcome these difficulties and to promote the development of education, it is important to open up new avenues, increase necessary expenditures and facilities, improve the quality of teaching and teachers in institutes of higher learning, and expand adult education.

FINANCING SCIENCE AND TECHNOLOGY FOR DEVELOPMENT

Expenditures on science and technology

Expenditures on science and technology in China come mainly from government's budget allocation in two categories, i.e. research expenditure and capital construction expenditure, which are alloted to the various ministries or provincial governments through the Ministry of Finance. Within the research part of the budget there is a special fund under the control of the State Science and Technology Commission for developing new products, pilot plant experiments and/or as subsidy to priority research projects. In addition, the ministries and provincial governments can also allocate a certain amount from their operating expenses for S and T activities according to the needs and possibilities. Our institutes of higher learning and production enterprises too raise funds for the purpose, but not reflected in national statistics. China's national expenditure on science and technology, excluding those in institutes of higher learning and enterprises, was 6,167 million yuan in 1982, and 7,400 million yuan in 1983, about 1.6 percent of the national industrial and agricultural output.

Internal sources for financing research and development :

Expenditures on scientific research in China come mainly from the financial sources inside the country. These sources are already cited above.

External sources for financing research and development :

Basically there are no external R and D financial sources. Although some R and D project assistance has been received from the United Nations system, the amount has been very limited. In order to accelerate technical transformation process, China is actively using foreign investments and loans to purchase research and experimental facilities, yet these do not fall into the category of R and D expenditure.

Incentives for S and T development according to policy goals :

China has a number of policies and regulations for encouraging initiatives in and promoting the development of science and technology. These include "Regulations on Natural Science Award" for scientists with major scientific discoveries or outstanding achievements, "Regulations on Inventions Award" for those with important inventions, and "Regulations on Award for Rationalization Proposals and Technical Innovation" for those who have made significant contributions to enterprise technical progress.

In addition, the Chinese government has adopted a series of economic policies in terms of taxation, pricing, loan provision and so on, to encourage increased enterprise expenditure for developing new technologies and products. Income taxes on royalties received by foreign firms in China for their technologies are reduced or in some cases exempted.

Risk and venture capital/credit for S and T activities :

While China's S and T expenditures are allocated from the national budget according to plan, banks do provide low-interest loans for developing certain new technologies and new products on a case-by-case basis. Yet, there are no institutions which provide risk or venture capital/credit as in other countries.

Problems in financing science and technology :

For most developing countries, China included, lack of financial resources for R and D is a common problems. The Chinese government has decided to gradually increase its R and D expenditures. Incomplete statistics shows that national R and D expenditures in 1983 has increased as much as 19 percent, amounting to 7,400 million yuan. What is crucial, however, is not just magnitude of the amount, but more importantly, how efficiently it is used. This involves reforms in institutional arrangements for S and T and improvement of S and T cost-benefit performance, which are currently being undertaken in China.

SCIENTIFIC AND TECHNOLOGICAL INFORMATION

National scientific and technological information system :

At the national level, the Institute of Scientific and Technical Information of China functions as an information collection, retrival and research center. It accumulates information from both within and outside China, processes and publishes it as well as provides other information services. It also organizes, coordinates and gives guidance to information related activities on a nation-wide basis.

S and T information in China takes the following formats: (1) research reports; (2) conference proceedings; (3) publications and periodicals; (4) samples or sample books; (5) standardization documents; (6) patent literature; (7) registration of research results; (8) audio-visual literature.

The source of information includes extensive subscription to S and T journals and publications, exchange or information with various organizations, both at home and abroad. The Institute of Scientific and Technical Information of China has wide international contacts and has established regular S and T information exchange with 63 countries or regions and 53 international organizations, including over 2,000 counterparts. It has joined UNESCO, PGI, FID, ISO and other such international organizations and has developed cooperation arrangements with information centers in Thailand, the Philippines, France, the United Kingdom, the United States, Japan, Canada, Sweden, Federal Republic of Germany, etc. It also keeps computer on-line contacts with information centers in Europe and the United States. In 1983, it had over 150,000 customers and edited, translated and published 376 journals or books.

Sectoral information systems :

China has at present over 30 S and T information institutes at the sectoral level. The major ones are in the Ministries of Agriculture, Transportation, Coal Industry, Petroleum Industry, Post and Telecommunications, Machine Industry, Metallurgical Industry, Chemical Industry and Electronics Industry.

Such institutes also exist in the areas of health, textile industry, urban construction, building materials, geology, ocean, etc.. Administratively, these institutes are under the jurisdiction of the respective ministries, while professionally, they act under the guidance of the Institute of Scientific and Technical Information in China.

Statistics on science and technology activities :

Apart from the State Bureau of Statistics which compiles statistics on a limited number of S and T indicators, there exist no other specialized organizations in China for such activities.

Lack of coordination and unified plan has resulted in scattered statistical work constituting a major defect in S and T management.

Weaknesses related to scientific and technological information :

Major weaknesses in this regard are (1) the means of information collection, storage, retrieval,etc. are backward; (2) as no standardized Chinese character processing system has been established, language barrier poses a great constraint on the use of computers and has deterred the creation of a national computer retrieval network; (3) for research personnel, aging knowledge has beomce a problem; information updating and training are required.

In order to improve and expand the role of scientific and technological information, it is highly necessary to train information management and processing personnel on the one hand, and information users on the other. Increased expenditures and upgraded facilities are also necessary.

STRENGTHENING OF RESEARCH AND DEVELOPMENT IN AND FOR DEVELOPING COUNTRIES AND THEIR LINKAGE TO THE PRODUCTION SYSTEM

Linkage between research and development projects/unviersities and the production system :

Over the recent years, great efforts have been made in China to foster close linkage between research institutes and the production systems. Apart from encouraging technology transfer from laboratores to production sectors and the adoption of new technologies in enterprises, the following measures have been taken to effectively integrate S and T and production.

(1) The establishment of research and production alliance: Through economic contracts, alliance is forged among research institutes, universities and production enterprises under different jurisdictions to form a system of research, design, demonstration, pilot plant experiment and industrial production. The benefits will be shared by the participating organizations.

(2) The establishment of technology development centers: Research institutes, including those within universities, under different jurisdictions join together, through economic contracts, to develop certain production technologies and then provide integrated technologies to the production sectors.

(3) The establishment of regional science and technology exchange, consultancy and service centers: These centers organize and provide links among research institutes, universities and enterprises to facilitate inter-organizational technology transfer, joint research, sharing equipment, technical consultancy, personnel training, etc. Most cities in China have now established centers of this kind.

(4) Long term cooperation between research institutes and production sectors: Research institutes, universities and production sectors can establish long term stable cooperative relations through provision of consultancy and research results on the one hand, and making available pilot plants and production facilities on the other. Economic benefits could be shared by both sides.

(5) Promotion of production oriented research institutes within enterprises.

Potential of local consulting engineering and design services :

During the past few years, extensive consulting engineering activities and design services have been carried out, and a large number of engineering consulting agencies set up. For instance, China Metallurgical Engineering Consulting Corporation, Chemical Engineering Consulting Corporation, Coal Engineering Consulting Corporation, Machine Engineering Consulting Corporation, Electrical Engineering Consulting Corporation, etc.. In 1982, 17 such corporations specialized in building construction, light industry, civil aviation, highway construction, forest product processing and so on merged into China International Engineering Consulting Corporation. It has over 12,000 employees including engineers, architect designers, economists and so on. It receives orders from organizations or individuals in and outside China to supply either comprehensive or partial engineering consulting service to projects of various forms, types and scales. Such service includes planning, exploration, design, feasibility study etc.

Facilities for assisting traditional technologies :

China has over 380,000 enterprises with most of them still using traditional technologies. Technical transformation in these enterprises therefore poses a challenge. From 1979 to 1982, the government spent 16.8 billion yuan, or an annual average of 4.2 billion yuan, on technical upgrading and renovation of equipment, improvement of existing installation, engineering and designs, quality control and expansion of enterprise R and D capabilities. Many organizations have been established to provide enterprises with technical transformation services.

Use of local R and D institutions :

The application of important scientific and technical results are usually incorporated in the national plan.

Incentives are given to production sectors by the government to use local R and D results. Products based on local R and D results can enjoy tax reduction or even exemption for a period varying from one to three years. The government has also adopted the "Regulations on Award for Rationalization Proposal and Technical Innovation" for the purpose.

Problems in strengthening R and D and linking it to production systems :

Major problems are (1) lack of R and D capabilities in a large number of enterprises; (2) weak pilot plant and industrial experiment facilities, resulting in slow process of research attainments being engineered and commercialized; (3) lack of sound legislation, management systems and avenues for technology transfer; (4) inadequate information service to the production sectors.

STRENGTHENING OF COOPERATION IN THE FIELD OF SCIENCE AND TECHNOLOGY AMONG DEVELOPING COUNTRIES AND BETWEEN DEVELOPING AND DEVELOPED COUNTRIES

Volume and forms of cooperation with developing countries :

From 1979 to 1983, China established cooperative relations in the field of science and technology with 59 developing countries in Asia, Africa, Latin America, and signed cooperation agreements with 25 of them: Democratic People's Republic of Korea, Pakistan, Bangladesh, Thailand, the Philippines, Algeria, the Sudan, Egypt, Morocco, the Libyan Arab Jamahiriya, Zambia, Turkey, Iran Islamic Republic of, Democratic Kampuchea, Viet Nam, Nigeria, Argentina, Chile, Venezuela, Columbia, Brazil, Mexico, Cuba, Mongolia and Indonesia. 714 exchange and cooperation projects were carried out, out of which 408 are financed by the Chinese government. They include (1) dispatch of Chinese experts abroad to transfer technologies; (2) arrange study tours in China for foreign experts; (3) organize field studies and practices in China for foreign students; (4) providing information, seeds, plant specimen to foreign countries. In 306 projects, other countries have sent experts to China for technology transfer, arrange study tours for Chinese experts, accepted Chinese for field studies and practices in their countries, and provided information as well as seeds, etc..

Volume and forms of cooperation with developed countries :

China has established cooperative relations with 24 developed market economy countries, and signed science and technology cooperation agreements. They are the United States, Japan, the United Kingdom, France, Federal Republic of Germany, Italy, Sweden, Greece, Finland, Denmark, Norway, Belgium, Luxembourg, Australia, Canada, etc. 1200 cooperative projects were carried out, covering visits by 24,000 Chinese experts to other countries for either exchange, coopration or international conferences.

China also has cooperative relations with centrally planned economy countries such as the Soviet Union and other East European countries, and signed agreements with nine of them. Since 1979, cooperation in this regard has resulted in 797 projects, out of which 366 were undertaken by Chinese, 382 by its counterparts, 36 joint research projects, and 13 training courses or international symposia. The cooperation includes exchange of experts, field study tours, joint research, exchange of information, seeds and samples, etc.

In addition, China has sent over 8,200 experts to 3,362 international science and technology meeting since 1979.

Problems in international science and technology cooperation :

China endeavours to strengthen its cooperation with all countries in the field of science and technology on the basis of self-reliance, independence and keeping the initiative in our own hands. It is ready to carry out such cooperation in the normal forms of internatioal practice- exchange of experts and information, study tours, joint research, training, technical assistance, technology transfer, etc.. The emphasis of all these activities, however, should be laid on the actual results and mutual benefits. Due to limited economic and scientific-technological capacities, China's international cooperation in this regard is still of a modest and unsatisfactory scale. With the development of its modernization, however, such cooperation shall be expanded to cover a wider scope and richer contents.

ISSUES IN SCIENCE AND TECHNOLOGY FOR DEVELOPMENT IN THE FUTURE :

Concerns during the next 5 years :

Need for realignment of policies and implementation structures:

China's basic policy guidelines for science and technology development will not change and will be implemented consistently. This, however, does not imply any rigidity in specific policies and measures. To carry out our general guideline linking economic development with scientific and technical progress, realignment of policies in certain specific areas will be necessary. The same holds true for sectoral technical policies, which may be readjusted as the general environment develops.

China is presently undertaking reforms in economic system and science-technology management systems. The existing unsatisfactory implementation structure will also undergo necessary reforms at appropriate time.

Sectors requiring special attention :

Agriculture, energy, transportation and communication, science-technology, education are the five strategic development areas in our national economic development, and will receive special attention.

With regard to science and technology priorities, in the future, the following areas have been identified by the Chinese government: agriculture, energy, transporation and communication, iron and steel, non-ferrous metals, petrochemical industry, food industry,health and medical care, environmental protection, biotechnology, computers, computer software, optical fibre communication, new material, nuclear technology, basic research, etc. In addition, space technology and ocean engineering will also be accorded priority. Based on these priorities, we are now formulating the seventh five year plan from 1986 to 1990, and the long term development plan from 1986 to 2000.

Emerging technologies :

Priorities in emerging technologies are listed above. Among these, however, the development of microelectronics, including computer, and software, will rceive top priority. Efforts are being made to establish a sound IC industry as early as possible, with the immediate goal of producing and extensively applying micro-computers and developing mechatronic products. Meanwhile, China will speed up its modernized communication systems in areas with fast economic development and high communication flows, such as Beijing, Tienjin, Tangshan, the Yangzhi River Delta, etc. In addition, space technologists will be explored actively, with emphasis on communication, broadcasting satellite, while land and meterorological satellites will be developed according to our resource potential.

Social implications of scientific and technological development :

The development of science and technology in China has strong socio-economic implications. It increases labour productivity and economic benefits, provides more education opportunities, improves the living environment, advances material and cultural prosperity and betters the quality of life. It also expands life expectancy.

In the process of industrialization, certain social diseases have occurred and would occur, such as environmental pollution and so on. Yet, it is not science and technology which is responsible; rather, the cause lies in policy and management.

Under certain circumstances, mechanization and automation can also lead to labour surplus. This issue holds special implications for China, a country with a billion people, which has to cope with the problems of employment at all times. Fortunately, the application of new technologies has so far not caused serious unemployment, but only created more job opportunities on the contrary. At least, new technologies have not posed any threat in this regard.

Science and technology in a longer term perspective :

As indicated earlier, the Chinese government is presently formulating a long term science and technology development plan from 1986 to 2000, and has identified a number of priority areas. The major objective of this plan is: (1) apply extensively before 2000 the advanced technologies which are widely used in the developed countries in the seventies and early eighties, which also comply to China's specific conditions; (2) develop a number of emerging technologies and industries, such as microelectronic industry, biotechnology industry, new material, space, ocean industries, etc.; (3) organize scientific and technological pre-investment preparation for the several hundreds of key projects and solve their key technical problems; (4) organize certain basic research projects, so as to accumulate adequate scientific reserve for long term development; (5) organize a large number of technical importation items, their digestion and assimilation.

Ways of increasing S&T co-operation in the ESCAP region

China supports the Tokyo Programme of Action on Technology for Development adopted at the 40th ESCAP Session, and will participate in a selected number of follow-up projects.

Regarding technology atlas, some Chinese departments believe that a feasibility study in a few technological areas may prove useful, as it will provide an assessment of the value of such an atlas. China will join this project on the condition that it aims at the actual usefulness to the developing countries in improving their science and technology cpabilities. We have no experience in this field, and could not offer any specific recommendations at present. But we will participate in the disucssion on the issue and the State Science and Technolooogy Commission will act as the focal point.

Demonstration projects :

Concerning demonstration projcts, China is ready to participate in the proposed solar cell project and would like to send people to joint training activities. With financial support from the United Nations or other donor countries, China can undertake demonstration projects in areas such as commercial biogas digester technology, rural mini-hydro power, solar heat utilization, fresh water breeding, etc.. We will also take part in demonstration activities in other countries, particularly on the improvement of labour productivity through micro-computers, biotechnology, waste treatment, environmental improvement, etc..

Training programmes :

The following areas are of special interest to us: microcomputer application, computer software, industrial microorganism and fermentation engineering, genetic engineering and biotechnology, new and renewable energies, energy conservation technology, remote sensing application, isotope application, and "soft sciences" like science-technology policy, planning, forecasting, management, etc..

China has done much work in certain areas and would offer to organize training courses with financial support from the United Nations or other donor coutnries. These include biogas technology, remote sensing application in agriculture and land planning, acupuncture, mini-hydro power, silkworm, grassroots health care, integrated rural development, fresh-water breeding, etc..

Advisory services :

China needs a variety of advisory services, i.e. advisory services in specific technical projects including technology transfer, and more urgently advices on development strategies. Since China is developing new technologies and transforming traditional technologies thereby, it is inevitable that problems of one kind or another would occur. Therefore, the departments concerned in China would appreciate advisory services in these areas, such as on the application and development of microelectronics technologies, the establishment of software industry, etc.

With regard to advisory services on development strategy, the relevant Chinese departments are most interested at present in assessing the challenges and threats posed by the new industrial revolution to the developing countries, and the counter-measures and policies required.

Meanwhile, China could also offer other countries advisory services on specific technologies, such as laser treatment of eye diseases, tea planting and\processing, as well as on strategic policy making.

In international cooperations, we have adopted a policy of opening to the outside world. We have agreements with around a hundred countries in the world in science and technology or technical economic cooperations. We believe that through international cooperations and exchange, we can share our experiences and avoid unnecessary duplication of efforts, thus mutually benefitting all countries.

PROMOTION AND PLANNING: SOME PECULIARITIES OF THE SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT IN CUBA

INTRODUCTION

Cuba is a relatively small island of about 111,000 sq. km. (42 860 sq. miles) and 10 millions inhabitants, with a population density of approximately 90 inhabitants/sq.km. (233/sq.mile) Child mortality was 15.2 per 1000 live births in 1983, which is the lowest in Latin America, and comparable to the rate in the developed countries in this respect. Life expectancy reached 73.5 years in the same year. The annual growth rate of the economy for 1982-83 was +5.0%.

In 1958, the year proceeding the Cuban Revolution, Cuba a very limited number of scientists; and research units were virtually non-existent, hindering the elaboration of a complete scientific foundation for many of the first projects launched by the Revolutionary Government in several areas of social and economic development.

Thirty percent of the total population was illiterate. The yearly output of medium and high-level specialists was at a low level. The Agriculture was backward and the industrial sector largely depended for its funtioning on imported inputs and with a mix of old installations, as those prevailing in the cane sugar industry--our main industry--, with a few modern units. The technological development of the whole Cuban economy depended upon foreign source.

Research being scarce, the country experienced a great lack of information about the characteristics of its agricultural potential and of its natural resources and environment. Technological research was practically non-existent and could not respond, in any case, to real plans for economic development because the old society was not in the least concerned with the planned approach to development. If, in 1959 Cuba happened to count upon some eminent personalities in several scientific disciplines, it was mainly due to their own individual efforts.

Presented by Emilio Garcia Capote

THE "ORIENTED PROMOTION" STAGE

Since the very beginning after the Cuban Revolution triumph in 1959, the leadership of the Revolution was fully aware of the role of science and technology in national development. In 1960, in a speech delivered at the Speleological Society of Cuba, Comrade Fidel Castro stated that "the future of Cuba must necessarily be a future of scientists", and in 1963, addressing a large group of medium-level students, he pointed out that "the social revolution was carried out in order to undertake the technological revolution", thus affirming the linking of scientific and technological progress with social progress as the fundamental principle for a true national science policy.

By virtue of this understanding of the need of scientific and technological development, human and material resources for the creation of research centres were alloted to meet the country's future development needs, inspite of the shortage of university graduates in the country and the necessity for them to fulfill the urgent production tasks, and inspite of several difficulties imposed on the country as also other limitations inherent in an underdeveloped country.

The research centres created at this stage were mainly characterized by a series of steps for the establishment of scientific research institutions, equipping them, within the available means, with the essential material resources; training the future scientific cadres; establishing the necessary international cooperative relations; and formulating and carrying out the incipient research projects to solve crucial socioeconomic development programmes. These tasks were undertaken through the guidelines of the Revolutionary Government, in the absence of a central structure for the management of scientific and technological activities.

It is interesting to note that a National Council of Science and Technology was not created in Cuba until 1974. This is due to assumption then that the existence of a central structural body requires a minimum level of research base, and a "critical mass" of S and T activities sufficient number of scientists and engineers. It was believed necessary, therefore, to wait for those conditions to come about, at least partially. These developments chronologically coincided with the growing institutionalization process of the nation with its membership in the Council for Mutual Economic Assistance.

The most important aspect of this stage was that decisions concerning the development of science and research were made at nearly the same time as the decisions on socioeconomic development aimed at satisfying the needs of the masses were taken, thus guaranteeing the greatest possible coherence between them. Hence, it was possible to carry on a national science policy without the existence of an explicitly designated structural body. The scientific research institutions established during that period have since undergone several structural changes, but have accomplished their initial overall objectives and have demonstrated the social need for their existence.

By the end of 1983, the national R and D system was composed of about 150 research units, to which more than 230 experimental stations and other types of branch units were attached. About 5000 full-time researchers were employed that year in this network and 6000 professors taught at the 45 higher education centers, devoting 20-25% of thier working time to research tasks. These were 65 R and D scientists and engineers (full-time equivalent) per 100,000 inhabitants. The R and D expenses totalled 163 millions of Cuban pesos in 1983 (*), amounting to 1.6% of the total annual state budget or to 1.0% of the GNP.

Although modest and still in a developing stage, the national R and D system has already generated some important results such as the sugar cane harvester KTP-1, now being produced at a rate of more than 600 machines per year; the building of cane sugar factories with 60% of indigenously-generated technology; and the construction of 64K minicomputers. The contribution of the national R and D system to the process of technology transfer has greatly increased in the last few years. The successful fulfillment of the complex Cuban-Soviet cosmic flight in 1980 must be taken as a sign of maturity of the national R and D system.

THE SHORT AND LONG-RANGE PLANNING OF S AND T SINCE 1976

At the First Congress of the Communist Party of Cuba, held in 1975, the thesis and resolutions on national science policy and on the Economy Management and Planning System were approved. A higher degree of formalization of science and technology planning was established as part of the National Plan.The first experience of a National Plan of Science and Technology was the elaboration of the Five-Year Plan 1976-80. This plan consisted of 77 State Main Problems which were linked to the main direction of the socioeconomic development of the country, and also by other research problems of branch character and the scientific and technological services.

During this first Five-Year Plan a great effort was made in planning and organization of the scientific and technological activities and to increase the effectiveness of the research centres. Inspite of the structural limitations of the 1976-80 Five-Year Plan of State Main Problems, a review of the achievements of that period shows an important set of scientific and technological results. The elaboration of the Scientific Projection 1974-80 of the Academy of Sciences of Cuba, was an essential antecedent to the national structuring of research and development in terms of problems and themes.

(*) 1 Cuban peso = 1,17 US$ at the offical rate of exchange of the Banco Nacional de Cuba during the first half of 1983

The Five-Year Plan 1981-85 was elaborated starting from the experience obtained in planning, management and control of the scientific and technological activities of the previous quinquennium. For this period, the scientific and technological research problems were classified according to its level of approval in two categories: Main Problems and Branch Problems.

Main Problems must be related to the objectives of the strategy of scientific and technological development of the country; they tackle integral solutions which generally require the participation of more than one organization in its fulfillment and as such they demand a differentiated attention by the Academy of Sciences of Cuba in their fulfillment and control, according to effective regulations.

Branch Problems integrate the research approved by the organizations corresponding to their branch development and the needs of production or services in each branch. They emphasize those research areas which would contribute to exports development and imports substitution; to quality improvement; to the increase of productivity; and to cost reductions.

According to their characteristics and objectives, Main Problems are classified into four groups:

- State Main Problems
- Medicine Main Problems
- Social Sciences Main Problems
- Basic Research Main Problems

In order to guarantee the appropriate interrelations among different factors which participate in the planning and control of these Main Problems, a Problem Commission is created for each of them. It is formed as a consultative scientific and technological collective body charged with the integral assessment of the development of the activities of the agencies and units which participate in the given research; and the introduction of the results generated by the Main Problems into social practice. Its members are institutionally subordinated to the corresponding agencies.

For each Main Problem, a Coordination Plan has been elaborated which constitutes the guiding document of the Problem for the 1981-85 period, and serves as a basis for the preparation of the annual plans. In this document, the compromises of the various agencies in the fulfillment of the Problems are established.

The control of the state of fulfillment of Main Problems is carried out twice a year by means of established methodological procedures. Problem assessment is accomplished starting from informations elaborated by themes heads, which are analysed by the scientific councils of scientific institutions and approved by the executing agency. The process ends with meetings among the Academy of Sciences of Cuba and the executing agencies, where the research progress and the measures to apply the results, in order to secure the fulfillment of foreseeable objectives, are determined.

Selection of the State Main Problems for the 1981-85 period was carried out by groups of experts chosen among the most talented high-level researchers, specialists and officials in the different branches of economy. The first-level objectives have now been defined for the scientific and technological progress in the strategy for the economic and social development up to the year 2000. These objectives correspond to the aspirations to develop or solve a set of matters of present and future importance to the Cuban economy and society.

Starting from this principle, 53 State Main Problems were approved in the National Economy Plan:

. 20 Problems in the agicultural, cattle and fishing sphere
. 25 Problems in the industrial sphere
. 4 Problems in the aspects of environmental protection and natural resources conservation
. 3 Problems is transportation, building and geology.

In the methodological instructions for the Elaboration of the National Economy Annual Plan, Section 1 on Planning of Scientific and Technological Progress, deals with tasks ranging from basic research to the necessary development works for the introduction of new technologies. This Section outlines, the resources necessary for the fulfillment of the priority tasks regarding the solution of the Main Problems of science and technology explicitly identified for the five-year period. Also , within the framework of this section, aspects of coordination and execution in the integral planning of scientific and technological development are specified; thus ensuring the increase of the efficiency in the national economy. This Section is related to other sections of the Methodological Instructions.

This Section of the annual plan contains tasks relating to the fulfillment of the science policy approved for the corresponding five-years period; to the coordination plans for the solution of the science and technology Main Problems; and to the plans for technical improvement of production and the assimilation of new technologies. It also includes the material and financial resources for the planned works, including basic tasks for the preparation of scientific cadres.

In its elaboration, the planning of the scientific and technological progress includes three levels:

. Global level: for the whole economy
. Branch level: ministries and other branch agencies
. Base level : research and development units, enterprises, engineering offices

The main parts of the Scientific and Technological Progress Plan are:

- Task on scientific and technological research
- Assimilation of new types of products
- Acquisition and sale of licenses and patents
- Introduction of Computerized Management Systems and Computer techniques
- Scientific organization of labor
- Standardization, metrology and quality control
- Preparation of scientific cadres

In recent years, the new Economy Management and Planning System was applied in our country. It was introduced in the Methodological Instructions for the National Economy Planification. The Section corresponding to scientific and technological progress has enabled a qualitative improvement in the organization of these activities. The cycle science-technology-production, however, is still relatively weak as a consequence of the very process of development and strengthening of the Economy Management System and of the application of autofinancing in the enterprises.

At present, taking into account the experiences of other socialist countries in this sphere and our present level of development, the measures for the improvement of the scientific and technological progress planning are being studied, aiming to guarantee its role in the solution of socioeconomic problems. Among the measures that can be pointed out are:

- The precision in the forecasting of the development of scientific and technological progress up to the year 2000, which constitutes a previous requirement for the improvement of science and technology planning at the present stage;

- the analysis of financial variants for the scientific and technological activities and for the introduction of new technology;

- the improvement of planning of the scientific and technological activities, thus guaranteeing the integrality of works and tasks from their initial conception to the application of assimilation of the results;

- the stimulation measures which would guarantee the interests of the productive enterprises and of the research collective bodies regarding the assimilation of scientific results;

The application of these and other measurs under study, will guarantee in the coming years the accelerated creation and application, in a more efficient manner, of new technologies, technical means and materials and also of the introduction of other elements of the scientific and technological progress as basic premises for the increase of work productivity and products quality; for the improvement of working conditions and the level of life of the population.

FORECASTING AND CONCEPTION OF S AND T IN CUBA UPTO 1990

Taking into account the necessity for a long-range perspective of the development of Cuba in the successive five-years plans, the Political Bureau of the Communist Party of Cuba and the Executive Committee of the Council of Ministers promulgated on 20 July 1978 a Joint Resolution launching the elaboration of the Economic and Social Development Strategy up to the year 2000. In the Joint Resolution the Programme of Studies for such elaboration was approved. This programme was proposed by the Central Planning Board and it established the necessary linkage of the strategic objectives of this development till the end of the century with Specific Programs of Long-Range Cooperation in the framework of the Council for Mutual Economic Assistance.

The Resolution also defined the responsability of the Central Planning Board, which was charged with managing, organizing and controlling the elaboration process of the Project Strategy and of orienting, coordinating, controlling and synthesizing the corresponding partial studies.

The 44 problems with which the Strategy was originally organized, defined the analytical tasks relating to the characteristics and trends of our economy, and the foreseeable objectives of the medium- and long-range development of the country taking into consideration the experiences of the socialist countries in the field of perspective planning. In order to achieve a uniform treatment of many different problems, methodological regulations of several main links were elaborated.

The first materials were elaborated at the beginning of 1979 with the participation of global and branch agencies of the national economy. Among the main elements which were characterized at that moment, it is worthwhile to mention:

- The selection of more than 60 indicators referred to activities pertaining to scientific and technological progress; to cadres, specialists and techniciansp; to the scientific and technological infrastructure; and to material and financial allocations;

- The diagnosis of the starting point analyzed the dynamics, level and structure of the labor force engaged in science and technology activities; the proportions in R and D works; the situation concerning the introduction of research results into social practice; the National System for Scientific and Technological Information; the purchase and sale of patents and licenses; standardization, metrology and quality control; automation, and the scientific organization of labor;

- Concerning the future development of scientific and technological progress, an analysis was made of those science and technology matters to be taken into consideration in selected branches of the economy; an examination was made of the possibilities of Cuba as a subtropical and underdeveloped country in the medium- and long- range scientific and technological specialization and in those activities related to the Latin American, Caribbean and African co-operation; an outline was prepared of the primary elements for the projection of the total number of workers concerned with scientific and technological research, with special reference to the qualified labor force; some elements to project the preparation of scientifc and scientific-pedagogical cadres were also sketched.

The analysis of the first materials generated by this problem, carried through elements contributed by the other 43 problems, allowed to make the necessary adjustments and to project, in June 1980, a second variant, more objective, containing indicative figures about the human and material resources necessary to undertake the 15 general objectives of first level for the year 2000, which were the following:

1. In agriculture: attainment of high agricultural yields at the lowest possible production cost.

2. In cattle: cattle production by means of modern genetic breeding; of feed systems based on national resources, and of animal health conservation and improvement.

3. In fishing: national sources of sea and river fishing and their industrial processing.

4. In the industrialization of sugar-cane and its by-products: integral use of sugar-cane as basic renewable raw material for economic development.

5. In sugar-cane industry: equipment and technology necessary to reduce fuel consumption, liberating begasse for its technological or energy use.

6. In mining-metallurgical development: integral utilization of useful ores, specially laterites.

7. In mechanical development: scientific and technological bases of the mechanical production of the country.

8. In chemical industry: potentialities for low-energy consumption productions and others which take into account the national base of raw materials.

9. In energy: potentialities of conventional and non-conventional energy sources.

10. In food industry: elaboration and preservation of animal and vegetable origin products, achieving their maximum utilization.

11. In electronics: scientific and technological bases of electronic equipment production.

12. In natural resources and environment: rational utilization and preservation of natural resources and environmental protection.

13. In transportation: integral development of the transportation system for passengers and goods traffic.

14. In communications: enlargement and modernization of the communications network, based on scientific and technological results, particularly of electronics.

15. In building: improvement and development of building production technologies.

This set of 15 most general first-level objectives was segregated into 100 second-level objectives of more concrete terms, and, in turn, these were specified into more than 300 third-level objectives, which identify themselves with specific products and technological processes and researchs.

For each member of the set of second-level objectives a further precision of the results expected in each one of them for the 1981-85 and 1986-90 periods and for the 1991-2000 decade was carried out; a search was made of the existing interrelations until 1990 with the Accelerated Program for the Development of Science and Technology in Cuba, which is executed in the framework of the Council for Mutual Economic Assistance, and with the State Main Problems Plan for 1981-85; a first outline was produced by the agencies participating in its elaboration and of the socialist countries from which the arrangement of cooperation plan were required.

The basic quality of this second variant lies in its dovetailing with the objectives of long-range economic development of the country. It can be asserted that practically all the objectives contained in the strategy of scientific and technological progress respond to tasks or development works established by the different branchs and sectors of the economy, even though there may be some aspects insufficiently discussed in this chapter.

It does not mean, however, that all the tasks of the scientific and technological development have been directly deduced from the productive development conceptions, since there is a set of science and technology problems of great importance and social value which are not established in this manner, such as the development of basic sciences, social sciences and medicine.

The second variant of the scientific and technological progress chapter was conceived within the managing-by-objectives approach, which begun with goals definition and argumentations of the scientific and technological development to be reached in order to solve certain long-range economy problems.

Once having made this analysis, during 1981 and 1982, in coordination with the USSR and other socialist countries, the 44 problems were restructured into 13 problems. Among these, the one corresponding to scientific and technological progress and the one corresponding to the territorial distribution of productive forces remained as the only global problems, and the other 11 were referred to the development of the main branches of the economy.

In this context, a third variant was elaborated in which the 15 first-level objectives were incorporated into four big complexes, representing the top priorities for R and D, which should be carried out through the provision of the necessary scientific and technological infrastructure and resources. These complexes are:

- Mineral and non-mineral natural resources, their derived economic activities and the natural environment.
- Chemical and energy related resources which include the sugar industry and its by-products.
- Mining-metallurgical-mechanical, which includes electronics.
- Support sectors: building, transportation and communications.

As the fourth stage in what concerns the scientific and technological progress, with the participation of the Academy of Sciences and more than three global and 10 branch agencies of the national economy and with the central management of the Academy of Sciences of Cuba and the Central Planning Board, all the available information is revised, the objectives and the scientific potential counted upon are precisely defined, and a new projection of human and material resources is made by five-years periods up to the year 2000.

In this stage a final definition of objectives and the resources necessary for the elaboration of the General Scheme of Development of our country is made, with emphasis in the process of integration, cooperation and specialization of its economy with the whole of socialist countries, CMEA members and specially the USSR.

The General Scheme of Development, as a logical prolongation and material concretion of the Development Strategy, turns itself to be the base of future five-years plans and, particularly, of the one corresponding to next 1986-90 period, and at the same time establishes the outline of what would be the first long-range perspective plan of our economy. This conceptions conveys a new quality in all the planning work in Cuba, with scientific and technological progress playing a main role in it.

NATIONAL EXPERIENCE IN PLANNING OF SCIENCE AND TECHNOLOGY IN CUBA: INSTITUTIONAL FRAMEWORK

INTRODUCTION.

One cannot speak of coherent and effective foreign policy towards the stimulation and progress of science and technology for development, without a well-defined and structured national policy for such a purpose.

This idea was clearly stated in the Vienna Programme of Action and it has been defended by Cuba since the preparatory process for the United Nations Conference on Science and Technology for Development.

The primary responsibility for directing the scientific and technological programmes with steps towards advanced stages of development, belongs to each country, whose governments must play the main role. Undoubtedly, the aim of the scientific and technological development should be the constant improvement in the quality of life for all people through their full participation in the development process.

For this purpose, it is necessary to create the structure capable of guaranteeing the conditions for a stronger technological capacity. The Cuban experience has shown that even through the external factors, such as financing and technology transfer, are needed for advancing scientific and technological capacity in the developing countries, the fundamental step has to be initiated through profound social and economic transformations. The existing social and economic structures in many developing countries are the main obstacles for achieving such objectives.

In the case of Cuba, science, as a factor of national priority, came to be recognised from 1959 with a revolutionary process of radically changing the social and economic structure which was formerly characterized by a dependent backwardness and under-development. Within the last 25 years Cuba has taken a great leap forward with respect to its science and technology programmes.

Presented by Carlos Fernandez de Cossio Dominguez

To start this process, it was necessary, first of all, to change and create to a great extent the concepts of what would be the science and technology policy.

The starting point was the development and implementation of the idea that science could not be created without a massive educational preparation that would incorporate the few professionals dedicated to science in the prerevolutionary years. A radical campaign was launched that erradicated illiteracy within only two years from the revolutionary triumph.

The second step was the massive training of professionals at a time when lack of professors and teachers was a serious problem. The solution had to be found utilizing the students themselves. A group of them were trained during extra hours so that they would be able in their third year to teach second year students.

As a result, in 1980 Cuba had more that 2 million university students with a staff of more than 10 000 teachers and professors at 40 universities. Before the Revolution there were just three universities in the country.

The Vienna Programme of Action establishes the principle that the ultimate goal of Science and Technology is to serve national development and to increase the well-being of humanity as a whole. Thus, as the Programme also recognizes, the components of science and technology should be included in the plans and strategies of national development as basic instruments for achieving the different aims of those plans and strategies.

The Cuban programmes have been devoted from the beginning to the socio-economic perspectives, to respond to existing needs and to establish conditions for development of industry, agriculture and society as a whole. Hence only illimited resources could be devoted to scientific programmes. Major portions of our foreign currency resources were used for creating and modernizing, acquiring and adapting new technologies obtained from international sources.

The three fields that have mainly received scientific attention and dedication are health, cattle breeding and the sugar cane industry. Cuba stands among the leaders of world research on sugar cane by-products. The purpose has been to apply these programmes to the solution of concrete problems. Cuba's scientific policy is not intended mainly to cope with world class research but rather to focus on the country's immediate needs.

we are at present penetrating new and important fields such as computers, production of interferon, tissue culture and biotechnology. Of important significance has been the creation of an institutional apparatus that would respond to these requirements and facilitate in a coherent and planned manner the formulation of the county's national scientific policy.

BACKGROUND OF SCIENTIFIC RESEARCH IN CUBA

Organization of scientific research at national level

Prior to 1959, there was hardly any significant scientific research in Cuba: The research centres were then concentrated in Havana City. Isolated efforts were made by the few high-level educational institutions existing. The National Commission of the Academy of Sciences of Cuba was established in 1962, thus initiating the promotion and fostering of scientific activities.

During the early years, Research and Development (R and D) centres were set up and the human and material resources allocated for sceintific programmes were increased. The Council for Agricultural Research (Consejo de Investigaciones Agricolas) and the Council for Sugar Cane Research (Consejo de Investigaciones Azucareras were set up. In the same decade the Calculation Plan (Plan Calculo), for computing development, was also established aimed at co-ordinating and monitoring the main sectors of the economy and constituted the foundation for the achievement of the current organization pattern.

This System was characterized by the decisions related to the national Science Policy which were closely related to those for social and economic development, thus ensuring proper correspondance between both policies.

The National Council for Science and Technology (Consejo Nacional de Ciencia y Tecnica) was set up pursuant to Law 1271 of 6 June 1974, for implementing the scientific policy at national level, working out scientific and technical research projects aimed at practical objectives, following the guidelines of the Revolutionary Government.

The most important activities of this National Council were:

- To get acquainted with the projects being developed in R and D institutions and their scientific and technical potentialities;
- To establish a standard terminology for scientific and technical research at national level;
- To carry out a preliminary survey of the scintific and technological activities in the country;
- To set priorities and work out the 1976-1980 five-year plan for science and technology;
- To work out primary methodological papers and standards for science and technology in the country;
- To co-ordinate scientific and technical activities so as to aim at common goals;

- To establish Scientific Councils and other collective organizations;

- To create the National Commission for the Peaceful Use of Atomic Energy.

A number of relevant measures were implemented, including: resolutions and instructions on scientific policy; the categories of higher-level teaching and research; and the setting up of the Ministry of Higher-Level Education.

During this period Law 1323 of 30 November 1976, relating to the Organization of the Central Administration of the State was passed. This Law stipulated:

- The emergence of three different organizations in the Central Administration of the State: State Committees (global control), Ministries and Institutes;

- The hierarchical organization of the scientific-technical activities by establishing the State Committee for Science and Technology (CECT), the State Committee for Standardization, the National Institute for Automatic Systems and Computering Techniques and to attach the National Bureau of Inventions, Technical Information and Trademarks to the above CECT:

- Compulsory setting up of Advisory Technical Councils in all organizations to render advise in the relevant fields of scientific and technical development; and

- Establishment of Divisions of Science and Technology in the various organizations.

The major tasks undertaken by the State Committee for Science and Technology were:

- To organize the National System of Science and Technology;

- To monitor the Main Research Tasks;

- To assess the local potentialities and the budget allocated to science and technology;

- To work out a plan for the accelerated development of science and technology in Cuba;

- To introduce a unique system of scientific and technical information;

- To follow up the development of scientific and technical research;

- To grant scientific positions to researchers;

- To establish and monitor the activities of the National Commission for Environmental Protection and Preservation of Natural Resources.

The National Policy for Science determines that the integration to the economic development is basically achieved by means of the Plan for National Economy. The fundamentals of short- and medium-term plans for scientific research and technological development are based on the guidelines worked out by the Academy of Sciences of Cuba in close co-ordination with R and D organizations and institutions. These guidelines, once approved by the Council of Ministers, are mandatory to the institutions responsible for R and D.

They are closely related to the strategy for the social and economic development of the country and are deemed as goals to be achieved by means of R and D subjects to be dealt with in order to give solution to the problems; thus, each social-economic guideline can originate one or several problems grouping a number of subjects.

At present, there are four categories of R & D Problems:

- Major Problems of the State;
- Major Problems in the field of Medicine;
- Major Problems in the field of Social Sciences;
- Major Problems in the field of Basic Research.

The four Major Problems listed above have been identified by the Academy of Sciences, which is responsible for co-ordinating and monitoring their implementation. The Major Problems of the State are approved by the Executive Committee of the Council of Ministers. Fifty three (53) of the said problems have been selected for the present five-year term. The Major Problems in the field of Basic Research are grouped under activities related to long-term strategic plans for the economy.

There are also the so-called Branch Problems which include those generally grouping subjects corresponding to an institution or organization. Thus, the level of co-ordination remains at a branch or institutional level. Likewise, there are research subjects which are not categorized as problems but which should be implemented in order to give an answer to the requirements of a given institution.

Budget allocation :

Expenditure on research and development increased over 95 million Cuban pesos in 1980, which represented an increase of some 30 per cent compared to the one achieved in 1977.

The national budget is the financing source for the R and D; for introducing their results in the economy and society; technical standardization; for formation of scientific cadres; for the formation of national network of reseach centres; and others.

At present, the financing of the R and D activity, for both current expenditure and investment, is primarily reflected in the indexes approved as directives within the five-year plan; which are aftewards specified in detail in the annual plan, as one of the sections of the National Economy Annual Plan.

Interrelation among the research and development organizations :

In January 1980, by Decree Law number 31, the duties of the State Committee for Science and Technology were assigned to the Academy of Sciences of Cuba for improving the organization of the Central Administration of the State and making easier its co-ordination and control mechanisms. Since then, it is directing the scientific and research activity at national level and is responsible for the activities carried out in 22 research institutions. The duties of the Academy of Sciences are the following:

(a) Working out the plan of the scientific-technical progress and monitoring its implementation; as well as, recommending the approval of budget proposals for scientific research works and the scientific-technical services proposed by the members of the relevant State administration system.

(b) Approving the main problem plans for scientific and technical research and the scientific-technical services in the country; monitoring and implementing them and proposing to the government the setting up, the changing and abolishment of the institutions devoted to the scientific-technical research and services.

(c) Proposing and monitoring the plans for the introduction of the achievements of the scientific-technical activity in the social practice.

(d) Establishing the standards and procedures related to planning, organization and control of the science and technical activity in co-ordination with the members of the relevant State administration system.

(e) Co-ordinating and controlling the national system of Environment Protection and that of the rational use of natural resources.

(f) Establishing, directing and controlling the development and improvement of the National System of Scientific-Technical Information.

(g) Establishing, directing and controlling the record of patents requests resulting from innovations, industrial models, other trademarks and forms of industrial property of national and foreign applicants, approving the documentation of the technological projects of its competence and directing and organizing the experts committees for their assessment.

(h) Directing, supervising and controlling the application of the scientific category system.

(i) Promoting, guiding and controlling the development of scientific and technical organizations and societies.

To perform the above-mentioned duties the Academy of Sciences of Cuba has the following structure:

- Five divisions and two independent departments which are in charge of different activities related to the management of science and technology at national level.

- Three divisions and six independent departments to handle internal affairs and to execute scientific and development activities.

- Commissions for the preservation of the environment and the rational use of the natural resources, commissions for the co-ordination of cosmic research, for the granting of categories to research workers and for the co-ordination of the national system of scientific and technical information.

- Twenty-two scientific research institutes, a National Network of Historical Records, a network of Scientific-Technical Information Centres, eight museums of natural sciences, archeology and history, three zoological gardens, an aquarium and several scientific facilities all over the country.

The Institutes are grouped by fields of science according to the work to which they are devoted. These fields are the following: agricultural science, biological and chemical sciences, physical-technical and mathematical sciences, soil sciences and social sciences. The Academy of Sciences also has an Institute of Documentation and Technical-Scientific Information and Trademarks.

The Institutes and the rest of the scientific research units direct and control, at the national level, the following research and development activities in their respective areas of sciences:

The study of Cuba's natural resources that is soil as well as sea resources, their characterization and national use, including the detection of new resources and the development of new methods for their use.

- The preservation of environment and the protection of the human activity, which include the study of environmental pollution as well as the means to forecast certain natural phenomena and struggle against them.

- The laying out of the scientific foundation for agriculture, comprising the study of the soils in Cuba, ecological research, the procurement of new varieties of plants, the protection of these plants against plagues and diseases, the development of modern agrotechniques and other fields, making special emphasis in studying the sugar cane and other important crops for our country.

- The development of the scientific foundations for industry and communications, which include, among other things the introduction and assimilation of modern knowledge and technology, the studies on the propagation of electromagnetic waves at great distances through the ionosphere; the assessment of the technical and economic possibilities of using the solar energy in Cuba; the principles and applications of the quantum electronics and the studies and research leading to the pacific use of nuclear energy.

- The improvement of the National System of Scientific and Technical Information and the development of the scientific foundation for the application of electronic computing at directing the economic and technological process and the scientific and research activity.

- The study and research of the social, historical and other processes taking place in Cuba, as well as in the rest of Latin America and North America.

The functional divisions have close and systematic working relations with the directing organizations and institutions in the field of activities related to science and technology such as: the Ministry of Higher Education (Ministerio de Educacion Superior, MES), The Central Planning Board (Junta Central de Planificacion, JUCEPLAN), the State Committee of Finances (Comite Estatal de Finanzas, CEF), the State Committee of Statistics (Comite Estatal de Estadisticas, CEE), the State Committee of Economic Co-operation (Comite Estatal de Colaboracion Economica, CECE) and others; they are also related to the branch organizations through the different branch divisions of the Academy of Sciences.

Besides the organizations and institutions mentioned above, the Academy of Sciences assembles the outstanding scientists and tchnicians of the country in their relevant collective bodies such as the following:

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The Higher Scientific Council, organized in scientific sections, which are composed of experts and researchers of the institutions of the Academy of Sciences and other organizations is the governing scientific body, which has been established to give advise to the Executive Council of the organization in the formulation and assessment of prospects and trends in the implementation of scientific problems and subjects dealth with by the Academy.

The members of the Higher Scientific Council hold plennary meetings to discuss the general problems. They also meet, by field of specialization, to advise the five sections of scientific activity of the Academy.

Branch Scientific Councils: Each branch of the Academy of Sciences has its own Scientific Council, composed of senior scientists and technicians of their respective branches. They support the various branches in the direction and implementation of their respective activities. Some functional divisions also have their own Scientific Councils.

Commissions for Problems: A Commission, whose Chairman is responsible for the solution of problems before the Academy of Sciences, is established for the control and analysis of each Major Problem of Research.

Intercosmos Commission: This Commission is to foster the development of research in outer space and its use for peaceful purposes, the coordination of work carried out in this field, the promotion of the country's involvement in organizations and programs dealing with international cooperation and the follow up of the implementation of the corresponding international commitments.

Council for the Coordination of the National System of Scientific and Technical Information :

Composed of representatives of concerned organizations it supports the coordination of activities carried out for the organization and implementation of the system. A bureau, under this Council, is constituted by 10 organizations and 5 working groups.

Procedures for the allocation of resources for the various areas of research :

In order to finance the current expenses and the annual budget, the necessary funds are allocated to each organization for the corresponding year upon the basis of the average number of workers, salaries and wages and other expenses broken down in items.

The projects are worked out by R and D institutions. Upon the review of these projects by the corresponding organizations, they are submitted for approval to the governing bodies of the National Economy.

In approving the funds for the implementation of the R and D plans the following objectives are kept in view:

- To lay emphasis upon applied research and development activities without prejudice to the development of necessary basic research nor to those necessary for the prospective economic and social development of the country.
- To upgrade the organizational structure of research activities and to analyse the feasibility of attaching R and D centres to enterprises with high technical and production levels.
- To pay special attention to research activities aiming at the procurement of new sources of local raw materials and at a better use of the existing raw materials.
- To follow up geological prospecting, exploration and development so as to maximize the exploitation of mineral resources.
- For research and development relating to new energy resources and for more efficient use of traditional ones.
- To estimate the increase in the effectiveness and yields of agricultural crops intended for industrial use, sugar cane in particular.
- To improve the efficiency in the better use of natural resources, in particular soils and water resources.
- To asssess the use of industrial by-products and wastes.
- To accelerate the design and to build a Centre for Nuclear Research, with necessary equipment and personnel to undertake relevant studies and research.
- To complete the stages of study of the integral transportation plan aiming at achieving the maximum use of every transportation means available.
- To concentrate efforts in the fulfillment of the plans of major problems of the country and in the development of subprograms for Science and Technology, agreed upon within the CMEA context.
- To ensure that international cooperation relationships are in full agreement with the scientific and technical guidelines directed to the solution of national economy's major problems.
- To start implementing and developing the National System for Scientific and Technical Information and to ensure its efficiency.

- To make a periodical evaluation of the results of research and its implementation at social level, by monitoring the plan of national economy.

- To work out a financing instrument for scientific and technological activities within the framework of the System of Management and Planning of the Economy (SDPE). Enterprises and ministries are to contribute to the above financing.

- To pay special attention to the intensive introduction of computer techniques and R and D activities aimed at the production of the necessary equipment, in particular, to support the SDPE and in the thrust towards automatic production processes.

- To foster the organization of amateur scientists, taking care of the field of activity and contents. To continue supporting the National Association for Innovation and Rationalization as well as the Youth Technical Brigades.

- To intensify the scientific and technical upgrading of personnel involved in R and D; training of new cadres, in particular, in those branches on which the scientific and technical progress exerts more influence.

Principal Scientific Institutions :

- Central Planning Board
- State Committee for Economic Cooperation
- Academy of Sciences of Cuba
- State Committee for Standardization
- State Committee of Finances
- Ministry of Education
- Ministry of Higher Education
- National Institute for Automated Systems and Computation Techniques

Third Implementation Level of S and T activities :

There is a total of 100 centers which carry out the scientific and technical activities of the country.

No. Organization and Institutions

<u>Central Planning Board (2)</u>

1. Institute of Economic Research
2. Department of Integral Transportation Development

<u>State Committee for Standardization (2)</u>

3. Institute of Research and Metrology
4. Institute of Research and Standardization

State Committee for Labour and Social Security (2)

5. National Institute for Scientific Labour Research
6. Institute of Labour Protection

Academy of Sciences of Cuba (22)

7. Institute for Sugar Cane Research
8. "Alejandro Humboldt" Institute for Fundamental Research in Tropical Agriculture
9. "Jorge Dimitrov" Agricultural Research Institute
10. Institute of Soils
11. Institute of Meteorology
12. Institute of Fundamental Technical Research
13. Institute of Geography
14. Institute of Geophysics and Astronomy
15. Institute of Geology and Paleontology
16. Institute of Scientific-Technical Documentation and and Information
17. Institute of Experimental Chemistry and Biology
18. Institute of Oceanology
19. Institute of Zoology
20. Institute of Botanics
21. Institute of Fundamental Research of the Brain
22. Institute of Mathematics, Cibernetics and Computation
23. Institute of Nuclear Research
24. Institute of Social Sciences
25. Institute of Literature and Linguistics
26. Centre of Studies of History and Science Organization
27. Centre of Philosophical Studies
28. National Archive

Ministry of Agriculture (14)

29. Centre of Genetical Research and Improvement
30. Experimental Centre for Root-crops and Vegetables
31. Centre of Poultry Research
32. Central Institution of the Research of Coffee Crops in the "III Frente"
33. Centre of Porcine Research
34. Experimental Centre of Tobacco Crops
35. Institute of Plan Protection
36. Institute of Soils and Fertilizers
37. Institute of Agriculture Mechanization
38. Research Centre of Pasture and Fodder "Nina Bonita"
39. Institute of Irrigation and Drainage
40. Rice Experimental Centre
41. Centre of Forestry Research
42. Fruit Crop National Centre

Communication Ministry (1)

43. Telecommunication Central Laboratory

Ministry of Construction (2)

44. Experimental and Research Centre of Construction
45. Laboratory of Hydraulic Patterns

Ministry of Education (2)

46. Central Institute of Pedagogical Sciences
47. Science and Infancy

Ministry of Higher Education (23)

48. National Centre of Scientific Research
49. Centre of Energy Research
50. Research Centre of Microelectronics
51. Centre of Research of Building Materials and Techniques
52. Centre of Hydraulic Research
53. Centre of System-Engineering Studies
54. National Centre of Animal Health
55. Institute of Animal Science
56. Institute of Agricultural Science
57. "Jesus Menedez" Sugar Cane Experimental Station
58. Centre of Agricultural Mechanization
59. Centre of Demographic Studies
60. Centre of Research of International Economy
61. Centre of Informatics Applied to Management
62. National Botanical Garden
63. Laboratory of Marine Research
64. Laboratory of Solid-State Electronics
65. Institute of Informatics
66. "Alvaro Barba" Experimental Station
67. Experimental Station of Zootechnics
68. "Pedro Lantigua" Experimental Station of Sugar Cane
69. "Indio Hatuey" Experimental Station of Pastures and Fodder
70. "Tomas Roig" Agricultural Experimental Station

Ministry of Food Industry (1)

71. Research Institute of the Food Industry

Ministry of Sugar Industry (2)

72. Cuban Institute of Sugar Research
73. Cuban Institute of Research of Sugar Cane by-products

Ministry of the Basic Industry (4)

74. Research Centre of the Metallurgical and Mining Industry
75. Centre of Geological Research
76. Centre of Chemical Research
77. Centre of Electromagnetic Research

Ministry of the Light Industry (1)

78. Laboratory of Quality Research and Inspection

Ministry of the Fishing Industry (2)

79. Centre of Fishing Research
80. Fishing Products Development Centre

Ministry of the Sidero-Mechanic Industry (3)

81. Centre of Metallurgical Research
82. Research Centre of Machine Construction
83. Institute of Refrigeration and Climatization

Ministry of Public Health (15)

84. Institute of Health Development
85. Institute of Angiology
86. Institute of Neurology and Neurosurgery
87. Institute of Occupational Medicine
88. Institute of Nephrology
89. National Institute of Cardiology and Cardio-vascular Surgery
90. Institute of Endocrinology and Metabolic Diseases
91. Institute of Gastroenterology
92. Institute of Hematology and Immunology
93. Institute of Oncology and Radiobiology
94. Institute of Hygiene, Epidemiology and Micro-biology
95. Institute of Tropical Diseases
96. Centre of Experimental Surgery
97. Centre of Cibernetics Applied to Medicine
98. Research Centre for the Production of Drugs

National Institute of Physical Education, Sports and Recreation (3)

99. Centre of Technical Development of the Production
100. Research Laboratory of the Higher Institute of Physical Culture "Comandante Manuel Fajardo"
101. Institute of Sport Medicine
102. Institute of Sport Research and Informatics

National Institute of Automatized Systems and Computation Techniques (1)

103. Central Institute of Digital Research

Local Popular Power (1)

104. "Martinez Villena" Laboratory of Livestock Research

Ministry of Culture (3)

105. Centre of Music Research and Development

106. Centre of Polgraphic Development, Experimentation and Control

107. Centre of Studies of Marti's works

State Committee of Statistics (1)

108. Institute of Statistical Research

Ministry of Transportation(1)

109. Institute of Transport Research

State Committee of Technical and Material Supply (1)

110. Centre of Research and Development of Technical and Material Supply

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FIVE-YEAR SCIENCE AND TECHNOLOGY RESEARCH PLAN OF EGYPT

HISTORY OF SCIENCE AND TECHNOLOGY IN EGYPT

Until the establishment of the Academy of Scientific Research and Tecnology (ASRT) in 1971 by Presidential Decree No. 2405, the General Organization of Scientific Research went through the following basic historical stages:

1948-1956: Developed the first government-sponsored institution of scientific research in Egypt, i.e. the National Research Council (NRC). Its main thrust was the completion of necessary infrastructure such as the establishment of the NRC's laboratories.

1956-1961: The Supreme Science Council whose main task was the organization of science in Egypt. The Council's members were a number of ministers and competent scientists. They were required by the Council to develop the first "Scientific Research Plan" which was made up of a number of ambitious national research projects distributed over different scientific institutions such as universities, specialized institutes, etc.

1961-1965: A new national ministry: The "Ministry of Scientific Research" developed in 1961 to supersede the previous Council.

1965-1968: The Supreme Council of Scientific Research came into existence in 1965. However, the re-establishment of the Ministry of Scientific Research in 1968 resulted in the abolition of the Supreme Council of Scientific Research.

SCIENCE AND TECHNOLOGY INFRASTRUCTURE

The first attempt at drawing a framework for national scientific research began about 25 years ago when the "Supreme Science Council" prepared through its 8 commissions in 1960, a plan which included a number of research projects in different fields.

This paper was written by Aboul-Fotouh A. Latif, Vice President, and Ahmed I. Naguib, Director, Specialized Councils' Affairs, ASRT, Egypt and presented by A.I.Naguib.

1971: In 1971, by Presidential Decree No. 2405, the ASRT was established as Egypt's main and official body for Science and Technology.

The second attempt took place in 1966, when the Supreme Council for Scientific Research prepared a list of research priorities. Technical Committees were established to study and formulate each project.

Previous attempts in R and D planning failed to attain their goals, although they focused on what seemed to be national needs or problems, mainly because:

- they failed to integrate themselves with the users (initial, intermediate and/or final);

- they were geared to support self-interest objectives of a select few (mainly University Staff) at the expense of the rest of the Society;

- they were rather ambitious as regards the budget requests, the problems listed and the national potential and capabilities then available as regards research personnel, institutions and equipment;

- the suggested problems did not directly serve national goals, pressing needs or immediate priorities and were of no utility to the community of users.

Therefore, the net result of those previous attempts was that the available resources were mostly directed to meet incoherent problems.

Generally, the milestones of S and T at present in Egypt are the following:

Research Facilities:

Egypt with its 47 million population has established 12 Universities with research departments in several disciplines in addition to the research facilities and institutions attached to the various ministries and the Academy of Scientific Research and Technology. There are 265 such facilities.

S and T Personnel:

The total number of students in the University is 530 000 with an annual enrollment of 90 000 students of which about 80 000 graduate each year. Of the yearly output of University graduates, the Scientific and Technical personnel in Egypt with post-graduate qualifications such as diploma, master's or doctoral degrees, consists of about 44 500 persons. Egypt also avails itself of the services of its graduate nationals residing abroad through the project entitled Transfer of Knowledge Through Ex-patriate Nationals (TOKTEN) in collaboration with UNDP.

Non-Governmental Organizations (NGOs):

The Scientific Community in Egypt enjoys the membership of 90 scientific societies in various fields and disciplines. In addition, Egypt is a member of 30 international (non-governmental) Scientific Unions, Associations and/or Committees.

Foreign Links:

Egypt is also currently party to several treaties of S&T co-operation with UNDP, OAU, EEC, Austria, Brazil, China, Czechoslovakia, the Democratic People's Republic of Korea, France, German Democratic Republic, Germany, Federal Republic of, Poland, the Republic of Korea, Romania, the Sudan, Turkey, the United Kingdom, the United States and Yugoslavia.

AUXILIARY S and T SERVICES

Information:

Four such facilities belong to ASRT, namely: National Information and Socumentation Center (NIDOC), Patent Office, Statistical Information Division of the Office for Innovation and Discovery. A National Information Network (ESTINET) is being established at present in collaboration with the United States Agency for International Development (USAID), housed at the Academy and with five separate nation-wide nodes covering the areas of agriculture, industry, health and medicine, S and T, energy.

Another data bank concerning the information on ASRT and its institutions, various activities and personnel, in collaboration with International Business Machines (IBM) is also housed at ASRT.

Instrumentation, Repair and Maintenance:

Nine such facilities exist at present:

- The Scientific Instrumentation Center (ASRT).
- Center for Biomedical Equipment, Ministry of Health, Abbassia.
- Workshops at National Research Center and six Universities.

Standards and Measurements:

Two facilities exist at the National level:

- The National Institute of Standards (ASRT).
- The Egyptian Organization for Standardization (Ministry of Industry).

Extension and Innovation Services:

Several such facilities exist on the national level:

agricultural experiment stations, pilot plants at the National Research Centre, universities and industry;

Engineering and Industrial Design Development Centre, Ministry of Industry;

university polyclinics;

CENTRAL S and T PLANNING, FUNDING AND MONITORING

The ASRT is the existing body at the highest level of Egyptian Government which has the understanding and competence to shoulder the responsibility of integrating R and D planning at the national level. The Structure, institutions and services of ASRT are shown in figs. 1 to 3.

Its main functions are as follows:

- to enhance the contribution of Egyptian scientific capabilities to development;
- to bridge the existing gap between scientists on the one hand and industry, agriculture and other sectors on the other;

For fulfilling the stipulated nation-wide role of ASRT, conforming to its previously mentioned multi-organizational links, an Academy Council - its supreme legislative organ - is formulated as shown in Table I.

The ASRT's major terms of reference are as follows:

- To support research directed towards solving problems of national interest.
- To encourage application of modern technology.
- To formulate policies that strengthen linkages between science and technology organizations.
- To co-ordinate the major research projects of various research institutions or departments.
- To define priorities for research in scientific and technological aspects of major development areas.
- To encourage basic research and support research schools.
- To participate with universities in manpower development for training of researchers in specific areas.

- To organize State Awards in branches of science.

- To disseminate information concerning the potentialities of international modern technology.

- To support scientific societies.

- To develop international relations in science and technology.

Table 1

THE ACADEMY COUNCIL OF ASRT

Chairman: President of ASRT
Members : 12 University Rectors
15 Ministry Representatives:
- Planning
- Finance
- Economic Co-operation
- Agriculture
- Irrigation
- Land Reform
- Electricity and Energy
- Petroleum and Mineral Resources
- Education
- Higher Education
- Health
- Transport and Communication
- Construction and Housing
- Insurance and Social Affairs

3 Directors of the largest research institutes:a/
- National Research Center
- National Institute of Sociological and Criminological Research
- Atomic Energy Authority

1 Representative of Union of Scientific Societies b/

10 Members appointed by President of ASRT c/

2 Vice-Presidents of ASRT.

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a/. Representatives of national and multidisciplinary areas and and interests.
b/. Representative of non-governmental organizations.
c/. Appointment only of persons of high calibre on personal merits.

Academy Council:

The policy-making body of the Academy is its Council. Its resolutions are generally based on recommendations submitted by the Specialized Research Councils and Principal Committees on matters concerning scientific research and technology.

The Academy Council is headed by the President of the Academy. The membership reflects the national responsibility and relations with other Egyptian agencies.

Principal Committes:

Three committees are functioning at the present time, namely, Scientific Relations, Technology Policy and Scientific Publications.

Specialized Research Councils:

These councils carry out the Academy functions in planning and co-ordinating scientific research at the national level. They are concerned with all the scientific, technological, economic and social activities which are related to the Council's field of interest. For this reason, each Council constitutes an integrated team of members selected from scientists and technologists in the various disciplines from various ministries, research institutions, universities and users. At present, about 1000 members, belonging to the Specialized Councils and their affiliated 50 divisions and 24 committees are involved.

The Councils are:

Resources and Production

1. Food and Agriculture
2. Industry
3. Petroleum, Energy and Mineral Resources

Services

4. Health and Medicine
5. Environment

Infrastructure

6. Transport and Communications
7. Construction and Housing
8. New Settlements

Socio-economic Development

9. Management and Economics
10. Social Sciences and Demography

II. Basic Sciences

To have access to the concerned governmental bodies and institutions, whereby the problems could be brought to the attention of the scientific community and the results of research projects could be directed to the users, the Academy's hierarchy included the following four interrelated structures (supervised by the Vice-President of ASRT for Specialized Councils):

- Sector of Specialized Councils' Affairs.
- Sector of Technical and Financial Monitoring and Follow-up.
- Sector of R and D links (12 Universities, Regional Research Centres for Integrated Development).
- Marketing Directorate.

The Academy Conferences and Meetings:

In order to mobilize the scientific efforts of the members of the scientific community in the country and to obtain general consensus on Academy plans and procedures, two types of general conferences are held every year:

(a) Each Specialized Research Council convenes a conference to which it submits its progress report and future plans. The President of the Academy nominates the members (200-250) of each conference.

(b) The Academy convenes its annual conference to which it submits a progress report and the outline of the future plans in the different fields. This conference is attended by all members of the Specialized Research Councils and other scientists and technologists invited by the Academy Council, the total number being about 1500-2000.

(c) Symposia held by ASRT to discuss special issues related to national development or research trends and impact of their results on development (Attendance: 50-100).

ASRT Research Grants and Need for Planning:

Since 1974, the ASRT has introduced the contracting system with national research bodies, in universities, research institutions and ministries. More than 200 grants were provided in the different fields including basic sciences, agriculture, industry, energy, transport, construction, social sciences, etc. The evaluation of ASRT experience in contracted research could be summarized in the following:

- lack of organized focus of S and T capacity on economic services with limited access to S and T information;
- projects were generalized and incomplete, several without a time schedule for implementation and priorities.

- the plans were not integrated by the Specialized Councils;

- lack of multidisciplinary, multi-sectoral projects; and there was also a shortage in management, control, reporting and monitoring;

Therefore, to overcome these difficulties or bottlenecks and rationalize the available human and financial resources, a planned research programme appeared necessary, especially after the establishment of the ASRT. When the national institutions became familiar with the role of ASRT, the relations become increasingly stronger. The idea of the 5-Year S&T plans has thus evolved.

The Academy Council in January 1982 resolved that the Specialized Councils formulate the necessary scientific research plan to meet the requirement of having scientists and technologists participate in solving the problems of the society and in implementing the plans for social and economic development. The plan should be based on the present situation with projections for the future, taking into consideration world conditions and challenges facing Egypt both nationally and internationally.

The 5-Year Plan by ASRT Council Resolution is adopted as the basis for foreign co-operation.

THE FIVE-YEAR S and T PLAN

Specialized Councils Division:

The actions of the Specialized Research Councils comprise the arena within which R and D planning takes place. Councils with membership from research and users sectors serve research and development, science and technology planning. The five-year plan focuses on identifying the role of S and T, on setting priorities and organizing international inputs to serve national goals.

The research councils strengthen and support S and T services through:

- information
- extension
- instrumentation, and
- standards.

R AND D LINKS

Linkage with the Universities:

A Linkage Committee has been developed by ASRT with all universities in Egypt and its structure is shown in table 2.

Table 2.

Chairman: President of ASRT

Members: 12 University Deputy Rectors for Research and Post-Graduate Studies.

1 Vice-President of AUC for Research and Post-Graduate Studies.

1 Secretary-General, Supreme Council of Universities.

1 Vice-President ASRT for Specialized Councils

3 Representatives of Military Academy and Central Organ for Mobilization and Statistics.

1 Under-Secretary of State for Specialized Councils' Affairs.

3 Directors of Scientific Statistics Department, NIDOC and National Information Network Project, ASRT.

Links with Local Government Units:

Egypt is divided into eight integrated economic regions, shown in the accompanying map (Fig. 4). It was decided to establish eight R and D Centres directed to achieve integrated regional development through:

- identification of problems hindering development;
- maximizing the utilization of regional resources;
- adaptation of available S and T know-how;
- effective application of S and T to serve regional development plan;
- legislative, organizational and managerial measures.

The Perspectives of the present 5-Year R and D Plan:

The following aspects are reflected in the present five year plan:

- the national responsibility of ASRT;
- the involvement of over 1000 top-level specialists and expertise in the activities of the Councils;

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- the obligation of the Scientific Community to contribute to the National Development Plan;
- gearing research work to national problems and needs;
- research results should have a user;
- technical ministries should be closely linked with or approve the proposed Plan;
- R and D work to coincide with the national socio-economic *development;*

The plan in this manner places emphasis on the role of the research worker and best possible investment of the available resources. The Specialized Councils, while presenting this document consider it as a means towards their active participation and effective performance in solving the problems of socio-economic development in Egypt.

Initial Phase (1981):

- Careful review of past activities, meetings and conferences from 1974-1981 (a total of 17 volumes, 2258 pages).
- An overview of the needed research projects to bridge existing gaps.
- Careful study of the respective strategy in 12 volumes of National 5-Year Plan for Socio-economic Development.
- Coordination between the Specialized Councils in topics of common interest.

Preparatory Phase (1982):

The Specialized Councils, their offices, divisions and committees held 403 meetings during the period January/September 1982. The time spent in the preparation of the 5-Year research plan amounted to 9090 man-hours in addition to approximately 30000 man-hours spent in the preparation of the working papers by experts and minutes of meetings, documents and conferences of the councils.

Each Minister, in his respective capacity, then reviewed the plan which was later presented to the implementing agencies and to all interested parties at the conferences (general assemblies) of the respective Councils. The necessary amendments were made and the 5-Year research plan was passed by the Academy Council on October 14, 1982 (39th session), Resolution No.505.

Approval by Higher Authorities:

By December 1982, the final 5-Year Plan of Specialized Councils (1983-1987) was published in a 414 pages volume which was sent to the concerned ministries for approval and to the Ministry of Planning for allocation of requested funds. The Council of Ministers allocated LE. 112 million for the 5-Year Plan of the ASRT including LE. 30 million specified for the 5-Year Plan of the Specialized Councils.

S and T is thus no longer a marginal activity but an inseparable compnenet of the National Development for which 1.3% of the GNP on the national level is allocated.

December 19, 1982, marked a crucial event in the history of R and D Planning in Egypt when the 5-Year S and T Research Plan of the Specialized Councils was presented to President Mobarak at Qubbah Palace during his meeting with the Academy Council.

Directives for implementing the 5-Year R and D Plan

- to maximize the values of planning, monitoring and control;
- to maximize the utilization of all marketing research results to improve productivity both quantitatively and qualitatively;
- to ensure sufficient information to enhance public awareness;
- to set priorities according to the following criteria:

  . meeting immediate needs of the society;
  . integration and co-ordination with national S and T potential.
  . timing with the implementation schedules of the 5-Year Plan;
  . Volume of endeavour to solve national problems.

New Structures (Inter-Council Committees):

Following the Five-Year Plan, certain multi-disciplinary projects were presented treating critical problems in the following domains:

- Development of rural areas.
- Potable water and sewage.
- Food industries and nutrition.
- Urbanization and magalopolis.
- Sinai development.

Implementation:

In March 1983 the Academy Council adopted the resolutions regarding the implementation of the 5-Year S and T Research Plan. The Specialized Councils identified the first-year priorities of their research projects outlined in the Plan. Public notice of those selected priority projects was made during the period from April-October 1983.

The statutes and regulations governing the whole process of implementation were published by the end of April 1983. This booklet also contained the necessary details of selection criteria of research proposals to be contracted upon, in addition to the procedure to be followed for management and follow-up of contracted research.

Overall Follow-up & Executive Committee of 5-Year Plan
Chairman : President of ASRT.
Members : 11 Chairmen of Specialized Councils.
2 Planning and Finance Ministries' representatives.
1 Vice-President of ASRT for Specialized Councils.
1 Under-Secretary of State for Specialized Councils Affairs.

Present and Future Highlights:

- practising the national role of ASRT as it should be;
- better definition of national problems and projects in terms of needs;
- enough courage and experience to address multi-sectoral maxi-projects;
- rationalizing the efforts of Council members stressing their national role.
- establish confidence in the role of scientific research to solve national problems;
- establish a sound basis for proper R and D management;
- upgrading the contracting system and rationalizing available resources to ensure maximum returns;
- raising competition between scientific schools and agencies, devising new concepts in organizational hierarchy;
- the 5-Year R and D Plan is the corner-stone in foreign cooperation.
- readiness for future plans as part of long term R and D planning.

CONCLUDING REMARKS

Policy guidelines are stipulated in the terms of reference, goals and major functions of ASRT. In elaborating the 5-Year Research Plan, ASRT followed the committee-expert-evaluation approach. The 5-Year Research Plan is the output of ASRT organizations, Specialized Councils and Academy Council, whose members are drawn from universities, R and D committees in executive ministries and Academy Specialized Research Institutions taking into consideration the studies of the Specialized National Councils (Advisory to the President of the Republic).

Fundamental research is the main function of universities to satisfy scientific curiosity and contribution to development of science in general. It represents 60% of R and D efforts of the universities. At ASRT, 10% of funds available for R and D are devoted to fundamental (preferably oriented) research.

ASRT's Principal Committee on Technology Policies held several meetings, 3 national and 3 international seminars over a 3-year 2650 period in the sectors of industry and agriculture. ASRT's 5-Year Plan includes some projects on the economic and social effects of new technologies. However, there are as yet no organization dealing specifically with for S and T forecasting.

1.2% of gross national product is earmarked for S and T in 5-Year National Plan for Socio-economic Development of which LE. 30 million is stipulated for ASRT research projects.

S and T policy depends on planning, legislation, financing, scientific research and technology application, technology transfer at the beginning, selected areas as leading sectors, quality control of product, cultivating appropriate atmosphere for technological development, continued managerial and administrative amelioration as a basis for controlling productivity and future technologies and these aspects needs careful attention for future development.

This is the first time a 5-Year S and T plan which can contribute to Egypt's development has been formulated to help the development of Egypt. It is the product of an enormous effort in the ASRT, with careful attention to include the views of other ministries, universities, industry and with the active collaboration of the Ministry of Planning at each stage of preparation. Following its publication, there were several impressive manifesttions of political support for the plan, including the endorsement of the Council of Ministers and personal meeting with President Hosni Mubarak to address the Academy Council and express his enterest in and support for S&T.

The 5-Year S&T plan is a significant achievement and a step forward in asserting ASRT's visibility and influence in Science and Technology affairs. The plan also gains credibility in being derived from Egypt's national 5-Year Development Plan. Full implementation is under way.

Annex 1

EGYPT'S ASRT 5-Year S&T Plan

1. <u>Food and Agriculture</u>

- To maximise the use of land and water resources and and climatic conditions to raise production of field and fruit crops.
- To implement the scientific approach in agricultural practices especially for production of strategic crops.
- To intensify the vertical expansion through the use of hybrid, high-yielding and fast-growing seeds.
- To expand mechanisation on the farms.
- To control plant diseases integrating plant protection, plant production and environmental aspects.
- To study the water requirements for different crops suitable for the expansion areas comparing various irrigation systems.
- To increase local animal production, aquaculture and non-conventional sources of food.
- To raise the level of nutrition and to assure that food (local and imported) reaches the consumer in good condition and high nutritive value.
- To integrate rural development.
- To improve rural industrialization to raise the farmers' income and prevent migration to the cities.
- To intensify and co-ordinate agricultural extension services and solve problems concerning agricultural labour.

2. <u>Industry</u>

- To develop new products using up-to-date technology.
- To improve the quality and minimize waste.
- To use local raw materials.
- To recycle factory wastes economically.
- To replace imported raw materials with local ones. 2650

Industries covered are:

Chemical, Metallurgical, Engineering, Electrical and Electronic, Textile, Food, Construction Materials and Ceramic.

3. Petroleum, Energy and Mineral Resources:

- To improve the performance of oil products and rationalise their consumption.
- To intensify exploration for oil, natural gas, coal and uranium.
- To maximize the use of available hydro-electric energy and rationalise energy consumption.
- To determine the potentialities of non-coventional sources of energy; solar and wind.
- To complete the geological map of Egypt especially for magnetic fields.
- To explore for other mineral deposits, potassium salts and radio-active deposits.
- To extract uranium from phosphates.
- To prepare alum from desert clays.

4. Health and Medicine:

- Nutrition research, problems of malnutrition to establish a sound nutrition policy.
- Basic research on health protection and diseases such as bilharzia, tuberculosis, asthma, eye, liver and cardic diseases, diabetes and cancer, environmental health, emergency services for medical care.
- Diseases of old age (senility) and infancy; ways and means to raise the life span of the individual.
- To improve the standard of services in hospitals and medical establishments, revise medical legislation to cope with new development.
- Basic medical sciences up-dated with world trends both clinically and applied aspects; effects of medical education in Arabic and reduction of curricula on the clinical competence of the medical students.
- Upgrade the manpower working in the medical field; research workers, assistants, paramedics and nursing staff.

- Drug research to develop and determine the clinical application of new drugs from plant and industrial sources.

- To develop local technology to manufacture drugs from intermediate and imported sources.

- To determine the long range consumption of drugs, raising their efficiency and determining production needs; rationalizing their use through studying the chemical reactions between drugs, common foods and endemic diseases.

- Storing drug research data to avoid duplication.

- Developing milk subtitutes in relation to food security,; medical contituents from raw materials;
- Medical research for Sinai: complete medical survey of medicinal plants, survey of posionous pests, availing emergency medical services to residents and tourists, hazards of mining industries, determing the percentage of flourine in drinking water.

- Research in biomedical engineering and application of radiation technology.

- Problems of rising demands for dental care in Egypt.

5. Environment:

- The plan comprises of 3 vertical sectors: protection of the environment from pollution; health; and natural resources; and 5 horizontal inter-related sectors: education and training; models and systems; environmental legislation; social; and economic studies.

- To raise public awareness on evironmental consciousness in scientific and popular media.

- To prepare maps of natural resources and design the style of both developing and exploiting them.

- To review present national legislation on evironment to fill in existing gaps and devise ways and means to implement them effectively.

- Techniques for treating potable water and liquid industrial wastes, water recycling for agricultural purposes.

- Occupational Health Research: different industries and different locations, survey changes in blood enzymes.

- Natural Resources: a national network for protection of nature, a national bank for known natural genetic resources. To evaluate the deterioration of irrigated land due to soil pollution. To map environmental capacity of natural resources.

- Environmental Education: support environmental education courses throughout the education system. To prepare research programs in mathematical models, data, economy, environmental legislation and social studies related to environment.

- National programs on handling solid wastes and on sand dunes and desertification.

- Air pollution.

- Environmental side-effects of Qattara Depression project.

6. Transport and Communications:

- To solve problems in national transport (rail, road, maritime, fluvial, and air transport) international transport (air and sea) and communications (wire and wireless services and mail).

- To solve problems in transport such as freight transport and port congestion to meet the needs of social economic development and increasing population.

- To link and co-ordinate the activities of the Council with the end-users on the national level.

7. Construction and Housing:

- Rural housing and rural development planning.

- Urban housing.

- Desert architecture, house-planning and design, housing conglomerations, use of solar energy in heating, improving low-cost housing, social and architectural studies in designing both the interior and exterior of houses.

- To upgrade present water treatment procedures and to maximise the use of treated Nile water.

- To obtain better quality under-ground water (iron and Manganese-free).

- To survey treatment of sewage water by oxidising ponds, effects of sewage on the drainage network inside and outside the buildings.

- To preserve the architecture of certain areas in Cairo studying the problems of traffic and parking.

- Efficiency of management of large cities, evaluation of different suburbs, broad features of Egyptian cities of the year 2000 and probability of expansion on neighbouring desert.

- Building Materials: for rural housing units to avoid scraping top soil, red brick-substitutes; special concretes to suit local conditions and habitats, economics of using resin-reinforced concrete; use of mortar in building industry and preservation of houses against termites.

- Economics of Construction: specifications for design and execution of concrete and metal structures according to current standards; specifications for design and laying foundations and the effects of salt there upon. To study suitable construction methods and their economics. Maintenance of present buildings and methods to correct their structural defects to minimise risks of sudden collapse and unnecessary fatalities. To evaluate conditions for using prefabricated concrete structures as adapted to local conditions.

8. <u>New Settlements:</u>

- Encourage settlement, use natural resources and study architectural environment in the new settlements.

- To determine the basis for site-selection of new settlements, their size, economy (production and services), environmental considerations.

- To preserve the urban heritage through integrated renewal and replacement of old suburbs of historical value.

- To use new and renewable sources of energy, setting pipe-line networks of both water and sewage, best suited building materials and industrialization policy to develop new settlements.

- To develop new settlements on integrated economic basis, well-planned and fully-linked with universities and research agencies.

- To plan phased-in development of new settlements.

9. Management and Economics:

- To help take the right decisions to correct the economic path without inflation nor unemployment.

- To investigate the real reasons for economic problems irrespective of political ideology, passion, raising public expenditure nor temporary solutions to face inflation.

- To apply rigidly the rules on the management sector to perform tasks required by government posts both at centreal or local levels.

10. Social Sciences and Demography:

- Notarisation and establishing a national notarising centre.

- Statutes and legalities.

- Demographic research.

- Educational Research:

  Expansion of basic education, policy for building schools, ecouraging technical education, gearing religious education to fulfill religious and social targets and cultural programs for youth towards social change, planning to develop labour force, adopting technology and solving and educational development of new settlements.

  Development and Social Sciences:

  Forecasting research to determine future configuration of Egyptian society, identify efforts to meet people's needs, demographic characteristics, social relations and problems of new settlements, family, social policy and map social activities of S and T.

11. Basic Sciences:

- To support research projects of top priorities in areas of society development and national economy.

- To encourage new branches of science and develop necessary staff to address them.

- To establish national research institutes and new centres of excellence wherever necessary all-over the country.

EXPERIENCE, APPROACHES, POLICIES AND PROBLEMS IN SCIENCE AND TECHNOLOGY PLANNING AND MANAGEMENT IN ETHIOPIA

INTRODUCTION

This paper provides a general overview of Ethiopia's science and technology (S&T) situations and the major problems, prospects and trends it has experienced and is experiencing in recent years. It is, indeed, a difficult task to describe adequately the scientific and technological activities of a country - even of a least developed country - in a short paper and discuss in a meaningful manner all the problems and prospects which are faced in this crucial field. Efforts have been made however, to present the salient features and general characteristics of the scientific and technological profile of the country.

In preparing this paper an extensive use of the materials contained in various documents has been made. These documents include, among others, the "National Paper of Ethiopia", which was prepared for the UNCSTD meeting in Vienna in 1979, the "Ten Year Indicative Plan for Science and Technology of Ethiopia" prepared by the S&T Task Force, and to a lesser degree the draft prepared by two Swedish planners from Research Policy Institute of Sweden on "A Tentative Framework for Science and Technology Plan in Ethiopia" and comments made by the Team of Yugoslav planners on "Long Term Development of Science and Technology in Ethiopia."

The documents mentioned above contain important, though general, information on the scientific and technological conditions of Ethiopia and present an overall picture of the situation in these fields. Unfortunately concrete and detailed information on the various aspects of science and technology are lacking in Ethiopia at present and much of the comments are based on educated guesses and conjectures. Even though concrete analytical and empirical evidences are lacking in most cases, it is hoped that the observations made would convey a general overview of the situation in the country.

Presented by Lakew Birke

GENERAL BACKGROUND

Ethiopia with its propulation of about 34 millions is the most populous of the least developed countries in Africa. The average GDP per capita at present is about US$127 per year.

Over 86 percent of the population, living in the countryside is mainly engaged in crop cultivation and livestock herding using traditional modes of production and management. The yield, both per unit of land and head of livestock, is extremely low even by standards of many developing countries forcing the rural population to lead a subsistence existence. This traditional sector has produced, when climatic condtions are favorable, most of the food the nation requires and the agricultural commodities which are Ethiopia's principal exports. It is also the main supplier of raw materials for the country's industries which produce mainly the consumer goods.

The industrial sector is undeveloped and very weak contributing a mere 16 percent to the GDP per year. It is based almost wholly on imported technologies which has created a high level of dependency situation, benefiting mostly, the urban sector of the population, now estimated to be about 14 percent. The socioeconomic activities of this sector depend substantially on technologies, manufactured goods and services from the industrialised countries.

STATUS OF SCIENCE AND TECHNOLOGY IN ETHIOPIA

The attempt to assess the status of science and technology in various production and service sectors in Ethiopia at present revealed major features common to all of them which are very briefly indicated hereunder.

The Demand for Technological Imports:

Traditional technologies are predominant in most economic and service sectors. These technologies have remained unaltered for ages and make very limited contributions to national development. The low level of development attained at present, have been built with the small surplus in the agricultural sector which operates with traditional technologies. The present very low level of development in Ethiopia correspondingly restricts the demand for technological imports across production and economic sectors. It is obvious that the demand for technological imports will rise as the pace of development accelerates.

Organisation of Research and Development:

The pursuit of research and development (R&D) relevant to national needs depends on the availability of appropriately trained manpower, funding, and research facilities. These three prerequisites have never been met in most production and economic sectors. As a result, R&D institutions are yet to be properly organized. The few R&D establishments in agriculture, health and mineral resources and some R&D conducted in the university are making limited contributions to development.

Since the Revolution, the effort to interlink R&D with education, production and service activities is widening. Though it is appreciated that R&D is one of the pillars for building the national scientific and technological capability; for relaxation of the dependence on external sources of technology; and for overall economic development; nevertheless its pursuit is yet to be given the attention it deserves.

The capacity to Survey, Choose and Negotiate for Appropriate Transfer of Technology:

Technologies imported into pre-revolution Ethiopia, through various channels, whether by government or by private entrepreneurs were acquired often in "package deal" arrangements, at exhorbitant costs. High profits were made by the suppliers of technology and their representatives. The technology import transactions were dominated by such interests and considerations rather than the benefits that would accrue to balanced national economic growth or to technological capability building.

Importation of technological packages on terms weighted in favour of the suppliers was a common practice in pre-revolution Ethiopia. The technologies involved were seldom examined or analysed. Attempts to unpackaged the technologies were not made and could not influence the negotiations of the transaction. The national manpower that could select appropriate technologies in various sectors, therfore, were never formed and the organizations engaged in such activities did not develop. These deficiencies still persist today.

Factors Limiting the Benefits of Imported Technologies:

As already noted, production and service technologies imported into Ethiopia in the past fifty yearts came mostly as complete packages. As a result, only very few of the users of the technologies were enabled, in any sector, to acquire technical skills essential for the proper utilization and maintenance of these technologies. Some of the factors that aggrevate the technological dependence are:

- Little importance was attached to regular preventive, maintenance and repair programming. The cadre of engineers and technicians who have the requisite skills and experience is insufficient.

- Drawings, detailed instruction manuals and catalogues of machinery and equipment are seldom available. Where they exist they are often in several languages according to the makers.

- Repair workshops are grossly inadequate where they exist.

- Facilities are lacking for the fabrication of even minor spare parts requiring unsophisticated technological capability, although there may exist an appreciable demand for such particularly for example in the textile and transport sectors.

- Equipment and machinery imported for the same or closely similar utilization not only originate from a wide variety of sources but were acquired haphazardly with standardisation requirements being seldom prescribed. The variety of spare parts that must be held in stock is therefore excessive.

- Much of the machinery in use in production and service activities is more than 15 years old, beyond the period over which the maker is customarily obliged to deliver spare parts.

Demand for Skilled Manpower, its Training and Retention:

The continuous and dynamic development of technology necessitates the training of ever more skilled manpower at ever-higher levels of sophistication for production and service sectors. There is at present a high demand for professional and technical skilled manpower relevant to development needs in production and service activities. The educational curricula were until quite recently not oriented to serve this need adequately.

The output of graduates by the higher educational institutions does comprise a limited supply of trained manpower at various levels in sectors such as agriculture, health, and mineral resources. In addition sub-professionals are trained within enterprises and institutions in a few sectors. But training to upgrade skills and follow-up new technological developments through service workshops, seminars, study tours, conferences, exhibitions and demonstrations is not being sufficiently pursued.

Salaries and benefits offered to skilled manpower vary across sectors widely. So do the training and career prospects. This has aggravated the propensity of trained manpower to move out of fields of training and accumulated experiences, in search of better remuneration with serious consequences.

Acquisition, Generation, Dissemination and Popularization of S&T:

The availability of appropriate S&T information is indispensible for national S&T capacity building as well as for national development. Numerous developed and developing countries utilize S&T information for periodically enhancing technologies. They exchange R&D results and new technology application modes. S&T information serves to improve technology assessment and its choice.

The lack of an adequate national S&T information system in Ethiopia is one of the obstacles confronting the application of

S&T to development. Also S&T has to be made available to the broad masses before it can make an impact in their daily lives. S&T popularization, which is a nonformal process of transfer of knowledge, broadly relevant to enhanced satisfaction of basic needs, has yet to be nationally established in Ethiopia.

S&T Policy:

There are at present a few random guidelines and practices established over the years in the area of S&T orientation. In the absence of clear cut, coherent and comprehensive national S&T policy, the choice and transfer of technology, R&D as well as the development and utilization of natural resources etc., lack appropriate and mutually reinforcing guidelines.

Financing of S&T capability Building:

Funds from domestic sources are not allocated to R&D or to other components of national S&T capability in many sectors of the economy. In a few sectors where such activities are pursued, allocations are grossly inadequate. Both the operational expenses of R&D as well as provision of technical equipment and expertise have relied heavily on international agencies and bilateral aid. Funds allocated for search of technology, its choice and negotiations for its transfer etc., from domestic and external sources are far from adequate.

The Status of Traditional Technologies:

Benefits or yields obtained from the application of traditional technologies in Ethiopia are generally low in any sector. No coordinated attempt to enhance productivity of such technologies have been made. There are no mechanisms which would disseminate traditional practices proving of appreciable benefit in one part of the country to another where it may prove equally useful. The absence of a system for testing their efficacy in practice and for promoting and supporting their pursuit has meant that even the few improvements devised, which appear interesting are wasted.

The Use of Indigenous Resources:

Until recently, the industries imported into Ethiopia by private entrepreneurs were exclusively chosen on the basis of their profitability. The utilization of indigenous raw materials, and the creation of employment opportunities received little or no consideration. Up to 50 percent, by value, of raw materials for many such industries are still imported, thereby imposing a serious burden on meagre foreign exchange earnings. The lack of indigenous capacity to furnish domestic raw materials in adequate quantity and quality has been a major deficiency.

International Collaboration in S&T:

Ethiopia receives a modest level of assistance from international and bilateral sources, in S&T capacity building in several sectors in the form of research collaboration, education and training funding, consultancy, information exchange etc. There is as yet no significant technical cooperation with other developing countries in this direction, even though such cooperation has the potential for yielding considerable benefits.

EXPERIENCE IN PLANNING AND IMPLEMENTING S&T POLICIES IN ETHIOPIA:

Ethiopia does not have any practical experience to speak of in the area of planning and working out scientific/technical policies. Technology policy as a basic function of the government aimed at creating a network in which decisions concerning technological choice can be made and complemented is almost absent.

An undesirable consequence of this lack of experience in scientific and technological policies is the inadequacy in technological planning as a means of developing a formally constructed, internally consistent set of goals, objectives and instruments in promoting, building and strengthening the country's scientific and technological capacities and capabilities. Thus S&T Policy, as an issue, is yet ot be treated more explicitly, more thoroughly, and more systematically in Ethiopia.

There are, of course, a certain amount of fragments of facts, opinions, and expectations that can serve as important inputs into the formulation of S&T policy in the future. More favourable conditions are being created which would enhance the possibility for the formulation of the scientific and technological policies of the country. The Ethiopian condition for comprehensive planning has improved rapidly which is clearly exemplified by the preparation of the ten year perspective plan. Repeated efforts have been made by the Ethiopian Science and Technology Commission to draft the ten year perspective plan for science and technology (1985-1994) and the effort has been very useful and worthwhile.

Deliberate S&T capability building and the utilisation of such capability to enhance the pursuit of development goals is receiving attention for the first time in many sectors. But an explicit policy for developing the elements of S&T capacity, such as upgrading skills of S&T personnel, technology selection and transfer, adaptation of modern technology, improvement of traditional technology, optimal technology utilisation, project design and management, scientific research and technology development and demonstration, S&T information services and science popularisation, is lacking. In short, experience in planning and working out scientific/technical policies is highly deficient in Ethiopia.

In the agricultural sector, the Food and Agriculture Research Council has formulated an R&D policy guideline for the agriculture sector. This guideline was prepared with full participation of all concerned and relevant organizations and individuals. The draft was presented to the National Council for S&T for approval (the supreme national body in matters concerning S&T). The policy guideline was approved by this national council about three years ago and in being implemented by the Central Planning

National Committee Office in assessing and approving R&D programmes and projects in the agricultural sector. Similar policy guidelines have been prepared for some of the other sectors and are awaiting the approval by the National S&T Council.

Possibilities in Planning in the Field of S&T:

As indicated earlier, Ethiopia has just completed preparing a ten year development plan which is to be implemented in 1985 through 1994. One of the areas in which such a plan was prepared was in Science and Technology. The S&T plan consists of eight sections: an introduction, a general assessment of the present state of S&T in Ethiopia, major problems of S&T in Ethiopia, objectives of S&T development, major S&T programmes, projection of investment expenditures into the S&T sector and the issue of Policy and Organisational measures required to build national technological capability.

The plan, as its name implies, is only indicative showing the general thinking and trend for the next ten years. Detailed elaboration of the S&T plan will be provided in separate 2-year, 3-year and 5-year Plans and Programmes of S&T Development.

The preparation of the Plan has proven to be an exceptionally difficult task. It was originally thought that the S&T Task Force which was charged with the responsibility for drafting the ten year S&T perspective plan would prepare a guideline concerning the major issues to be considered in preparing the plan. This guideline would then be distributed to all Task Forces established in the various production and service sectors so that each Task Force would prepare, on the basis of this guideline and detailed data on specific problems of S&T within its sector, drafts of sectoral S&T plans and programmes (e.g. major R&D projects, manpower and facilities required, estimation of required financial needs, etc.). The S&T task force would then integrate sectoral draft S&T plans into a national plan and the Central Planning National Committee Office (CPNO) would check the draft S&T plans with respect to their consistency in relation to the overall development plan (development priorities, available resources, etc.). The CPNCO would thus perform the final consistency analysis of the national S&T programs, whilst the S&T Task Force checks internal consistency of sectoral S&T plans, in order to eliminate unnecessary duplication of research effort, scale down expenditure requests and focus available resources on key priorities.

Unfortunately the above scheme did not materialise. Although the S&T Task Force had prepared the necessary guideline and distributed it to the respective Task Forces it was never implemented with the exception of the agricultural sector. This difficulty has forced the S&T Task Force to draft the S&T Plan on its own without detailed operational data located in sectoral ministries, corporations and state enterprises and in most cases even in Task Forces thus making the planning document to be somewhat general. The problem of implementation will certainly appear, since organizations which are supposed to implement national S&T plans did not take active part in its preparation. To make the matter worse, the S&T draft was not presented at the meeting of the Council of Minsters when this body considered, discussed and approved the ten year development plan. Thus, even though the Ethiopian Science and Technology Commission had made a tremendous effort in preparing the ten year S&T development plan there is still a long way to go in refining it and making it part and parcel of the socio-economic development plan of the country. The draft plan was considered, however, at a special meeting which was chaired by the Chairman of the Provisional Military Administrative Council. This has helped a lot in many ways. Even though the task of preparing the plan had proven to be an extremely difficult one the effort was worthwhile and those who had participated had gained some valuable insight into the possibilities of planning in the field of S&T. It is also to be noted that both the programme of the Workers Party of Ethiopia and the 10 year perspective plan which was approved by the Party just about 6 weeks ago have each a chapter on S&T development plant. This will greatly facilitate the elaboration and implementation of the S&T plan in the future.

ORGANIZATION OF MANAGEMENT IN CONDUCTING SCIENTIFIC RESEARCH

Ethiopia does not have a long history of conducting scientific research. The first attempts in agricultural research and development was undertaken by the Addis Ababa University in the 1950s. The Debre Zeit Agricultural Experiment Station was established in 1953 and the College of Agriculture followed in 1957.

Almost ten years later, the first step was taken to establish the Institute of Agricultural Research. This has now grown into a network of major research stations each of which is established to focus on the problems of a specific region with regard to cropping pattern and climatic conditions.

Ethiopia is the host country of the headquarters of the International Livestock Centre for Africa (ILCA) which belongs to the international network of agricultural research centres. Given that the livestock resources of Ethiopia, are the largest in Africa, the country naturally benefits from the research activities of ILCA. However, it must not be overlooked that the research programmes of the Centre are determined by the needs of all participating countries. Thus the Veterinary Research Institute at Debre Zeit may be more important to solve immediate problems for Ethiopia.

The country also has the Ambo Scientific Phytophathological Laboratory which has been established by the Ministry of Agriculture of the USSR.

The Central Laboratory and Research Institute (CLRI) was the first research institute in the health sector to be established in Ethiopia (1950). Originally it was closely linked with the

Pasteur Institute in Paris, a link which was severed in 1964. The Insitute provides training and laboratory diagnosis.

The Ethiopian Nutrition Institute (ENI) has grown out of an institute which was established in 1954 with Swedish aid. It is now under the Ministry of Health and its activities include research in the various aspects of food and nutrition, dissemination of information to the public and training.

The Armauer Hansen Research Institute (AHRI) was established with foreign assistance in 1969. It is closely connected to the All Africa Leprosy and Rehabilitation Training Center (ALERT), located in the same compound. ALERT provides the clinical facilities necessary for AHRI's research activities. AHRI in return provides diagnostic services for the hospital and clinic, assists in the training programs of ALERT, and collaborates in the clinical research program of ALERT physicians.

Research activities are carried out at the Medical Faculty, Gondar Medical College and the School of Pharmacy all belonging to the Addis Ababa University. However, all three institutions are mainly engaged in teaching programs.

Ethiopia's potential for mineral resources exploitation is believed to be considerable. However, very little exploration has been carried out so far and the country is still poorly mapped.

The major institution engaged in geological research today is the Ethiopian Geological Survey Institute which was initiated by UN project activities in 1968, which followed a mineral survey conducted till 1967.

In addition, two other organizations, the Department of Geology and the Geophysical observatory are to some extent engaged in research activities. These are both integral parts of the Addis Ababa University and are mainly engaged in training.

Although in an uncoordinated way, research on hand-pumps, wind pumps and solar powered pumps initiated by the Ethiopian Water Works Construction Authority (EWWCA) is being conducted at present. The training of manpower has been accorded higher priority than research.

There is virtually a total absence of domestic technological reseach within the industrial sector. Still, the contribution of the industry to GDP is about 16 percent - about half of this coming from traditional handicrafts and cottage industry.

In the University, research projects are initiated by individuals and the proposals are submitted to research committee in their department. If approved by the departmental research committee, the proposals are forwarded to the faculty research committee. From the faculty research committee, those proposals that are approved are submitted to the Research and Publication

Office of the University. Those research projects that are accepted by the Research and Publication Office are submitted to the Commission for Higher Education and lastly to the CPNCO for final approval and funding.

In the case of the Institute of Agricultural Research (IAR), research coordination and management was first provided by annual project preview meetings by stations, at which station research programs were decided, and a series of co-ordinating committees, were formed, the most active of which was the National Crop Improvement Conference (NCIC). The NCIC still meets annually to discuss on the work accomplished in the preceding year, to finalize the programs for next year and to recommend the "release" of improved crop cultivators.

With the creation of disciplinary departments, research workers' proposals are submitted to Department Co-ordinators by mid-February of each year, Departmental proposals are submitted to management by mid-March and, after discussion, Department Programs are approved in the second half of March.

The recent arrangement is that the Department programs approved by the Management would be submitted to the IAR Board for comments and recommendations, before they are forwarded to the CPNCO for final approval. Progress reports are submitted to the CPNCO on a periodic basis on the undertakings of the research programs.

The Ethiopian Science and Technology Commission was set up in 1975. Its main tasks include, among other things, the formulation of R&D policies and the strengthening and promoting research activities in various fields. It attempts to carry out its tasks through research councils which are organized in various fields. It supports research projects by providing grants from funds it receives from international organizations. The relevant research councils supervise the research projects which have received grants from the Commission.

EXISTING AND PLANNED ORGANIZATIONS AND NETWORKS DEALING WITH TECHNOLOGY FORECAST AND EVALUATION

It is difficult to say that Ethiopia possesses organizations and networks dealing with technology forecast and evaluation. Ideally, in the search for technology for a specific purpose, all potential sources should be surveyed. The technologies identified should be screened for suitability and those short-listed should be assessed in depth. It should also be possible during the negotiations to prescribe modification in design to further enhance the suitability of the technology to the conditions in Ethiopia. This is rarely done, if at all, except perhaps by the Ethiopian Airlines which has built a commendable capability in the aircrafts technology over the years.

The Development Projects Study Agency (DPSA) which was established in 1980 at the CPNCO may be of special interest in this area of technology evaluation. The main objective of the Agency is to strengthen the capacity of Ethiopian institutions involved in project planning. Its main function is to assist institutions engaged in project activities in strengthening their capabilities. The Agency compares technical and economic options and rejects inferior projects in order to achieve the more efficient allocation of scarce resources. The Agency also houses the Ethiopian Centre for Technology which has been established with assistance from UNCTAD to screen and influence technology imports, in order to further the development of a national technological capability.

The Agricultural Implements and Services corporation does a limited amount of technological evaluatin in the agricultural sectors. However, because of shortage of trained manpower and facilities its activities are severely limited.

In short, Ethiopia does not have national organizations and networks which can deal with technology forecast and evaluation.

EXPERIENCE IN COORDINATING OF BASIC TARGETS IN SUBSECTIONS OF A PLAN FOR DEVELOPMENT OF S&T AND WITH OTHER SECTIONS OF NATIONAL PLANS

Ethiopia never had an S&T development plan before and as such it does not have any experience in coordinating S&T development targets with other sections of national plans. Sectoral development plans in the past did not consider in an explicit manner the issue of building and strengthening S&T capabilities of the sectors. Even at present when the 10 year development plan was drafted most sectors failed to give adequate attention to S&T capacity building even though they have mentioned in a haphazard way their need for such capacities.

The S&T Task Force which was given the responsibility for drafting the 10 year indictive plan for S&T had attempted to consider the national S&T capability building in terms of the following elements:

- The ability to effectively conduct research and to develop technology, as well as to demonstrate it and subsequently supply it to users.

- The capacity to search for, select and transfer foreign technology on the best possible terms so that it will contribute to long-term national gains and internal technology development.

- The ability to operate and utilize technology to derive optimum possible benefits attainable therefrom.

- The capacity to adapt technology to improve its benefits.

- The ability to acquire and disseminate scientific and technological information as needed.

- Project design and implementation management capacity.

- The ability to periodically upgrade the skills of scientific and technological manpower at all levels. This is required additionally to the capability to impart basic training in the formal education system to the manpower profile required for development priorities.

- The capacity to identify traditional technologies which have the potential for improvement and to enhance their efficiency and benefits.

- Science and technology popularisation capacity.

The various production and service sectors were assessed in terms of the above elements and were found to be highly deficient and inadequate. The degree of inadequacy in one or another of the above elements varies from one sector to another and may also vary among sub-sectors in a particular direction.

Depending on the need of the sectors, a ten year indicative plan was drafted for the sectors in terms of the above scientific and technological elements by the S&T Task Force. As was explained earlier, however, this plan lacks the active participation of the other task forces organized for the various sectors, and as such it does not have the necessary coordination with the national development plan.

FINANCING SCIENTIFIC RESEARCH AND S&T PROGRAMMES

Ethiopia today uses between US$30 and US$35 million for various science and technology activities which amounts to 0.7 - 0.8 percent of the gross national product (GNP). This level of spending may not be considered low when compared with many other developing countries. However, most industrialized countries are allocating resources for research and development alone about 2-3 percent of their GNP. In absolute terms the difference becomes immense and clearly indicates the gap which has to be closed if Ethiopia is to achieve full social and economic development.

Embryonic beginnings of a modern science and technology system exist in several of the country's economic and social sectors including agriculture, health and geology/mining. It is almost non-existent in most other sectors like industry and construction.

Funds from domestic sources are not allocated to R&D or to other components of national S&T capability building in many sectors of the economy. In the few sectors where such activities are pursued allocations are grossly inadequate. Both the operational expenses of R&D as well as provision of technical equipment and expertise have relied heavily on international agencies and bilateral aid. Funds allocated for search of technology, its choice and negotiations for its transfer etc., from domestic and external sources are far from adequate.

The pursuit of S&T objectives of the ten year plan with the strategies formulated therefore, will call for an extensive implementation program. From the nature of the objectives and strategies formulated above, it is clear that the S&T implementation programs are to be integral components of the development programs in each sector. Such a concept is completely different from the opposite view which is often met, which regards national S&T activities as largely extrinsic to the development process.

Sectoral S&T program outlines in ten priority sectors are being recently made available to the S&T Task Force. Gross estimates of funds required for carrying out these programs have also been furnished therewith. The following section covers the sector-specific S&T objectives and strategies as well as the sectoral S&T progrms and financial estimates.

The S&T capability building aspect of the sectoral programs will obviously require central guidance, promotion, coordination, support, monitoring, assessment, orchestration and management. There is at present no Ethiopian organization with the legal mandate and executive powers carrying out such functions across the whole range of national S&T activities enumerated earlier. Such central management, it is estimated will cost about 10 percent of the total allocation for the activities enumerated. In addition, the central organization will also undertake the following:

- The establishment and operation of a national S&T information network. A UNESCO study had in 1979 put the cost of establishing such a network at US$20 million over a ten year period. A project has also been proposed for the setting up of S&T information centre within the Development Projects Studies Agency in collaboration with the Pan African Development Information System (PADIS).
  The Ethiopian Science and Technology Commission also very recently run a seminar with the assistance of UNESCO on the objectives, development and structure of a national S&T information system.

- A national Science Popularisation Program to be executed in all sectors and in all regions, districts, towns, etc., will also need the guidance, supervision and management of the central organ. Exhibitions, science fairs, publications, broadcasts, amateur clubs, hobby circles, professional associations, prize competitions, etc., will be organized and operated in the national S&T popularisation effort. The activities will be rather similar to those conducted now by the Sports Commission. The financial requirements will partly be drawn from sectoral sources.

- A central laboratory and equipment repair workshop is also envisaged under the central organ. Such a laboratory would acquire and operate expensive sophisticated equipment such as electron microscopes, high power computers, etc. The workshop would be a repair centre for special S&T equipment and instruments.

- The central organ should also organise and run conferences, seminars, symposia, workshops, training courses in various themes in national science and technology capacity building, in R&D, in transfer of technology, in technology acquisition, etc.

A total of US$50 million is earmarked for investment in the above programs being implemented by the central S&T organization during the ten year plan period.

The preliminary versions of the sectoral S&T plan in the ten year plan period cover S&T in the following sectors: agriculture, construction, education, energy, health, housing and urban development, industry, mineral resources, transport and communications and water. Investment amounts have already been earmarked for S&T programs now still being elaborated in detail in each of these sectors. The investment sums set aside for each sectoral S&T program are indicated in summary form in Table 1.

PLANNING OF HUMAN RESOURCES DEVELOPMENT IN S&T

In terms of number of R&D personnel the target figure set by the United Nations Second Development Decade for Africa is 200 scientists, engineers and technicians per 1 million of population. To meet that target Ethiopia would need to have 6400 research workers in 1984. It is estimated that the number of S&T personnel in the existing institutions in Ethiopia barely reaches the figure of around 2200. The 10 year perspective plan on S&T Development in Ethiopia envisages that the total number of scientists and engineers will increase by more than 13 times its present level by the next ten year period. According to the assessment of some experts this increase in S&T manpower in ten years is hardly probable.

EXPERIENCES AND PROSPECTS OF INTERNATIONAL COOPERATION IN S&T

Technical assistance and S&T cooperation with international organizations and research organizations from other developing coutnries is a pre-requisite for domestic S&T sector development. Unfortunately this aspect of international cooperation in the field of S&T has never been given serious consideration in the past. Hence Ethiopia's experience in this area is very limited.

The prospects of international cooperation in the field ofS&T are, however, very promising. The plan of cooperation however, will have to be carefully prepared. In essence, this plan would select countries, institutions and research projects with which cooperation is to be undertaken. This approach aims at eliminating fragmented, uncoordinated cooperation with numerous international and national research organizations, in order to increase the efficiency of resource usage.

STRENGTHENING OF R&D, EXPERIMENTAL AND DESIGN CAPABILITIES

The purpose underlying the scientific and technological activities in Ethiopia during the ten year period of the plan shall be to heighten the substantive contribution of these activities towards the attainment of the social and economic goals of the planned development. In view of the existing pattern of technology flow in the Ethiopian socio-economic system, the three major objectives of the plan shall be the following:

A. Raise rapidly the effective internal component of Science and Technology inputs into the socio-economic system.

B. Ensure the suitability of technology, to be transferred from foreign sources, to the specific conditions under which it is to be utilised in Ethiopia. To this end conduct effective market surveys, selection and transfer negotiations.

C. Raise rapidly the level of general understanding and application in every day life, of science and technology by the masses.

These major objectives are very general, and can be pursued only through the building and/or strengthening of the requisite elements of national scientific and technology capability.

Ten main objectives are enunciated for the ten year perspectice development plan. One of these is "laying the foundation for the development of science and technology in Ethiopia". This goal, it is explained therein, is envisaged in order to create conditions conducive to the building of the S&T capability because the main source of the country's backwardness at present is the low level of science and technology.

The building and strengthening of the specific elements of national scientific and technological capability will also contribute significantly and directly towards the pursuit of the following other main goals of the ten year perspective development plan:

- Enhance the productive cpacity of the economy in order to raise aggregate production output to a high level.

- Build a strong national economy with firm and effective inter-sectoral and intrasectoral linkages.

- Search for, identify, develop, rationally utilize and conserve the country's natural resources.

- Promote the educational and proficiency levels of the broad masses.

- Eliminate unemployment step by step.

- Promote balanced and equitable regional development.

The priority ranking given to a specific S&T capacity element in a particular socio-economic sector during the plan period will, of course, depend on the present status and trends in the sector. It will also depend on the weight given to the contribution that national capacity in the particular S&T element is expected to make to the attainment of the sector's goals in the plan.

It is well appreciated that the resources that can be made available for the pursuit of the S&T objectives of the plan, will be severely limited. On the other hand, the effective building and strengthening of the S&T capacity elements of the sector as integral parts of the relevant sectoral plans, will pay-off in the optimization of scarce resources absorbed by the implementation of socio-economic development programs as well as the avoidance of delays. This return to investment in S&T capacity building and strengthening is likely to be available in the medium term for most S&T elements.

The principal overall strategies proposed for the implementation of the S&T objectives are the following:

1. Formulate a national policy, laws, regulations and guidelines that promote the building of S&T capability as essential in each sector in accordance with the goals and priorities of the perspective plan.

2. Design and implement programs of upgrading the skills of the S&T labour force at all levels as needed in priority elements of S&T capacity as integral parts off the pursuit of sectoral goals.

3. Promote the growth step by step of research, development and demonstration capacity as regular functions in the sectors where it is a priority, by facilitating the training of R&D manpower and by provision of infrastructure as well as equipment and material.

4. Organize and operate S&T information systems and procedures for the acquisition and utilization of S&T information in every sector and as part of a national S&T information network.

5. Organize and implement systems, instruments and procedures for the proper assessment, choice and negotiation for technological imports particularly suitable for application in Ethiopia.

6. Organise and implement a national program of S&T popularisation. Formulate and publicise a science vocabulary in the national language to facilitate S&T popularisation.

7. Organise close inter-linkage of R&D, with production and services, as well as with education and training.

8. Organise and conduct assessment of traditional technologies in sectors where these will continue to be important and enhance those with the intrinsic potential for improvement.

9. Build and strengthen project design and project implementation management capacity in priority sectors.

10. Strengthen the capacity to utilize, maintain and repair technology in every sector.

Thus, the above considerations are good indications that a lot of thought has been given to this issue of strengthening of R&D, experimental and design capabilities in Ethiopia. A lot remains to be done, however in the preparation of programmes and projects as a first step toward meeting the objectives of S&T capability building in Ethiopia. At present there is lack of capability in S&T planning and management in Ethiopia and, as a result, the attempts made so far are too general lacking in specificity, internal consistency, simplicity, clarity and concrete ways of achieving the objectives.

CONCLUSION

From the foregoing general presentation it is not difficult to see that Ethiopia faces a number of problems and deficiencies in S&T. These problems and deficiencies can be overcome by deliberate planned activities undertaken as appropriate and in consonance with national development priorities. To this effect an attempt has been made to draft a 10 year perspective plan for S&T. There is, however, lack of experience in S&T planning and management which has made the whole task of planning an extremely difficult and frustrating venture.

SCIENCE AND TECHNOLOGY PLANNING AND MANAGEMENT IN GHANA

INTRODUCTION

The concept of national planning implies the institution of conscious policies, processes and activities aimed at achieving specific desirable economic and social goals. As science and technology is a tool for development more than an entity in itself so is planning for science and technology an integral part of the National Development Plan. A Science and Technology Plan defines the most appropriate science infrastructures to be developed and the strategy for achieving the goals of the National Development Plan.

National Development Plans, however scantily documented, are de-facto expressions of the will of all Governments for the orderly development and progress of their people. Consequently, National Development Plans can be said to have had a history - related to the age of governing in all environments. Science and Technology, as organized in the 20th century, is new. Consequently planning of science and technology support for National Development Plans is also new for many developing countries including Ghana. This situation coupled with the lack of awareness of the need to expand knowledge for the promotion of action for national development may have accounted for the dilemma of the Third World Countries in harmonising science and technology planning with National Development Plans.

Nevertheless, due to the close linkages between science and technology and development in general and particularly in the context of the technological age of the 20th century, most national development plans, including those of developing countries have not completely omitted the role of science and technology even though these have not been spelt out specifically in any recognisable format as one would wish it to be.

In Ghana, the period from the 1950s to 1980s witnessed a period of trials in an attempt to locate science and technology activity vis-a-vis, the national development plans. The beginning of the 1980s however witnessed a transformation beginning with the establishment of the Ministry of Science and Technology, fused with industry, that would provide direct access to Cabinet. It would also provide a secretariat for the National

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Presented by Joy K.B.A. Ata

Science and Technology Commission that would primarily be responsbile for the formulation, promotion and monitoring of science and technology policy and plans. For the first time a Science and Technology Sector Plan was drawn up to provide a back-up to the proposed National Development Plan (1981-1986).

HISTORY OF DEVELOPMENT PLANS

From the early 1950s, when the country was preparing itself towards independence to the present moment, Ghana has enjoyed a number of National Development Plans. These include:

a) A 7-year Development Plan 1951-1957
b) A 5-year Development Plan 1959-1963
c) A 7-year Development Plan 1963-1970
d) A 2-year Development Plan 1972-1974
e) A 5-year Development Plan 1975-1980
f) A 5-year Development Plan 1981-1986
g) A 3-year National Economic Recovery Programme 1984-1986.

A significant observation about these plans is that it was only in 1980 that a formal science and technology sector plan was attempted as a back-up to the proposed National Development Plan - (1981-1986).

In the 1972-74 Development Plan, the broad policy objectives were:

a) to contain the balance of payments problem by systematically reducing the large budget deficit; and
b) to strengthen Ghanaian participation and control of the strategic sectors of the economy.

These necessitated the directing of the main thrust of the Government economic efforts towards:

i) increasing agricultural production to feed the people and provide raw materials for industry;
ii) rehabilitating and expanding certain sectors of the economy (e.g. ensuring that state-owned factories not only become viable but expand and operate at a profit);
iii) increasing export earnings; and
iv) establishing the proper priorities in the provision of social services such as low cost housing; rural water supply, rural health facilities, etc.

In this National Plan, policies were determined in sensitive sectors such as Agriculture, Cocoa, Forestry, Mining, Manufacturing and Essential Services but not for Science and Technology.

In a report prepared by UNESCO (1972) on the "present situation of, and future prospects for Science and Technology Policy in Ghana" the following excerpts can be found:

i) "Although a separate chapter on Science and Technology will not be found in the 2-year Development Plan, the Government is fully alive to the key role which scientific research and its application will play in the fields of agriculture and industry for the success of the programme."

ii) "The main weight of scientific and technological research programmes continues to be shouldered by CSIR although there are significant contributions by the Universities. Annual budgetary allocations to these institutions are made through the Development Planning Secretariat in the case of the CSIR, and through the Council for Higher Education in the case of the Universities."

iii) "Indeed it can be argued that the national scientific research organization has become so much a part of the government planning machinery that, in a sense, it becomes almost redundant to devote a seoparate Chapter to it in the present very short term 2-year Development Plan as had been done for previous plans. And there is, in fact, no difficulty in locating those sections of the plan where heavy support from science and technology is presupposed."

This does not however render the contents of the previous plans devoid of science and technology input. On the contrary, the plans prepared between the period of independence and the end of 1970 provided the largest science and technology infrastructure.

For example, the effects of previous plans include:

a) The Development of Science and Technology - Universities to train high level engineers, pharmacists, architects, agriculturists, doctors and technologists for the anticipated rapid industrialization programme.

b) The development of Science and Teachers University to train high level science teachers who would further train second level pupils, all aimed at generating a rapid development process.

c) The development of a National Research Council (later named the Academy of Arts and Sciences and now designated as the Council for Scientific and Industrial Research) to coordinate research in the various fields of activity such as agriculture, health, forestry, construction, initiation of new research activity and also to advise Government on all matters of scientific and technological importance.

d) The institution of several technical colleges, polytechnics, secondary schools and agricultural training colleges to provide the middle level technical skills that would be needed to support the industrialisation programme.

e) The liberal importation of technology with the aim of encouraging technology transfer and adaptation.

f) The granting of scholarships for science and technology both home and abroad.

These and many other achievements in the establishment of science and technology infrastructure were never spelt out in any specific science and technology plan.

THE APPROACH

Within the review period, Ghana's science and technology planning and management was pluralistic in character. The Ministry of Economic Planning and Finance played the over-all coordinating and regulatory role in national planning and management. Inputs were made by the key ministries of agriculture, health, industry, transport and communications, rural development and others and resources were assigned to each policy sector. It is significant to note that there was never a Ministry of Science and Technology charged with the overall direction of science and technology policy and activity.

By 1968, when the Council for Scientific and Industrial Research was formed to coordinate all research programmes and activity, the following understanding was reached.

"As the central national research organization, the CSIR serves as the scientific and technical arm of the Government and undertakes research on problems referred to it by the various Ministries; the Ministries or their agencies pass on their scientific problems referred to the appropriate institutes of the Council and these institutes are expected to take account of these problems in the preparation of their research programmes. The usual machinery for doing this is through representation of the Ministries on the appropriate management Boards of the institutes or on various technical committees."

It was thought that by making the Council for Scientific and Industrial Research responsible to the Minister charged with Development Planning, this would automatically ensure that scientific and technological research is closely geared to national development programmes.

As can be expected however, in any pluralistic model, a number of gaps were created. For example:

a) The Ministry of Industries, genuinely wished to engage in sophisticated manufacturing processes but had no mechanism to assess the local scientific and technological manpower capability.

b) Each sector competed strongly for comfortable shares of the scarce financial resources and within the sector, various science and technology activities were exposed to strong competition for the meagre resources, with capital investments, operational and service requirements in the same sector.

In an economic system that is financially balanced, such a pluralistic approach may still achieve desirable results. However in the Developing Countries which are plagued with chronic shortages including capital, non-conventional forces tend to dictate the direction of flow of goods and services. The management of the state machinery is personalized and directed more by political influences than by scientific plans. In Ghana, these forces included political parties, parliamentary personalities, top officials as well as the effect of culture conflicts existing between scientists and non-scientific administrators.

For an example, in the early stages of independence, the President of the Republic of Ghana being personally convinced of the need to create Science and Technology infrastructure to give effective support to industrialization, personally influenced anumber of state decisions in favour of such development. For example, scholarships were offered preferentially to science students in the area of education and all the research institutes were guaranteed enough funds to enable them to carry on. Some scientific associations were even promoted through the allocation of state grants. All these were intended to create a good climate and generate the required activity for rapid development.

Even at the lower levels of authority, the management of national development plans was greatly influenced by political intervention. Development programmes that could make an impression on the electorate received greater appreciation than those scientifically tested and evaluated.

A second obvious effect of the consideration of science and technology input at the sectoral level was that the inputs were provided by the sectors staff who were not necessarily professionals in planning processes and neither had an indepth concept of science and technology.

Consequently, targets that were set were never attained even after having the required financial resources support.

Violent fluctuations in budgetary allocation for research caused a major drawback in terms of time, money, and manpower to the national scientific effort. For example, any interruption or suspension of long-term projects meant starting all voer again in a number of cases when funds became available.

There was observed also a serious lack of any linkages between the needs and potential of the various economic sectors. There existed so much compartmentalisation that several gaps were left unattended to. There was an obvious evidence of a scramble to individual and institutional growth and autonomy more than any move towards cooperation and coordination.

In the first two 5-year Plan periods, there was no seperation of authority between the policy maker and implentor. However the 7-year Plan of 1963-1970 was designed by a National Planning Commission comprising of individuals that were selected in their own right.

THE POLICY

Within the period under review and particularly in the early stages, the policy on science and technology appears to be one of rapid development. This meant that the main elements of science and technology such as training, transfer of technology, research, industrialisation, diffusion of research and financing of research had to be done at a pace that was faster than the social and economic environment could absorb. Therefore it can be observed that instead of developing alternative technologies, relevant to our socio-cultural needs, and based on a consistent approach of engaging in problem solving research, the country's researchers were rather ushered into fierce competition to produce research results relevant to the 20th century advanced economy. This was not necessarily a defect attributable to the scientists but it is because the socio-economic expectations far outweighed the local scientific and technological capability. This resulted in a situation where the scientific and technological personnel were forced into a doubling up action of catching up on several fronts including pressures on the international scene.

THE PROBLEMS

In a situation in which the science and technoloyg input was in several instances a window dressing of the National Development Plan, and where the cultural conflicts between the politician and the technologist could not lead to an orderly appraisal of the National development needs, several distortions were created in relating the science and technology capacity and capability within the country to the tempo of industrialisation desired. Therefore, the earlier development plans built very large infrastructures but which were rendered under-utilized because the relative pace of development of science and technology in a third world country having a natural slow rate of progress in science was not fully appreciated.

Apart from the early sixties when the personal intervention of the President, caused the flow of financial resources, there has not been any definite budget for science and technology. Although each economic sector receives some funding from both internal and external sources, these have never been adequate to make the desired impact.

Research is basic in Science and Technology application but it can be overemphasised at the expense of other inputs. It is believed that the early planners must have mistakenly equated research and development to science and technology. This resulted in an accelerated development of research institutes covering all major sectors such as Agriculture, Health, Industry, Forestry, Mineral Resources and Construction while other science and technology issues such as the Regulation of Technology Standardisation and Metrology, Scientific Manpower Training, Adaption of Research Results, Diffusion of Science and Technology and the generation of funds for research and other activities were left unattended to.

At a certain stage, a Manpower Development Board was established and charged with the responsibility of keeping the manpower situation under constant review. Like many other units of State Adminsitration, the body sees itself as leading an independent life and has really not been able to influence the programming of the training of manpower for the National Development process.

MANAGEMENT OF SCIENCE AND TECHNOLOGY

The early stages of the period under review saw the management of science and technology activity vested in the various sectors such as the Ministries of Agriculture, Health, Education, Industry and others. However, due to very scarce resources and a general lack of appreciation of the long term benefit of investment in Science and Technology, most of the science and technology import of the National Development Plans were starved and neglected. However, these arrangements were altered and semi-autonomous instituions created to take over some of the functions of science and technology. For example:

i) The planning, programming, implementation and coordination of research in several fields of human endeavour necessary for the country's development was entrusted to the National Research Council, later named the Academy of Sciences and now referred to as the Council for Scientific and Industrial Research. These in turn set up management boards for each of the institutes.

ii) The Ghana Standards Board was also set up to coordinate all activities associated with standardisation and metrology.

iii) The Universities, under the Council for Higher Education, were left entirely on their own to develop the technical and professional scientific manpower needed for industrial growth.

There were also set up other organizations which were entrusted with one or the other aspect of science and technology function. These included the Geological Survey Department, Marine Fisheries Research Unit, Metrological Department, Forestry and Animal Husbandry, etc.

The only drawback in this new approach was the lack of an effective coordinating body. At a certain stage, the Council for Scientific and Industrial Research, the Ghana Standards Board, and the Science and Technology Universities were all assigned to different Ministries. Consequently no one Minister spoke with authority for science and technology at Cabinet level. Similarly it was very difficult to establish the necessary linkages. These errors could have been the result of the mistrust between technocrat and politician.

Science and technology has never administered independent funds. All institutions of science and technology except industry, receive state subvention on monthly basis and upon the submission of annual budgets. However as resources dwindled in the state machinery so were resources redirected for other services more than for research training. The Council for Scientific and Industrial Research had never had enough funds to manage properly its institutes and projects. These have resulted in the following:

a) Brain drain emanating from inactivity and job dissatisfaction.
b) Low turn out of research results.
c) Inability to advance laboratory research to pilot plant stages for testing and eventual adoption in industry.
d) Inability to extract, promote and advance inventiveness and innovative talents in promising Ghanaians.
e) Inability to regulate and control effectively technology purchase, adaptation and transfer.

FUTURE PROSPECTS

The 1980s however seem to have introduced a new turn. The Ministry of Science and Technology fused with the Ministry of Industries has been established so as to find science and technology a voice at Cabinet. It is envisaged that existing institutions such as the Council for Scientific and Industrial Research will be strengthened and restructured in order to enable it take on the policy issues of Science and Technology. The Council and especially its committees will draw their representation from all the sectors of the economy where the advancement of science and technology feature prominently. Consultations are currently taking place to create an independent fund for science and technology activity. Such funds are expected to be derived principally from industry who ultimately are the direct beneficiaries of research effort. A National Education Commission has been formed on which serves a high powered delegation of represntatives of the science and technology sectors. These are to ensure that scientific education receives enough consideration right from the planning stages and that it is related to the long-term national planning objectives.

A lot of infrastructure already exists in the areas of: research, education and training of personnel, information dissemination, adaptation and transfer of technology, regulation of technology, standardisation, establishment of linkages with industry and a systematic approach to funding of research (Figures 1 to 4). These were built up over the years. These, however, remain as fragments of national effort except when the important issue is of coordination, is tackled seriously and settled. This, I believe is what the turn of the 80s will be working towards.

PLANNING AND MANAGEMENT OF SCIENCE AND TECHNOLOGY IN INDIA

> "When merchant adventurers from the West made their first appearance in India, the industrial development of the country was at any rate not inferior to that in the more advanced European nations."
>
> -- The (British) Indian Industrial Commission, 1918.

HISTORICAL EXPERIENCE

Ancient and Medieval India:

The earliest evidence of advances in science and technology in the Indian sub-continent dates back to circa 3000 BC. Town planning on geometric lines, drainage facilities; standardised bricks, granaries and marine ports -- all of these were to be found in the ancient Indus civilization.

India's most noteworthy contribution, and one that is the basis of all modern scientific and technological endeavour is, of course, the decimal place system using 9 digits and the zero. India also has to its credit major mathematical discoveries in the branches of algebra, geometry and astronomy.

In addition to Ayurveda, its famous health-oriented system of medicine, India had made notable advances in the field of surgery lithotomy, rhiniplasty, trephining as well as surgery with sharp and blunt instruments were used in the ancient times. Some Indian clans in the remote hills, as well as in some not so remote rural areas, still practice these sciences.

In the field of metallurgy, bronze castings and rust-proof iron pillars, as well as chemical distillations and great masonry observatories were known in ancient and medieval times as well.

Between the 12th and 18th centuries over 10,000 books on science and technology were written in India. There was free flow of knowledge between India and the middle-East.

Presented by Parvez Dewan

The Recent Past:

The British rulers of the colonial era tailored science and technology development in India to meet the needs and requirements of the colonial government: for revenues, defence, communications (for trade) and administrative control of the country.

Still some very valuable work got done. The country and its physical features were comprehensively and scientifically mapped for the first time. A nation-wide network of metereological laboratories and observatories was set up. Pioneering work on malaria and kala-azar was carried out. Fairly modern communication systems were set up.

The Indian Renaissance:

The 20th century brought with it a major reawakening in the Indian scientific community.

J.C. Bose first worked on the experimental demonstration of the production and detection of 5-25 mm electromagnetic waves, and later on accurate measurement of biophysical parameters relating to plant growth and behaviour. C.V. Raman discovered the famour Raman Effect in 1928. S.N. Bose worked with Einstein on the Bose-Einstein statistics. Meghnad Saha's theory on thermal ionization and Srinivasa Remanujan's work on number theory are equally well-known.

PLANNED DEVELOPMENT

After Independence in 1947, and especially with the advent of planned development in 1951, science and technology got a new boost. A chain of national laboratories covering the whole spectrum of science and technology, including medical and biological sciences, as well as engineering, were set up. Similarly, advanced research in nuclear energy and fundamental scientific research were encouraged. A major space programme was launched. Statistics were harnessed in the cause of planning. Expenditure on scientific and research has increased manyfold over the years.

Outlay (Rupees in millions)

Plan Number	Years	Plan amount	Non-Plan amount	Total
1st	1951-56	140	60	200
2nd	1956-61	330	340	670
3rd	1961-66	710	730	1440
4th	1969-74	1420	2310	3730
5th	1964-79	6930	6870	13800
Annual	1979-80	2080	2220	4300
6th	1980-85	19190	14780	33970

Assuming one US$ to equal Rs.5 during the first plan and Rs.10 during the 6th plan, one can say that Plan expenditure on scientific research has gone up from US$ 28 m. in the 1st plan to US$ 1919 m. in the current plan. Three quarters of this expenditure goes towards just five sectors: agriculture, atomic energy, space research, industrial research and general S and T matters. India now spends close to 0.6 per cent of its GNP on S&T.

S&T INFRASTRUCTURE

Today India has about 130 specialized institutions and laboratories engaged in R&D. These would be too numerous to list. Hence, I will merely mention the departments they come under, to give an idea of the scope of their activities: The Indian Council of Agricultural Research, the Council for Scientific and Industrial Research, the Indian Council for Medical Research, the Departments of Atomic Energy, Space, Electronics, Science and Technology, Ocean Development, Environment, Non-Conventional Sources of Energy, and Electronics; The Defence Research and Development Organization.

In addition, there are over 700 in-house R&D units in the various industrial corporations. Consultancy organizations have also blossomed. Over 150 such organizations today emply nearly 24,000 scientists and technologists.

India is keenly aware of the strides being made in the newly emerging and frontier areas of technology. Efforts are being made to create an infrastructure for VLSIs, micro-processors, biotechnology, new sources of energy and fibre-optics. In many of these fields some advance has already been made. A National Biotechnology Board has been set up, and also a Semi-Conductors Complex.

APEX MANAGEMENT

The scientific departments (which include Atomic Energy, Electronics, Environment, Space and Ocean Development) are being looked after directly by the Prime Minister of India, who is also the Presient of the national Council of Scientific and Industrial Research.

The Union Cabinet or the council of India's highest political executive at the central level has invariably had a scientific advisory committee (SAC). Since 1981 the SAC to the cabinet has been chaired by the member (Science) of the National Planning Commission. In addition there is a Cabinet Committee on Science and Technology chaired by the Prime Minister.

Manpower Management:

A National S&T Entrepreneurship Development Board has been set up to ensure that India's S&T personnel do not remain unemployed or misemployed. A National Council for S&T Communication

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has been set up to disseminate information regarding scientific developments and achievements, as well as to inculcate a scientific temperament in society.

The SAC to the Cabient has also concerend itself with the utilization of Indian scientists working abroad, the need for increased support for S&T in the educational system and the removal of regional disparities in scientific development.

POLICY FORMULATION, PLANNING AND COORDINATION

The various departments mentioned above, as well as various ministries of the Government of India, are responsible for R&D in their particular sector or investment and production in that area, as the case may be. The central Department of Science and Technology (DST) coordinates R&D efforts to an extent. It also helps remedy gaps and imbalances. Naturally the overall task of harmonising sectoral plans with the nation's priorities is that of the Planning Commission.

The DST provides the following facilities :

i) Through its Regional Sophisticated Instrumentation Centres it makes available to the scientific community major instruments that are either needed for a very short time, or are too expensive, or what is usual, both.

ii) It provides support to intensification of research in high priority areas such as biotechnology, plasma physics, cardio-pulmonary physiology, etc.

iii) It operates inter-disciplinary, multi-institutional programmes, e.g. algae as bio-organic fertilizer, new fibres and composites, instrument development programmes, etc.

iv) It provides grants-in-aid to institute outside the government sector engaged in advanced research.

v) It tries to ensure that technologies evovled in the country are made use of by industry.

vi) It encourages scientific activities in the states.

vii) It promotes technology in rural areas.

viii) It provides secretariat support to the SAC and the Working Groups and Task Forces of the Union Cabinet.

ix) It tries to mobilise the know how available with Indian scientists and technologists now working abroad.

POLICY

The Scientific Policy Resolution:

In 1958 the Government of India adopted a Scientific Policy Resolution which emphasized that national development was possible only through "the effective combination of three factors, technology, raw materials and capital, of which the first is perhaps the most important ... But technology can only grow out of the study of science and its applications..."

The Policy, briefly, was:

i) to foster, promote and sustain the cultivation of science, and scientific research;

ii) to ensure an adequate supply, within the country of research scientists of the highest qualtiy;

iii) to encourage and initiate programmes for the training of scientific and technical personnel on a scale adequate to fulfill the country's needs;

iv) to encourage the creative talents of men and women;

v) to encourage individual initiatives for the acquisition, discovery and dissemination of knowledge;

vi) and to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge.

The Technology Policy Statement:

In 1983, the basic objectives of India's Technology Policy were spelt out. Its aims are to:

i) attain technological competence and self-reliance to reduce vulnerability;

ii) provide the maximum gainful and satisfying employment to all strata of society;

iii) use traditional skills and capabilities, making them commercially competitive;

iv) ensure the right mix between mass production and production by the masses;

v) identify and eradicate obsolesence in technology;

vi) develop internationally competitive technolgies, particularly those with export potential;

vii) improve production through greater efficiency and fuller utilization of existing capabilities, and enhance the quality and reliability of performance and output;

viii) reduce demands on energy, especially non-renewable energy;

ix) ensure harmony with the environment, and especially to preserve the ecological balance; and

x) recycle waste material and make full utilization of by-products.

Technology for the Weaker Sections of Society:

One of the sorry aspects of Indian society has traditionally been the shabby treatment of certain castes. These castes, as well as certain tribes, have, since the emergence of the Indian Republic and the adoption of its constitution been scheduled in the constitution. They are now the beneficiaries of the world's oldest and most wide-ranging programmes for affirmative action or positive discrimination.

During the current Five Year Plan (1980-85) it was decided to launch specific S&T schemes for these castes and tribes, as also for other weak sections of society, such as women and hill-dwellers. A host of subsidies, waivers and benefits have been earmarked exlusively for these sections. It may be added that often caste and even sex, and occupation are interlinked. Persons from many of these castes are artisans or labourers.

The scheme is aimed at the:

i) improvement and development of new technology for existing as well as for linked occupations and sectors in which the primary beneficiary groups are engaged currently;

ii) improvement and development of new technology based on locally available existing and new resources;

iii) Encouragement and promotion of multi-sectoral approach to technology development and utilization preferably through a portfolio of projects and programmes; and

iv) Support to and promotion of all activities starting from identification of technological needs and generation, through field trials and adaptiove research, development and design upto setting up and operation of demonstration units to obtain utilisable know-how.

EXPERIENCE AND PROBLEMS

The results of its scientific and technological endeavours have been heartening for India. Enrollment in engineering and technology degree programmes have moved up from 3,000 in 1947 to 33,000 in 1981. Today there are 119 universities affiliating about 1650 colleges, five institutes of technology, 150 engineering colleges, about 100 medical colleges and 350 polytechnics. About 160,000 scientific and technical personnel are produced each year. With 2.4 million such personnel, India ranks next only to the USSR and the United States in this field.

While there have been some significant achievements, some problems continue to remain.

Agriculture:

India used to be known as a bread basket case. In recent years, however, it has been able to cope with some lean years through its food reserves.

Against 45 m. tonnes of foodgrains in 1950, today over 150 m. tonnes are produced. There is a fairly advanced plant and animal genetic resources conservation programme; the soil map of the country's 186 land resource areas is being prepared; high yielding and disease resistant varieties of plants are being tried out successfully; energy intensive fertilizers are being replaced by bio-organic regimes; good quality agro-implements are being produced.

Challenges ahead:

It is not as if India can now sit back and relax. It would be necessary to increase the yield of rice, pulses, oilseeds, and many cash crops; encourage large scale energy plantations and social forestry programmes; shift to bio-organic fertilizers; ensure that food is regularly available to our constantly growing population that is large enough as it is; consolidate and build buffer stocks; and, ultimately become a food exporter.

Possibly 40 percent of India's exports come from Agriculture, and 70 percent of Indians are engaged in it.

Medicine:

Successes include raising of life expectancy from 32 in the fifties to 50 today; decrease in crude death rates from 47.2 per thousand to around 15 today; infant mortality has come down - but nowhere near the point where we wish it were; the last census revealed that the birth rate had slowed down by a tenth of a percent -- once again progress here is far less than satisfactory, but the first signs of success are being seen.

Notable successes have included the eradication of small pox, the domiciliary treatment of tuberculosis; major advanced relating to nutritional disorders; there was a time it was believed that malaria had been eradicated but in the last few years the disease has raised its head again by inflicting many fatalities; kala-azar is no longer the problem it used to be; and deaths due to diarrhea have come down.

Problems:

In the field of health the backlog of problems continues to be the greatest. Major challenges to medical science in India include; population control; control of communicable diseases like malaria, filariasis, hepatitis and the problem of leprosy and tuberculosis, not to mention malnutrition.

Technological challenges continue to confront India. It is no longer enough to import Western technologies on the assumption that Western conditions can be replicated in India through technology.

For example, the oral polio vaccine does not work as well in India as it does in the West even when the potency of the vaccine (containing live virus) is ensured during transit under cold chain conditions.

Then the BCG vaccine is not really effective against tuberculosis in South India. The reasons are not clear.

Other mysteries which India needs to solve without the benefit of experience of dissimilar advanced countries include the dosage and effectiveness of drugs for the chronically undernourished and for those suffering from endemic parasitic diseases; and the interaction of common drugs with contraceptive agents.

Nuclear Energy:

Today India can cover the entire range of activities such as exploration and mining for atomic minerals, preparation of high purity nuclear materials, production of fuel elements for reactors, the design and construction of power reactors and their control systems, the production of heavy water and health and safety instruments.

The goal is to achieve self-reliance and reduce vulnerability in this area and to pursue related areas in the use of radio isotopes for agriculture, medicine and industry, as well as fall-out relating to electronics.

Space Research:

India has launched six satellites for communications, earth observations etc. It has also undertaken two successful projects, one (SITE) for nation-wide experimental television, and the other (STEP) for telecommunications.

Future efforts will be devoted to launch Polar (PSLV) and Augmented (ASLV) Satellite Launch Vehicles; advanced satellite design; improved techniques of space communication; and better use of space applications. Ultimately India proposes to replace the foreign procurred INSAT spacecraft with indigenously designed, developed, tested and qualified operational satellites.

PERSPECTIVES

Though India is among the world's ten most industrialised countries, several individual states of the United States or individual republics of the USSR signly produce more industrial goods than all of India put together. Inspite of the country ranking high among many fields, there is an undesirable skew in the nature and quality of its technological products.

Considerable strides have been made in many spheres of technologies such as indigenous tractors, construction industry, rural technology, alternate and renewable sources of energy, electronics goods, ocean development and mining of the sea-bed, environmental sciences, etc. Many of these developments have helped to save foreign exchange and increase export earnings.

Yet there are several persistent problems and challenges.

Energy:

The cost of our oil imports is still staggering. Improvements to indigenous and technological capacity is needed for oil exploration, utilization of natural gas, production of liquid fuel from cellulostic material, and upgrading the technology for the production of oil and gas, development of 150 kw aerogenerators against the present 5kw, more efficient photovoltaics, better ocean and thermal energy converters, and high voltage electrical transmission.

Metereology:

A better understanding of the mechanism of the monsoon, and of tropical metereology is required.

Oceanographic Research:

Here the target areas are off-shore hydrocarbons; fishery resources to augment food supplies, especially proteins; understanding of the weather, particularly the monsoon and easterly weather structures across the Bay of Bengal; mineral resources; and pollution.

High and Newly Emerging Technology:

Here again there is a long list of targets. The draft Third Country Programme prepared for UNDP's Governing Council session in mid 1985 contains over 90 such areas of specialisation.

Broadly these areas cover Energy Studies, Cryogenics, Atmospheric and Environmental Sciences, Ocean Sciences and Engineering, Material Sciences, Resource Engineering, Microprocessors, Solar Energy, Fibre Optics, Biotechnology, Fibre and Optical Communication, Genetic Engineering, Remote Sensing and the Hydrofracture of Coal.

S and T Planning and Management:

Here the main problem is to translate the achievements of the scientists and technologists into actual and real prosperity for the common person. Advances made in advanced fields such as the mining of polymetallic modules from the sea bed, or in photovoltaics, or in oil exploration can be translated with tangible benefits for the poor.

The lab-to-land scheme has been very successful in the case of agriculture. Many of the results of the work done by the Defence R and D Organization has been transmitted to certain applications as for example their work on vegetable development in Ladakh.

However private industry has been slow to make use of indigenous research. For instance, depsite proven technology for colour television within the country, many private corporations prefer imported technology. A host of incentives are being given to these corporations to use indigenous technology -- including delicensing, tax concessions and preferential treatment.

There is a need for better planning and coordination of S and T policy, especially to remedy gaps and imbalances.

There is also a need to solve the problem of migration of highly qualified scientists and technologists.

SCIENCE AND TECHNOLOGY DEVELOPMENT IN MALAYSIA

POLICIES AND TRENDS

INTRODUCTION

The social and economic development strategies and plans in Malaysia are based on the New Economic Policy (NEP). The NEP, which was adopted in 1971, has a two-pronged objectives of:

i) reducing and eventually eradicating poverty by raising income levels and employment opportunities for all Malaysians, irrespective of race; and

ii) accelerating the process of restructuring society to correct economic imbalances so as to reduce and eventually eliminate the identification of race with economic functions.

The emphasis of the NEP is on the achievement of better distribution of income, wealth and employment among the various ethnic groups that constitute Malaysia's multi-racial population of 14.8 million and also among regions in the country in the context of an expanding economy.

Malaysia does not, at the moment, possess an explicit science and technology policy as the subject of science and technology is diverse and overlaps various functions of different Ministries. This does not mean, however, that science and technology development is neglected. On the contrary, science and technology development in the country is considered as an important component of the overall development plan of the country and hence is incorporated into the development activities of the various Minsitries. Malaysia tends to relate science and technology with economic development and as such, science and technology becomes an integral part of the socio-economic plans. The development of science and technology is geared towards complementing efforts to achieve national goals and objectives.

Presented by Mohamad Noor Ajala

Therfore, it can be said that scientific and technological development trends in the country is closely reflected in the 5 year socio-economic development plans of the country and its development is emphasized in the sectoral development plans.

The socio-economic development policies of the country, are centrally planned, through consultation with the private and public sectors, into short term plans of 5 years duration each. Presently, Malaysia is in the midst of its 4th Development Plan (1980-1985) and currently planning for its 5th Development Plan (1986-1990).

Science and Technology Trends:

In 1970, the Malaysian Government declared that one of the pillars of the "Rukunegara", the National ideology, should be dedicated to the building of a progressive society orientated towards modern science and technology. This reflects the commitment and recognition by the government of the development of science and technology as a means towards modernisation and the key to rapid industrialisation. Subsequently, strategies were designed in various sectors to plan programmes geared towards the utilisation of science and technology for development. The first significant effort by the government in this direction was the implementation of educational programmes and infrastructure based on science and technology in an effort to increase the scientific manpower skilled in the utilisation of modern scientific techniques. Various technical institutions were established to train middle level technicians and in the primary and secondary schools. students are encouraged to enter the science stream rather than the arts stream as an overall plan to equip the nation with enough scientific and technical manpower.

Perhaps the most significant move by the government to boost scientific and technological activities in the country is the establishment of the Ministry of Science, Technology and the Environment. The establishment of the Ministry represents a spin off consequential to the promulgation of the "Rukunegara" and the launching of the New Economic Policy (NEP) with the ultimate aim of having a central agency or Ministry reponsible for the planning, promotion and coordination of all scientific and technological activities and development in the country.

The Ministry, as first established in 1973, was known as the Ministry of Technology, Research and Local Government. Shortly after in 1974, the Ministry underwent a change and was renamed the Ministry of Technology, Research and Coordination of New Villages. A number of agencies were placed under its jurisdication i.e. the National Institute of Scientific and Industrial Research (NISIR), the Standards Institute of Malaysia (SIM) and the Chemistry Department. As a result of the government's awareness of the need to create a Ministry solely responsible for guiding science and technology development in the country, a single Ministry responsible for science, technology and the environment was eventually created in 1976. The Minstry's role was further strengthened by the establishment of the National Council for Scientific Research and Development. This councl was primarily set up to advise government on scientific and technological matters.

The Standards Institute of Malaysia (SIM) and the National Institute of Industrial Research (NISIR) were merged through an Act of Parliament in 1975. This statutory institute, place under the jurisdiction of the Ministry of Science, Technology and the Environment, was named as the Standards and Industrial Research Institute of Malaysia (SIRIM). The institute was established to provide an impetus to industrial development through coordinated and concentrated efforts and to provide technical assistance and consultancy in areas relating to production, technological problems and the quality of goods produced. In 1977, the Coordinating Council for Industrial Technology Transfer was formed with the main intention of accelerating industrialization and coordinating various agencies which have been entrusted to perform activities related to technology transfer.

The Ministry of Science, Technology and the Environment was also given the important responsbility of coordinating and monitoring the activities of the Tun Dr. Ismail Atomic Research Centre (PUSPATI). This was to ensure that nuclear science which, at the time was a new field in Malaysia, would be given careful attention by a Ministry responsible for science and technology development and to ensure that the full potential of using nuclear science for development could be fully realised.

Research and Development Trends:

R&D activities on the other hand, can be traced as far back as 1879 with the establishment of the Forest Research Institute. This was subsequently followed by the establishment of the Institute of Medical Research in 1901 and the Rubber Research Institute in 1925. During the 1960's, Malaysia's economy depended mainly on the revenue received from the export of rubber and tin. As a result, the economic strategy of the government was to encourage diversification of the economy through research into efficient utilisation and extraction of natural resources. The Malaysian Agricultural Research and Development Institute (MARDI) was established in 1969 as a statutory body under the Ministry of Agriculture to conduct research into agricultural crops except rubber. Due to efforts undertaken by the Ministry of Agriculture and research activities conducted in MARDI, the large scale development of oil palm began in the 1970's as an important alternative crop to rubber. Subsequently due to the successful introduction of oil palm as a second crop in the country, the Palm Oil Research Institute Malaysia (PORIM) was established in 1979. Research undertaken by PORIM is financed by a cess fund, whereby palm oil producers are required by law to contribute a certain percentage of their income to the fund, as in the case of the Rubber Research Institute where cess is collected to finance research on the production of rubber. Research activities at

PORIM are based on the search for new methods to increase production of palm oil, to popularise the use of palm oil as an alternative to other oils and the search for new uses of palm oil and its by-products.

The 1970's saw the implementation of the New Economic Policy (NEP) and the launching of the national industrialisation programme and this naturally led to greater and more effective diversification of scientific and technological activites. Scientific and technological research in agriculture was geared towards the search for new clones, high yielding and fast maturing seeds for boosting the yield of various agricultural products especially palm oil and rubber. Research institutions like MARDI,and PORIM reacted instantly to the twin objectives of the New Economic Policy of eradicating poverty and accelerating the restructuring of society by concentrating on programmes to upgrade the income of the rural populatin who are basically involved in agricultural activites. These research institutions also concentrated on efforts to help the small-scale farmers through technology transfer in small-scale agro-based industry or processing plants or cottage industry whereby downstream economic activities to further process their crops can be carried out. Industrial extentsion work and technology transfer became more important.

In the late 1970's, the industrial sector became increasingly important as the government realised that in addition to setting up important substitution industries priority should also be given towards the setting up of an agro-based industry as a strategy towards increasing value-added to primary products and also as a measure to cushion against adverse fluctuations of commodity prices in the world market. During the 1970's, Malaysia's economy grew at an average rate of 7.9% per annum while per capita income increased from US$371 in 1970 to US$1637 in 1980. Significant structural changes occurred in the economy especially in the later part of the 1970's. The contribution of the manufacturing sector increased sharply from 13.4% in 1970 to 20.5% in 1980 while the agricultural sector declined from 30.85% in 1970 to 22.2% in 1980. This trend clearly indicates Malaysia's socio-economic strategy to encourage industrialization and to slowly move away from an economy that is mainly dependent on agriculture.

It is evident from the above that scientific and technological development in Malaysia, though not guided by a national science and technology policy, followed certain trends and adhered closely to the overall economic strategy.

POLICY AND TRENDS IN THE 1980'S

Social and Economic Development:

During the 1970's Malaysia's economy was growing at an average rate of 7.9% per annum. This progress was achieved despite adverse developments in the global economy during the decade. The industrialised countries experienced mild recession in 1970-1971 and by 1972-1973 were experiencing double digit inflation. In 1975-1978, due to oil shortage and political disturbances in the world, there was a sharp increase in oil prices and by the mid-1970's there was a slowdown in the rate of growth of industrialised countries. The price of oil increased further during 1979-1980.

By the end of the decade, curbing inflation became a crucial issue of economic policies as the world economy continued to suffer from the effects of inflation and increasing oil prices. In Malaysia, throughout the 70's and 80's, the economy attained a high rate of growth mainly due to the discovery and production of petroleum off the east coast of Peninsular Malaysia and Sabah and also due to the high price of palm oil which has become one of the main agricultural crops in the country. In the 1970's, the relatively abundant resources enabled the government to play a larger and more vital role in the promotion of industry and commerce, as well as to continue providing the necessary infrastructure and services for scientific and technological advancement. In the 1980's, however, due to prolonged recession in the advanced industrialised countries, there was a sharp decline of commodity prices, resulting in diminishing returns for Malaysia.

The combined adverse effects of recession and inflation had profoundly affected Malaysia's economy in the 1980's. Since more than half of the national income is derived from external sources while investments are increasingly financed from abroad, not only are the prices of primary commodities affected but there was a decline in the actual volume of some commodities traded. The increasing high rate of imports in relation to weakening exports had caused the balance of payments to swing from a traditional surplus to a deficit. The period witnessed a deceleration on the overall implementation programme of the economy.

Science and Technology Projects:

As a result of the sagging economy, an austerity drive was instituted which led to standstill budgetary allocations and in some cases, cutbacks from the normal operating budget in the public sector. Science and technology development projects were affected by this auterity drive. Only projects that benefitted the country directly and were most urgent and pressing in terms of providing facilities to the public were implemented. Therefore, during the 1980's numerous science and technology projects were shelved pending improvement in the economy. Among such projects were:-

i) The setting up of a science centre incorporating the concept of a science museum. The main aim of this project was to popularise science and technology and to [illegible]of the public in science and technology 2650

ii) The proposal to set up a national science and technology information centre to cater for planning of science and technology activities, and catering for the needs of researchers and academicians in the universities, research institutions and industries.

Nevertheless, inspite of the setback various projects were implemented in 1983. The Ministry of Science, Technology and the Environment, through the National Council for Scientific Research and Development, has initiated a review of the science and technology development trends in the country with the intention of strengthening the Ministry's coordinating, planning, monitoring and evaluating functions on science and technology development. This initiative led to discussions on the formulation of Science Policy for the country and is now at its final stage of preparation. The National Coordinating Council for Industrial Technology Transfer has also requested the Ministry of Science, Technology and the Environment to form a committee to propose to the government a Technology Transfer Policy. This committee was formed in 1982 and has conducted state of the art studies in various industries. At present, after studying models of technology transfer mechanisms from various neighbouring countries, the technology transfer policy is at the stage of being finalised.

Technology Transfer:

In the national social and economic policy level, there is a shift in the overal industrialisation policy of the government. Due to the recession and the effect of low commodity prices, a "Look East Policy" was introduced which is specifically meant for learning from the experiences and work ethics especially of Japan and Korea. Detailed studies were made of the progress made by them in science and technology, and research institutions in the country are presently studying their concepts and methods in the management of science and technology.

There was also a realisation by the government that Malaysia should venture into capital intensive, high technology based industries, with emphasis on resource based industries to act as a cushion against fluctuating commodity prices. It was also realised that only the government could provide the initiative and initial impetus for such capital intensive projects and this led to the formation of the government-owned Heavy Industry Corporation of Malaysia (HICOM). This company was established by the Malaysian Government to act as a catalyst to stimulate heavy capital-based industries in the country and as a channel for the inflow of high technoloyg into the country. The initial priority industries identified are cement, pulp and paper, sponge iron and motor car. It is envisaged that these industries will have a cost push effect on the creation of small and medium scale industries that will provide ancilliary services and products to the major industries. The spin off effect will be the establishment of a group of small and medium scale industries producing high technoogy precision products.

As a further boost to the inflow of foreign technoloyg and to ensure that the latest technologies are introduced into the country with adequate protection, the Ministry of Trade and Industry in consonance with the Ministry of Science, Technoloyg and the Environment will be implementing a new patents law which guarantees protection to innovators, technology owners and inventors. This law which is expected to be fully implemented before the end of the year is another measure by the government towards encouraging greater inflow of modern technology into the country. In addition, the Standards and Industrial Research Institute (SIRIM) will soon set up a Patents Information and Documentation Centre as a base for establishing a National Technology Information Centre. This centre will function as a service centre to the industrialists to aid them in technology choice, acquisition, pricing and technological problems.

SIRIM is also looking into the problem of translating research results into viable commercial undertakings and is setting up a unit to look into this aspect.

The National Agriculture Policy:

In 1983, the National Agriculture Policy was announced. This policy was formulated to maintain and sustain the growth of the agricultural sector in relation to the growth of the non-agricultural sector of the economy. The main objective of the policy is to maximise income from agriculture through efficient utilisation of the country's resources and the revitalization of the sector's contribution to the overall economic development of the country. Income maximisation refers to the maximisation of both farm income and national income. The maximisation of farm income, based on efficiency of production, involving the judicious selection of economically remunerative crops and employing the most efficient technology, will hopefully lead to the growth of the agricultural sector and consequently contribute to the overall economic growth and eventually towards a more equitable distribution of income as its main target. The National Agriculture Policy seeks to maximise farm incomes by increasing productivity. The production of all agricultural commodities, except rice, would be based on technical, including agro-climatic considerations, as well as economic returns. Rice production, however, will be based on national security considerations.

Agricultural support services such as research, extension and marketing will be given priority. Formerly, research and development in agriculture was concentrated mainly on increasing productivity and yield in the primary crops of the country. Now, research activities under the National Agriculture Policy stress commodity development and mechanization. These strategies will ensure high yield and improvements in quality in agricultural commodities and speeding up the process of technological modernisation. There will be a concentrated effort in conducting socio-economic research and data collection.

Extension services will emphasize on effective transfer of technology and research findings to farmers and to change their outlook so that they are more receptive to new technology introduced by the research institutions. Extension services will be strengthened to effect better coordination among them at both the planning and implementation levels.

RESEARCH AND DEVELOPMENT TRENDS

As far as research and development trends are concerned, the general direction for R&D development is that applied research in areas where Malaysia is already competent would be given special emphasis in order to develop the skills in design and fabrication of technologies appropriate to the national needs taking into consideration the climatic and cultural factors. The R&D trends foreseen in the future will be as follows:

Agriculture:

i) higher productivity through improved planting materials for crops like rubber, oil palm, cocoa, pepper and other crops;

ii) efficent production technology for agriculture through better utilisation of labour and other resources;

iii) post-harvest utilisation and processing of crops to prevent crop spoilage and other post-harvest losses;

iv) alternative uses of primary commodities apart from the already known uses so as to cushion against fluctuating prices and competition from near substitutes such as synthetic rubber against natural rubber, other vegetable oils like soya bean oil against palm oil etc.;

v) increasing rice yield through introduction of high yielding pest-resistant varieties and the encouragement of amalgamation of uneconomic rice plots into coo.erative farms whereby more economic practices and use of modern technology can be economically shared to enable efficient production methods on a large scale basis;

vi) introduction of other food crops such as fruits and vegetables into small scale farms to enable alternative sources of income to boost the income of farmers;

vii) utilisation of agriculture byproducts for the generation of animal feedstuff and biogas energy; and

viii) utilisation of remote sensing techniques on soil and ground analysis, climate and monitoring research.

Industrial Research:

i) on material sciences concerning properties of iron, tin, plastics, ceramics, alloys, glass and others;

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ii) on alternative sources of energy from biogas, solar, nuclear etc.;

iii) emphasis on building designs especially computed aided building design to cater for energy conservation, efficient material utilization and needs to adopt advance technology for structurally sound buildings;

iv) development of general mechanisms and infrastructure necessary to upgrade the technological know-how of industry in relation to technology acquisition, adoption and adaptation of technologies from abroad and to study the average time necessary for such technologies to be absorbed completely by the recipients;

v) testing of industrial products and building up of capability, of not only to test products but also to be able to give industrial consultancy services to the producers on product and process improvements;

vi) increasing the accuracy and uniformity of production process to enable ventures into precision product-making through the utilisation of facilities in the metrology laboratory in SIRIM; and

vii) linkages between industrial and research institutions whereby research institutions can provide high calibre technical consultancy and advisory services to the industries to overcome technical production problems.

Marine Sciences

i) energy resources exploration and exploitation for industrialisation and defence purposes;

ii) controlling pollution of the marine environment such as land-based discharges, oil spills, red tides etc.;

iii) know-how on utilization of the sea as a source of food and methods to maximise production from the sea;

iv) preservation of coral reefs and fish breeding areas in shallow sea beds;

v) conservation of sea turtles;

vi) conservation through gazetting of marine parks to guarantee unspoilt beauty for future generations and the restoring of fishing grounds.

Medical Sciences:

i) ecological control of endemic diseases;

ii) investigation of new diseases e.g. schistosomiasis; 2650

iii) development of new diagnostic procedures for blood, genetic and infectious diseases;

iv) assessment of new drugs for treatment and control of diseases;

v) the translation of advances in food and nutritional research into practical measures for improvement of the well-being of the people through R&D in surveillance of malnutrition in urban and rural areas, compiling of food balance sheet and food consumption patterns and habits;

vi) industrial health;

vii) primary health care especially in the socio-economic context; and

viii) biomedical research to eliminate the causative agents leading to the management of diseases.

Basically, the trend for science and technology development will be geared towards satisfying the objectives of the New Economic Policy (NEP) and the implied science policy in the country i.e. science and technology will be used as a tool for development. In relation to transfer of technology, a two pronged strategy will be adopted to strengthen the acquisition, absoption, adaptation of technology from abroad by encouraging the setting up of joint venture industries, import of machineries and capital goods. The strategy used is, firstly, to develop an internal atmosphere within the country for efficient and unhindered inflow of appropriate technology into priority targeted industries and secondly, to build up local expertise in the acquisition of technology through better technological information services, technology consultancy services, technology screening and evaluation services, fiscal and physical infrastructures so that buyers of technology are in a stronger bargaining position to acquire the technology at the most reasonable cost. Measures are also taken to ensure that the terms of contractual agreements on technology transfer are fair to the buyer and seller and do not jeopardise the interests of the nation.

In relation to endogenous technologies, the strategy adopted is to encourage scientific research institutions in the country to come up with endogenous technologies appropriate to local conditions and to strengthen extension services of such institutions so as to transfer these know-how to the targeted groups. Attention is also given to strengthening the infrastructure for technology transfer in research institutions and the commercialisation of their research results. Research institutions will play a major role in developing their technical consultancy services to the industrial sector so that the industries can achieve a certain level of technical know-how and expertise to review, adopt and adapt technologies to achieve a status of self-reliance in technology capability. On the other havd, industries are encouraged to conduct research and development activities by themselves. Incentives in the form of tax exemption on R&D expenditures was first given in 1982 and is still in force. Originally, incentives were only given to companies engaged in scientific research that is connected with the activities of the company but this clause was subsequently abolished in 1983. Now, a one and one third deduction is given to expenditures incurred in any approved research and development activity. The research can be carried out by the tax payer or on his behalf by any scientific institution, university or other institution of higher learning. Buildings for conducting research are to be considered as industrial buildings and the building cost incurred will be eligible for deduction from tax as in the case of industrial buildings.

The incentives were given due to the fact that there is very little R&D work in private companiues and major research continues to be conducted by government-funded institutions.

POLICY INFRASTRUCTURE

Ministry of Science, Technology and the Environment:

The Ministry of Science, Technology and the Environment is given the role for the planning, coordination and development of all activities related to science and technology. It is entrusted with the design and development of a National Science and Technology policy. Essentially the objectives of the Ministry are:

i) to develop and to promote the expansion of science and technology with the aim of impro ing the quality of life;

ii) to formulate, research, plan and determine that the extensive application of science and technology does not give rise to adverse effects so as to sustain a prosperous and peaceful nation;

iii) to ensure that material development through science and technology does not pollute the environment and destroy wild life and plants;

iv) to integrate physical development through science and technology with human and individual development in order to reduce undesirable conflicts and stress that may arise from environmental and technological changes.

The Ministry of Science, Technology and the Environment also functions as a centre for coordinating international relations on science and technology activities. It is the focal point for the United Nations Science and Technology for Development, the Asean Committee on Science and Technology and is a member of the National UNESCO Board and the Commonwealth Science Council. Though bilateral and international cooperation falls under the jurisdiction of the Economic Planning unit of the Prime

Minister's Department and the Ministry of Foreign Affairs, any offers of training fellowships and scientific and technological cooperation are referred to the Ministry of Science, Technology and the Environment. Therefore the Ministry acts as a focal point where such offers are coordinated and directed to relevant R&D institutions.

The Ministry is aided by the National Council for Scientific Research and Development in the planning for science and technology development. The Council advises the Ministry on matters relating to science and technology infrastructure, development, research priorities, science and technology planning and current problems in science and technology activities in the country.

The Ministry is also a member of the Council for Coordinating Industrial Technology Transfer and other technical committees which are established from time to time by other Ministries.

The National Council for Scientific Research and Development:

The National Council for Scientific Research and Development was established in 1975. Its general objectives are to ensure that scientific research activities are geared to national development needs and goals and its function is to advice government on all scientific and technological matters and to coordinate all scientific and research activities within the country.

The function of the Council are as follows:

i) be responsible for the formulation of Science Policy of the nation and undertake an innovative role in relation to science for the progress and modernization of society;

ii) to serve as the national scientific consultative and advisory body of the government;

iii) to identify R&D activities consonant with the national development objectives;

iv) to initiate and coordinate R&D activities of the nation and to ensure maximum utilisation of resources;

v) to develop the country's manpower potential for R&D activities;

vi) to collect and collate information on R&D, evaluate, print, publish and dessiminate documents related to R&D;

vii) to promote a free interplay in R&D between the private and public sectors;

viii) to recommend appropriate legislation for R&D activities;

ix) to undertake all other actions or measures that will provide speedy and effective scientific research and development in the country.

The members of the Council are appointed by the Minister of Science, Technology and the Environment and each serves a term of 2 years. Council members are normally drawn from various disciplines so as to reflect a fair and adequate representation from all the sciences. The Chairman of the Council is the Chief Secretary to the Government and is a permanent appointment. To facilitate the function of the Council and to enable issues and activities of scientific and technological development in the country to be thoroughly examined, various specialised committees were formed with representation from the Council and scienstists from various academic and research institutions. These committees are:

i) Agricultural Sciences Committee
ii) Industrial Sciences Committee
iii) Marine Sciences Committee and
iv) Medical Sciences Committee.

The Chairmen for the various committees are appointed from among members of the Council for a term of two years, subject to renewal for another two terms. The committees report to the council which normally meets once in every two months.

The activities of the Council are coordinated by a Secretariat which also coordinates the activities of the various committees, subcommittees, working groups and expert groups that are established from time to time. The Secretariat to the Council comes under the jurisdiction of the Ministry of Science, Technology and the Environment.

The National Coordination Council for Industrial Technology Transfer:

The Coordinating Council for Industrial Technology Transfer was formed in 1977 with the main intention of accelerating industrialization and coordinating various agencies which has been entrusted to perform activities relating to technology transfer.

Membership of the Council is based on specific representation from both public and private sectors. They are from the Ministry of Trade and Industry, Ministry of Science, Technology and the Environment, Economic Planning Unit of the Prime Minister's Department, Malaysian Industrial Development Authority (MIDA), National Productivity Centre (NPC), National Council for Scientific Researh and Development (NCSRD), Malaysian Industrial Development Finance and Industrial consultants (MIDFIC), Federation of Malaysian Manufacturers (FMM) and Standards and Industrial Research Institute of Malaysia (SIRIM).

The main task of the Council is to identify the priority sectors for development and to formulate technology transfer plans and policies as well as to monitor the technology development of the country in order to ensure a more effective growth of industrial and economic development of the country. It carries out public relation activities, coordinating and harmonizing reltionship between the donor and recepients involved in the process of technology transfer. It also cooperates with similar organizations in other countries in order to further promote technology transfer.

The Special Economic Advisor to the Prime Minister acts as the Chairman of the Council. The Council reports directly to the Prime Minister's Department. The secretariat to the Council is provided by SIRIM.

National Economic Planning:

The machinery for the planning, evaluation and coordination of national development is shown in the chart in the appendix. The Economic Planning Unit (EPU) of the Prime Minister's Department serves as the secretariat to the National Development and Planning Committee (NDPC) which has the overall responsibility for economic planning and development matters. The NDPC consists of heads of all major Ministries. The NDPC in turn reports to the National Economic Council (NEC), a committee of senior Cabinet Minister. The EPU coordinates the presentation of issues and policies for consideration of the NDPC and NEC.

This process, whereby fundamental issues are fully considered at the highest levels of Government, ensures that Malaysia's development policies and programmes meet the needs of the people in terms of the overall concept and strategy of the development plan. At the state level, the State Economic Planning Units and State Development Offices are responsible for formulating state development projects and programmes. In addition planning cells have been established in Ministries and departments to plan the departmental programmes and policies.

Implementation of programmes is the responsibility of executive Ministries, departments and agencies at Federal, State and regional levels. To ensure the effective implementation at the national and inter-departmental levels, the Implementation and Coordination Unit (ICU) was established under the Prime Minister's Department. The ICU serves as a secretariat to the National Action Council (NAC) which is chaired by the Prime Minister and serves as a forum to resolve implementation bottlenecks as well as to ensure that implementation of projects meet with national objectives.

Regulation of Industrial Technology Transfer:

The sole institution that screens joint agreements drom the economic and legal aspects and also to some extent from the technology transfer aspect is the Technology Transfer Unit of the Ministry of Trade and Industry.

The policy of screening and approving manufacturing agreements in Malaysia dates back to 1968 when the Investment Incentive Act was introduced. This Act was designed to attract industrial investment by providing total or partial tax relief to companies investing in new enterprises or expanding existing ones. Tax reliefs such as pioneer status allowed total exemption from income tax and development tax from 2 to 8 years. This incentive is only given to companies that submit all agreements signed with other firms for approval by the Ministry of Trade and Industry.

In 1975, the Industrial Coordination Act was introduced requiring all manufacturers employing 25 full time workers or more and with shareholders' fund of M$250,000 or more to apply for a manufacturing licence. The conditions laid down for the granting of licence is that the company must not enter into any agreement in starting up operations, technical know-how and assistance services (including employment of expert personnel), purchasing, marketing, payment of royalties and patents and trade marks without the prior written approval of the Ministry of Trade and Industry.

With the implementation of the Industrial Coordination Act in 1976, a Technology Transfer Unit was established in the Ministry of Trade and Industry with the following basic functions:

i) to ensure that all agreements signed will not be prejudicial to the national interest;

ii) to ensure that the agreements will not impose unfair and unjustifiable restrictions or handicap to the Malaysian party;

iii) to ensure that the payment of fees (wherever applicable) will be commensurate with the level of technology to be transferred and will not have adverse effects on Malaysia's balance of payments.

The Unit only plays a coordinating, advisory, regulatory and monitoring role while actual selection, evaluation and negotiation of technology are the responsibility of the local entrepreneurs themselves. During the period of January 1975 to October 1983, this Unit approved a total of 749 agreements of which 397 were for technical assistance and know how, 89 for management, 91 for joint ventures, 56 for services, 40 for trade marks and patents and 16 for basic engineering and 60 for other technical areas.

Japan topped the list in terms of the number of agreements approved. In terms of areas of technology, electronic and electrical industry is the highest at 17.9% while fabricated metal industry and chemical industry followed close behind.

Other Infrastructure for the Coordination of Science and Technology Development:

As was stated earlier, the screening and signing of technical agreements in technical and economic cooperation is the responsibility of the Ministry of Foreign Affairs and the Economic Planning Unit though such agreements are always referred to the Ministry of Science, Technology and the Environment for comments or suggestions if they involve science and technology matters. Thus the Economic Planning Unit and the Ministry of Foreign Affairs are the frontline offices for science and technological cooperation and the offers of cooperation are then relayed to the Ministry of Science, Technology and the Environment for action.

Recently, a committee was established in the Prime Minister's Department under the chairmanship of the Minister without Portfolio in the Prime Minister's Department to look into the training and manpower requirements for the HICOM projects.

Apart from this, the Malaysian Industrial Development Authority (MIDA) is involved to a certain extent on issues of technology transfer and it identifies projects and industries which the country requires in terms of utilization of resources, transfer of skills and location of industries. Industries that are encouraged to be set up through various joint venture bases and given incentives such as tax holidays, pioneer status, tax exemption on import of raw materials, quotas and protection against imports are all aimed towards the encouragement of the development of technical skills and expertise within the country so as to enable the industrial sector to absorb the technologies involved in the manufacturing process. MIDA has been active in promoting the free trade zone concept where industries are encouraged to be set up in certain areas whereby all the raw materials necessary for production are imported free of tax and all manufactured products are exported. The rationale behind this scheme is to provide employment for local manpower and to enable the manpower to increase the capability and know now to be absorbed into similar industries that will be set up later. Industries like microchip industries, electrical and electronic industries are identified as priority industries for the development of the industrial sector in Malaysia. Apart fom this, MIDA is assisting the Ministry of Trade and Industry to formulate an Industrial Masterplan with assistance from experts sent by UNIDO. This masterplan will identify the future development for priority industries and the necessary supporting scientific and technological know how and technical capability needed to enable future development of the industrial sector.

THE MAURITIAN SCENE

INTRODUCTION

Mauritius has an area of 2045 sq.km, and 477 people per sq.km with a gross national product of US$ 1270 per capita*. As a third world country it can ill afford to embark on fundamental research except in very narrowly defined areas; even then the meagre rsources dictate that it should rather go into research of an applied nature most relevant to its immediate needs.

The economy is one based mainly on the sugar cane, with a move towards industrialisation promoted by export processing zones to attract overseas investors and create employment so sorely needed.

S&T INFRASTRUCTURE

To feed appropriately-trained manpower into the above sectors the University of Mauritius was created in 1968 with three Schools intended to cater for the more important fields of Agriculture, Industrial Technology and Adminsitration. This major institution for Science and Technology (S&T) has stemmed from a previous College of Agriculture which used to form technicians for the mother (sugar) industry of the island, agriculture generally and, to a lesser extent, in management.

The College used to form part of the Ministry of Agriculture (MOA) where research activities in crop and animal production are still an ongoing concern; the reason is clearly to strive in making the country independent in so far as food products are involved. Food imports eat up a large proportion of hard-earned foreign currency acquired essentially through tourism, exports of sugar and its by-products, and some manufactured products besides certain other goods and services. Since industrialisation always implies energy, the import of fossil fuel accounts for an even greater proportion of overseas earnings than food - matters would have been far worse had the sugar manufacturing not been a net exporter of energy.

Presented by Francois Georges Carver

* This GNP per capita has effectively gone down with the soaring of the dollar between the time the paper was first prepared and the time of its presentation.

The third major S&T institution of the island is the Mauritius Sugar Industry Research Institute (MSIRI) which is financed from a cess on sugar produced and devoted to the development of new cane varieties, manufacturing processes and the peripheral disciplines concerend. The research is very practical oriented and the benefits reaped fast enough for a mainly privately run research institution.

The most important S&T society that has so far endured is the "Societe de Technologie Agricole et Sucriere de Maurice". Engineers are organised in the Council of Registered Professional Engineers (with government recognition) and the Engineering Institute of Mauritius concerend with the promotion of engineering.

The equivalent of a national research council does not exist in Mauritius. A first attempt, in the form of a Research Board, made by the University to group the three major S&T institutions mentioned above was followed by the setting up of a Research Committee grouping the three institutions in the wake of a National Seminar on Agriculture Diversification 1980. Although long standing institutions with their own independent research commitments, the MoA, MSIRI and UM have had fair success in coordinating their research activities. However, there are thoughts in government circles to set up a national research organization to coordinate all research activities. There exists no Ministry of Science and Technology as yet in Mauritius.

TRANSFER OF TECHNOLOGY

Apart from overseas industrialists implanting known technologies in Mauritius to take advantage of the export processing zones, tax incentives/holidays, and the relatively cheap local labour, a number of local entrepreneurs have managed to identify commodities and products that can act as substitutes for the imported ones. A number of administrative obstacles need to be overcome, the necessary capital raised, an import permit obtained and, with any luck, a development certificate obtained which carries with it tax holidays for five years. This activity creates employment; even if the substitution product is sold at a slightly higher price than the imported one, this is of little consequence so long as the quality of the locally manufactured product is up to an international standard. This is the weakest link in the system: after the issue of the development certificate and the manufacture started that the public often complains of poor quality of goods not meeting a standard. The authorities should ensure that the product must meet a local/international standard before issuing the development certificate. Matters are worsened when an import quota is imposed to protect a local industry manufacturing substandard goods.

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The import of a technology may well be technically and economically attractive but what if it is an outdated technology that is not recognized as such for lack of proper structures to scrutinize the offer, not by economists alone, but by scientists and engineers who can really understand the process, compare it with alternatives, visit a plant where it has been demonstrated (as a reference point), and pronounce on its suitability and viability. On the small enterprise scale, the Small Scale Industries' Unit of the Ministry of Industry offers valuable advice, but the number of permits required to set up such an industry can be deterring, and hence technological development impaired.

The protection of intellectual/industrial property is disseminated among three ministries, copyright (Education), trade marks (Finance), patents (Industry); they ought perhaps to come under a single umbrella.

FORECAST AND EVALUATION

The University could also help in technology forecast and evaluation in the domains relevant to its Schools, if only it were given first responsbility instead of relying on overseas "experts" who come and gather information from the University and other locals to repeat them in reports. The "help" from such expertise often comes at a huge cost, often with high interest rates, which could be diverted to finance more productive areas and possible visits overseas to ascertain the adequacy of technologies envisaged. In the meantime, an industry/university committee has been established to work out ways and means of offering mutual help.

To change the outlook of Universities, often accused of being ivory towers and inward looking, our academic institution is contemplating the setting up of a consultancy unit to help in all fields possible, with the help of similar institutions overseas with which links have been forged and where staff exchange is possible at minimal cost to the institutions concerend since international travel costs are borne by benevolent organizations or donor governments.

CO-OPERATION

Aid for S&T institutions, including their creation, has been forthcoming as the need was felt and expressed by Government donor countries, and for this we are most thankful. However, such aid has arrived in fits and starts, without real coordination.

We have a Meat Authority and Fisheries Research Station donated complete with building and equipment, which have proved quasi white elephants, at least initially. The Archieves have received micro-film equipment for recording documents falling apart with age but they cannot afford the film to use such equipment. On the other hand, laboratories of vital importance to science are operating on budgets of stagflation with no possibility of maintaining, let alone purchasing, equipment. All this has been made evident to the author as a member of an "Adhoc Committee to look into the Centralisation of Laboratory Services"; the report is awaiting further action. A number of different brands of Geochromatography are deployed in various laboratories of different institutions within a 200-metre radius. A lot of spare parts and technicians are needed for running and maintaining them.

The planning of human rsources development in the field of S&T has been rather on an ad hoc basis, the needs being filled as they presented themselves, with again the generous help of countries donating scholarships. Forecasts have proved difficult and the present situation is that of a glut of graduates who have remained unemployed as a result of reading in fields of interest to them but of little or no value in fields of development. The Government is now defining areas in which it offers scholarships.

Cooperation on the regional level (Indian Ocean islands of Reunion, the Seychelles, the Comoros, Madagascar) exists mainly in the form of AIRDOI (Association des Institutions de Recherche de l'Ocean Indien). An association of Universities of Eastern and Southern Africa has recently drafted a constituion in Harare (June 1984); among the intentions expressed was that of avoiding the creation of a centre of excellence if it already exists in the region. Mauritius has one such centre of excellence in the domain of Sugar Technology, shared by the MSIRI and the University of Mauritius. This is clearly one field of S&T which need not be duplicated in the region.

At the international level, the linkages with Universities and institutions in the United Kingdom, France, etc., have been established for reciprocal exchanges, particularly in S&T.

For example, the Commonwealth Science Council (Commonwealth Secretariat) is sponsoring local research in biogas* and solar driers; the Council for International Cooperation in Higher Education (CICHE, Britich Council) will be promoting S&T research and development at the University in the vanguard areas of Microelectronics, Physical Resources Planning, Biotechnology, Energy Studies, to name a few. All these topics require planning both in terms of human resources and appropriate equipment. For Marine Sciences, a linkage has been forged with the University of South Carolina; one must realize that the island and dependencies entitle us to roughly half a million of square miles of sea territory which is being exploited by foreign fishing vessels with impunity.

At a recent seminar held in Malaysia to discuss the mobilisation of indigenous S&T professional organisations to further development of developing countries, the issue was side tracked into a discussion of the organisations themselves rather than their mobilization.

CONCLUSION

An overall reformation of the system and more incentives to scientists and engineers in terms of both job and personal sastisfaction may perhaps stem the reverse transfer of technology, which is estimated at not less than US$150 million per annum from the Third World. In this respect, the planning and management of S&T is most desirable, possibly by the creation of Ministry of S&T. Organize a National Council for R&D to monitor S&T needs to be set up for better coordination of institutions/organizations.

NATIONAL SCIENCE AND TECHNOLOGY PLANNINNG IN MEXICO

INTRODUCTION

In countries like Mexico which still lag behind in technological self-determination in many areas, the interest in the national planning of scientific and technological development stems from a knowledge of their importance on independent economic progress as well as on the conviction that if they are allowed to evolve spontaneously, growth will be slow and the effects on economic development practically nil. In contrast to policies in the past, when a portion of public spending was alloted to institutions of research and technological development, now such spending is in the form of an investment with pre-established goals and a knowledge of the social values and characteristics which set the standards for these types of institutions. Thus, scientific and technological planning can be defined as the process whereby policies and actions are proposed to fortify and enhance the national system of science and technology, in close ties with the economic and social development.

This means a unique style of planning, adjusted to the objectives of society and to the interal and external factors bearing weight on the evolution of the country.

The intervention of the State in scientific and technological planning is justified, firstly because over 90% of national spending in these areas is made with public funds; secondly because public investment in the production of goods and services has multiplied; thirdly because there is a consciousness of the social cost of decisions involving the selection of technologies, such as environmental pollution, the abuse in the exploration of natural resources, and the deficit in the balance of trade; and lastly, because there is a consciousness that national goals have priority over private goals: an improvement of the living standard; a reduction of economic and social inequalities; technical self-determination; and international prestige.

State participation should not inhibit the role of affected communities. In scientific and technological planning the parti-

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Presented by Jorge Elizondo Alarcon

cipation of the scientific and technological communities is as necessary as that of the potential beneficiaries in the public, private and social sectors. Planning is not merely a technical matter requiring the intervention of specialists alone. For example, decisions on objectives which are crucial are based on value judgements and on subjective perceptions regarding the desirability of future alternative situations. It is a fact that Mexico requires not only the intervention of politicians and scientists but also that of the producers of goods and services; they are the ones who have a direct decision on the use of technology. This need defines the unique style of planning--a participation of various groups --and also defines the goal: a liaison of scientific and technological activities with the production of goods and services.

In scientific and technological development, the subject and the object of planning are based on an extremely complex economic and social macrosystem. Consideration must be given starting from consumer patterns right through the detection of scientific discipline, from which results are expected that affect the forms of future production in all sectors of the economy. This is why scientific and technological planning requires a multi-sectoral organization with an efficient exchange of information and points of view and with a close interaction with the various decision makers.

BACKGROUND

The first steps toward integration of Mexico's technical infrastructure were taken during the past century, through reforms in education legislation and the creation of professional schools adopted by President Juarez upon the consolidation of the Republic. Along the same lines, the National Univeristy was founded prior to the 1910 revolution, but during the revolutionary period the professional schools founded by Juarez were incorporated into the University. In the 1920s, government bodies responsible for the development of the hydraulic infrastructure and transportation were created followed by the organization of the National Polytechnical Institute under President Cardenas. In the last twenty years, there has been a progressive creation of numerous centers for the generation, diffusion and application of scientific and technological know-how.

For purposes of order and continuity in state actions related to science and technology, the National Council for Superior Education and Scientific Investigation was created in 1935, substituted in 1942 by the Commission to Develop and Coordinate Scientific Research, which in turn was substituted by the National Institute of Scientific Research and, lastly, by the National Council of Science and Technology (CONACYT), created by Law on December 29, 1970, amended by a Decree on December 27, 1974. The creation of the Council was the result of a study made in 1969 by the National Institute of Scientific Research with the participation of the scientific community.

The purposes of the CONACYT are established in the Law that created it, among which the following are highlighted:

"Article 2. To fulfill the purposes for which it was created, the National Council of Sciences and Technology will have the following functions:

"I. To act as advisor to the Federal Executive in the planning, programming, coordination, oreintation, systemization, promotion and direction of activities related to science and technology, their liaison with the national development and their relations with such activities in other countries.

"II. To be the mandatory consulting body for agencies of the Federal Executive, decentralized entitites and state owned companies, in matters related to investments or authorizations for funds allocated to scientific and technological research projects, higher education, the import of technology, royalty payments, patents, standards, specifications, quality control and, in general, in everything related to the proper fulfillment of its purposes.

"III. Provide advisory services to the State and County Governments and to individuals and companies pursuant to the conditions agreed in each particular case.

"IV. Draw up scientific and technological research programs in accordance with the national objectives of economic and social development, seeking at all times the broadest possible participation of the scientific community and the cooperation of government entities, higher education instituions and beneficiaries of the research.

"V. Promote the broadest possible communication and coordination among research institutions and higher education institutions as well as among the former and the State and the beneficiaries of the research, without detriment, in such case, of their respective autonomy or competence, to develop mutual areas of research and interdisciplinary pgorams, abolish duplication of efforts and assist in the formation and training of researchers.

"VI. Promote and fortify basic, technological and applied research as needed, and promote concerted action with public sector institutes, academic institutions, research centers and beneficiaries of the same, including the private sector.

"VII. Allocate additional funds from the State and other sources, toward academic institutions and research centers in order to promote and carry out research through specific programs and projects, without detri- 2650 ment to the own funds of the said institutions and centers, which can continue to manage and increase them.

"VIII. Promote the creation of new research institutions and propose the formation of companies that use national technology for the production of goods and services.

"XXVI. Carry out direct research exclusively in respect to research projects themselves, for which it will:

a) Improve and keep updated inventory of human resources, materials and financial resources oriented to scientific and technological research;

b) Establish priorities in respect to the national scientific and technological necessities; study the problems that affect them and their relations with the general activities in the country;

c) Set up a national scientific information and documentation service."

NATIONAL SYSTEM OF SCIENCE AND TECHNOLOGY (SINCYT)

The relationship science-technology-production points to the need of a joint plan to develop science and technology simultaneously, in accordance with the global objectives and strategies of economic and social development, bearing in mind the impact of science and the technology to be employed in solving the serious production, social and cultural welfare problems affecting the nation.

The purpose of such planning should include research activities as well as activities directed toward the formation of high level human resources in science and technology, activities that relate the results of research to the productive system, public information activities, and coordination and standardization of the whole. Thus SINCYT combines all the links in the chain starting from the generation through the publication and application of the scientific and technological know-how.

The purpose of the SINCYT is to produce new scientific and technological know-how and diffuse new findings generated both in Mexico and abroad, among all the strata of society, particularly in the productive system of goods and services.

To fulfill its purposes, science and technology should have well defined communication channels with other sectors of nations life. There is often a tendency to reduce the system of science and technology to one of its parts: the research subsystem. While this should be the nucleaus of the whole, to consider it as the whole leads to serious implications, mainly that research becomes isolated from its objectives. This leads to a definition of the National System of Science and Technology as the interrelated group of the following subsystems with their respective functions:

a) Research, whose purpose is to generate new scientific and technological know-how.

b) Research-production link which is to orientate the selection of technologies; apply technological know-how to the production of goods and services, and transform the requirements of national production into specific demands for technology.

c) Education-research link, whose purpose is to prepare researchers and professionals of the highest level, for the productive system.

d) Social communication, which is to diffuse for the use of society, information related to the nature, functions, problems and products of science and technology

e) Normative and planning, which should provide the legal and political framework within which the system of science and technology is to operate, establish a follow-up of this operation and evaluate it in terms of the national goals and strategies.

Research Subsystem :

There are many institutions in the ocuntry engaged fully or partially in scientific research and technological development. They may be grouped into three sectors: Higher Education Sector, including public and private institutions; centers and laboratories in universities; and technological schools. The bulk of basic research is carried out in these research centers although some, principally in engineering, agronomy and medicine, are often oriented to applied research and the development of technologies. Furthermore, they work to prepare squads of researchers, thereby uniting research activities with the formation of high level human resources. Many of these institutions enjoy administrative autonomy, which extends to research activities.

Public Sector includes all entities where research is carried out and which depend directly on or are coordinated by, a Ministry of State. Usually, this sector carries out applied research and development of technologies. Two groups can be distinguished:

a) Centers dependent on Ministries of State, whose objectives are consistent with the functions of those Ministries and are oriented to solving problems and offering scientific and technological services directly related to the operation of the said Ministries. Some examples are the centers that depend on the Ministry of Health and Welfare, Agriculture and Hydraulic Resources, and Energy, Mines and Public Industry.

b) The network of centers coordinated by the Ministry of Programming and Budget and CONACYT, where basic and applied research and the development of technologies are carried out, oriented basically to: i) the solution of major national problems, which generally are multi-disciplinary and inter-sectorial; ii) the forecast of changes in the country's economic, social and technological conditions within the international panorama, to give support to decisions of national importnce.

Private Sector, includes laboratories and research departments of private enterprise. In this group, the primary activity is technological development, but it must be noted that this type of activity in the private sector is still very weak.

Centers and institutes affiliated to higher educational institutions constitute the most important nucleus of basic research, although research necessities in the country are so vast that the actual size of this nucleus is still insufficient, particularly in certain areas considered as promisory for an independent technological development, such as those that will have an impact on the future production of food products and energetics.

Among the various qualitative aspects of the research subsystem, the following are highlighted:

- Centralization is enormous, both in respect to geographic location and to institutions. Despite the creation of many research centers throughout the states, between 80 and 90% of the researchers live in Mexico City and most of them belong to just four institutions.

- The academic level of the researchers is improving, but on the whole it is still low in comparison with the advanced countries. Around 25% of the basic science researchers have a doctorate and another 25% a masters degree. Education requirements for an associate researcher in most of the centers of the subsystem are very low usually a Bachelors' degree.

- Within the subsystem are found relatively strong and well developed research groups (particularly in agronomy, biomedicine, physics and certain areas of engineering and social sciences), with other very small and weak groups who have little or no impact.

- Still lacking are a set of standards and generalized practice for the evaluation of researchers, research groups and centers.

- The best endowed component of the subsystem, in so far as human resources are concerned, is basic research, but still lacking are policies, organization and mechanism to participate in projects linked to solving serious national problems.

- The disparity between Mexico's needs and the scarcity of healthy research groups is notorious; groups are needed for research on earth and marine sciences, meteorology, biology, economy and chemistry. In the first three areas, a differentiation of activities must be established between centers of applied research and those that compile data on natinal resources and conditions.

- The bond between national and international research centers for the exchange of data, information and researchers in on the whole inssuficient and, in some cases, non-existent.

- Domestic scientific equipment and materials are scarce and expensive and specialized workshops for their repair and maintenance are insufficient and, in some areas, non-existent.

- Some centers have economic instability because of insufficient and untimely financing.

Research-Production link subsystem

This subsystem is formed by: a) political instruments which promote and regulate technological development; and b) technological agents.

Some instruments stemming from the policies on technology were enforced in Mexico twenty to thirty years ago. The most prominent are the following, still in effect:

The Law on Control and Registration of the Transfer of Technology and the Use and Exploitation of Patents and Trademarks; it attempts to avert the acquisition of onerous technology by private enterprise or technology harmful to the national development.

The Law to Promote Mexican Investment and Regulate Foreign Investment attempts to control the amounts and orientation of foreign investment participation.

The Law of Patents and Trademarks has as its purpose the legal protection of technological developments. The 1976 Law establishes as a requirement that a trademark must be in effective use and the holder must prove its effective exploitation within one year following its registration.

The General Law of Standards, Weights and Measures attempts to establish technical standards for processes and products, and metrology for quality control.

The Decree that establishes the tax refund to exporters of technology attempts to reduce commercialization expenses. Also effective are the Decrees that create the Consulting Council for Technological Exportation, the National Registry of Scientific Institutions and the Registry of Technological Companies.

Lastly, there are several funds and other financial and credit instruments to lend support to the industry. Among the financial mechanisms are highlighted the three trust programs of Nacional Financiera: The Fund for Industrial Equipment Acquisition (FONEI); the Fund to Promote Exports of Manufactured Products (FOMEX); and the National Fund for Studies and Projects (FONEP). FONEI grants credit backings to prioritary national industries; FOMEX provides credits and financial guarantees for the development and sale of technology and technical services abroad; and FONEP finances preinvestment studies in high priority activities.

The following is mentioned in respect of the characteristics of the technological agents within the subsystem of research-production link:

Mexico has 13 engineers for each 10,000 inhabitants (the United States have over 100 and European countries and Japan, over 200). There are somewhat over 1,500 engineering firms in the country and almost 600 engaged in administrative consulting, organization of enterprises, economics, marketing, public relations, use of patents and trademarks and similar aspects, employing among them 30,000 persons. The natioal demand for engineering services is satisfied to a great degree in respect of feasibility studies, detailed engineering, purchasing specifications, selection of manufacturers and suppliers and building process supervision, but to a low degree in basic engineering. In the last years prior to the economic recession, the situation worsened; the growth rate of investment was higher than that of growth of human resources. There is a notable insufficiency of engineering and consulting services in the area of durable consumer goods and capital goods. On the other hand, sm ll and medium size industry has very limited access to engineering and consulting services.

Relations between research and development centers and engineering and consulting firms are practically non-existent. This is due to a great extent to the fact that those firms develop very little basic engineering which is, among their activities, the one most closely linked to research.

About 250 technical magazines are published in the country. Over half correspond to the agricultural and health sectors. Only 10% of all the magazines are oriented to industrial technology. Close to 30% publish original techniques and the remainder reproduce, in the form of news, technical information from abroad. Most of the technical books are translations and there has been no determined action to induce national researchers to produce high quality books or monographs on their specialties.

Education-research link subsystem:

It is constituted by post-graduate centers at higher education institutes. Between 1960 and 1983, studies at the level of bachelor of science grew at an annual average rate 12.2%, from 78,753 students in 1960 to 1,118,000 in 1983.

Of the total at this level, in 1983 37.3% majored in social and administrative sciences, 27.4% in engineering and technology, 20.9% in medical sciences, 7.2% in agronomical sciences, 5.8% in exact natural sciences, and 1% in education and the arts.

In respect to post graduate studies at the national level (specialization, master degrees and doctorates), they are heterogeneous in size, quality and features, the following facts being highlighted:

From 1970 to 1983, the number of students who went on to post graduate studies rose by almost 3.8 times; a slightly lesser growth than that at the bachelor level, which during the same years increased 4.1 times. In 1983, post-graduate studies were divided as follows: at the specialization level, 80% corresponded to health sciences and 15.5% to social and administrative sciences. At the master's level, 55% corresponded to social and administrative sciences, followed in importance by engineering with almost 17%. At the doctor's level, 45% corresponded to social and administrative sciences, 23% to natural and exact sciences, and 12.5% to health sciences. In the three levels, the area with the least growth corresponds to agronomy (with increases of 0.4%, 4.5% and 2.4% at the bachelor, master's and doctorate levels respectively).

At the bachelor level, the percentage is very high in respect to the social and administrative sciences; also noteworthy is the low percentage corresponding to the area of engineering and technology.

The ratio between the number of graduates and the total of students at each of the levels has remained steady, with slight annual variations, 25% in the specialisations, 15% at the master's level and 14% at the doctorate level.

The ratio of total post-graduate to total bachelor courses has remained steady in the last ten years, being close to 3% with a slight upward swing. By levels, the ratio of total specialization to total bachelor courses of study was close to 1% in 1983; the ratio of total master's courses to total bachelor courses that same year was around 1.7%, and the ratio of total doctorate to total bachelor courses was a minimum of 0.1%.

The number of programs offered every year in the country at the specialization level currently exceeds 300, at the master's level around 850, and at the doctorate level, the figure is calculated closely to 140 programs.

The average number of students registered by program is 25 for specialization, 22 for a master's degree and about 7 for a doctorate degree.

The supply of post graduates runs close to the market's demand only in certain biomedical specialties, and it is calculated that in areas linked to the country's industrial development, particularly engineering, the demand exceeds the supply by between 10 to 20 times.

Social communication subsystem:

The primary means available to the súbsystem for its purposes are libraries, publishers of textbooks and other books, mass communication media, scientific and technologicl museums, and especially zoos and botanical gardens.

The number of libraries is important because it indicates the number of accesses available to the public. There were 2,352 libraries in 1979, 1,835 of which have over 500 volumes. Of the 580 public libraries, 75 are within the Federal District and the others in the various states, but 64% of the municipalities have no library whatsoever. The majority of the 85,000 primary and secondary schools are also lacking a library and of the 2,290 medium and higher level schools, only 380 have a library.

Of the 1,935 libraries with over 500 volumes, 64% are general, 15% are specialized in social sciences and tne arts, and 20% in science and technology.

In 1979, the average in Mexico was 0.20 books per inhabitant; against 14 in the USSR, 6.36 in the United States, 3.26 in Japan, 2.98 in the Federal Republic of Germany and 2.55 in Canada and the Netherlands. Furthermore, practically all the libraries in the country are poorly endowed both in the number and the scholarly education of the library's personnel. As to the publishing of textbooks and other books, of 5,773 books published in Mexico, only 241 were textbooks.

Through the mass communication media (T.V. and radio), programs dedicated to science and technology are transmitted by Channel 11, by the Educational Network and the University Network and by the program "Science and Development", some with a sizeable audience, but Mexico does not have communication specialists able to translate the scientific and technical know-how to the community.

Mexico is one of the countries with the highest number of daily newspaper: 249; however there is practically no orientation in any of them to science and technology.

Mexico also publishes a very high number of magazines: 2,462. However, magazines with scientific and technological themes oriented to the non-specialized public are few. The best know are five: Science and Development, Scientific and

Technological Information, Universal Geography, Nature and Spark, this last publication being for children. Their circulation, however, is small (Science and Development publishes 50,000 while Nature, 4000). On one hand, they are highly priced and on the other, the reader needs a minimum scholarly level equivalent to a bachelor's degree to understand them. Two periodicals of the Secretariat of Public Education deserves a metnion: "How to do it Better" and "Manuals for Agronomical Educationa".

In contrast, the situation as far as science and technology museums and zoos and botanical gardens are concerned, is very poor.

Planning and Coordination Subsystems

Until 1982, Mexico did not have a science and technology policy stemming from a national development project; consequently, State action has not had sufficient information or orientation to deal with matters of such importance as the growth capacity of the research system, the areas of know-how most needed for national development, the proper mechanisms for linking research, higher education and proudction, and the strategies of the import-assimilation of technology process.

In an immature, insufficient and disjoined system of science and technology as ours, coordination plays a very important role. Currently, the majority of interactions among the components of the system are not yet even established and oftentimes objective and subjective obstacles are found, hindering their accomplishment. There is often a lack of awareness and trust between the research subsystem, the research-production link subsystem and the user or beneficiaries of the products of the science and technology system. Also crucial is the need to collaborate with other sectors of the State in the definition, study and tuning of the technology policy instruments to achieve consistency between them, with the scientific and technological development program and with the remaining national programs. Lastly, information banks have to be developed in respect of the current science and technology system these being much needed instruments for the planning and rational operation of the said system.

One of the most efficient mechanisms to achieve a liaison and coordination between the elements of the SINCYT is the formulation of specific programs and projects fusing the interests of scientists, technicians and users. To-date, this mechanism has not been sufficiently develoed by the CONACYT.

SOCIO-ECONOMIC AND TECHNOLOGY INFORMATION

The technological evolution of the country's productive sectors is closely linked to the policies for industrial development introduced many years. The present technological state in the production of goods and services may be explained vis a vis the measures adopted to accelerate economic development. The most relevant fact that may be observed is the negative and sometimes even non-existent correlation between economic growth and the development of local technologies; that is, the modernization of the national productive apparatus has been based essentially on the import of technologies with the resulting inhibition of national creativity.

The principal feature of the modelof growth followed since 1940 was the substitution of imports and until 1970 the strategy was carried out within a framework of long term financial stabilization policy which averted sharp changes in prices and in the parity of our currency. The Gross National Product grew throughout that period at an annual average rate of over 6%, while industrial growth was even higher. As a result, in 1970 the participation of imported products in the total supply had been reduced to 7% in non-durable consumer goods, 18% in intermediate goods and 47% in capital and durable goods.

The above figures show the preference given to stimulate the local production of non-durable consumer goods first, andonly to a lesser degree the local production of intermediate, capital and durable goods. The failure to promote the productionof capital goods has had a significant impact, resulting in a failure to promote the nation's own technological development.

The substitution of imports policy also included the protection of domestic markets for the benefit of local producers and the availability of abundant and cheap inputs. Indeed, while the agricultural sector was allocated 18.8% of public investment from 1960-1970, 67.2% was directed to the petroleum, petro-chemical, electric and communications and transportation sectors during that period.

The results of this policy on industrial growth were noteworthy. From 1960 to 1970 the Gross National Product practically doubled; the most dynamic sectors were electric which grew 3.6 times; the transformation industry, 2.3; construction and petroleum industries, 2.2; and transportation and communications, 1.9. The least dynamic was the primary sector, whose production in 1970 had reached only 1.4 times that of 1960 (for figures after 1970 see table 4).

Despite the industrial development, certain problems became critical: a) not enough jobs were generated to satisfy the demands; b) the distribution of income among families became more inequitable, the most affected being the rural population; c) integration of the productive apparatus was not agreed upon the dependence on inputs and foreign capital goods was not reduced and efficiency and competitiveness needed to participate in international markets were not developed. To correct this situation, in the first years subsequent to 1970, there was a change in the stabilizing economic policy followed for so many years; a policy was adopted in an intent to accelerate the economy even at the expense of a growing public deficit; as a fraction of the Gross National Product, the said deficit increased from approximately 2% in 1969 to over 7% in 1979 and to 17% in 1982.

One of the consequences of the accelerated demand and the over valuation of the peso was the de-substitution of imports in all types of goods. The participation of imported products increased from 1970-1980 from 7 to 13% in consumer goods, from 18 to 25% in intermediate goods, and from 47 to 55% in capital goods.

This phenomenon was caused basically by four factors: a) growth of demand; b) lack of capacity of the industrial plant; c) lower prices of foreign products due to the over valuation of the natioanl currency; and d) availability of foreign exchange from the export of energetics.

To the above described panarama, we must add that agricultural rpoduction dropped alarmingly. Mexico not only ceased being an exporter, but the import levels needed to satisfy internal demand placed the coutnry in a politically and economically vulnerable position.

The inconvenience of importing manufactured products does not lie so much in the volume of the imports, nor in the percentage participation in the satisfaction of internal demand, but rather in the imbalance between imports and exports. The deficit in the trade balance doubled between 1975 and 1980, going from 1,680 million dollars to 3,520 million (table 5). Since national exports consist primarily of energetics, the deficit corresponding to non-pegroleum products multiplied six times during the same period, reaching a figure of approximately 13,000 million dollars in 1980.

The above figures give a broad picture fo the country's commercial and financial dependence. Technological dependence is evesn more serious; since to the imported technology incorporated in foreign products must be added the technology acquired through the purchase of patents, trademarks, supply of technical know-how, assistance, basic and detailed engineering, etc., needed to manufacture antional products.

From the point of view of technological development, the clearest display of our dependence is the lack of vertical integration in the productive system; that is, the weakness of the prdouctive sector of capital goods. On the one hand, since it is the sector with the highest index of imports, andon the other, because what is produced in the cojntry has the least technological complexity and, is manufactured to great extent, with imported designs and processes, and has a low national grade of integration.

For the national investor, the productive sector of capital goods has been less attractive than that of consumer and intermediate goods, mainly because in that sector there are no protectionist policies, but also because it is technologically more complex and requires highly quallified personnel and susstained efforts in research and development.

The situation prevailing in these productive areas has its origin in the policies that guided national devleopment since 1940. Promotion of industrialization implied easy imports of capital goods. For the national manufacturer, whether public or private, foreign equipmetn was cheaper, offered better financing schemes,better quality and shorter terms. Furthermore, the participation of foreign investment in newly created companies materialized basically in capital goods from abroad. The import of investment goods multiplied six times between 1970 and 1980; it went from 1,135 to 6,900 million dollars. Among the main pieces of equipment imported in 1981 are the following: (between parenthesis is indicated the percentage ofnational consumption that is imported): machine tools (94), textile machinery (99), drilling equipment (30), pumps and compressors (47), electric machinery and equipment (34), turbines (100) and agricultural machinery (25).

The subsector of non-durable consumer goods represents almost half the added value of the manufacturing industry, followed by the subsector of intermediate goods and, lastly, that of durable consumer and capital goods with around 20% of added industrial value.

Despite the fact that aggregate cost of imports of technology is difficult to evaluate, it is calculated that that of technology not presently incorproated is 300 million dollars a year. Between 80 and 90% of the same corresponds to the manufacturing sector. An analysis of transfer of technology agreements approved by the Nationa Registry of Transfer of Technology showed that close to 60% of the agreements involved use of trademarks, 55% the supply of technical know-how, 40% technical assistance, and only 25%, the licensing of patents. It appears, then, that the problem of quality and prestige assoicated with trademarks is one of the basic motivations for the acquisition of technology in the manufacturing industr . The relative importance of patents as a form of transfer of technology is on the downswing, both nationally and internationally. Close to 60% of imported technologies come from the United States, and 15% from the four most important European countries in this area. This strucuture coincides reasonably with the composition of foreign investment in Mexico. Multinational compnaies which generate almost 40% of industrial production, are the principal purchasers of foreign technology, generally from their parent companies.

Offsetting this, Mexico now has technological development in industries such as cement, fertilizers, food products, special varieties of grains, civil engineering and other, whose financial and technical impact will enable exports to increase.

It is known that problems in connection with quality control and increased productivity for competitive production in the internal and external markets have to be solved soon in order to reduce imports and promote exports of Mexican products.

There is sufficient Mexican technological development to utilize regional raw materials and generate proudcts for internal consumption and for export, even in the case of the arid and tropical zones.

Except for few rare cases, the small and medium sized industry is not capable of developing new products due to the following factors: lack of capacity of their technicians, engineers and administrators; an inadequate infrastructure for the development of technologies; obsolete equipment; lack of access to test labs; and scarcity of capital. This generally leads to a copying of products from foreign patents or trademarks, or the in-bond processing of parts.

The small and medium sized industry frequently recur to sources of foreign technology not only for the acquisition of basic know-how or for the design and installation of plants, but also to solve oprative problems of commercial development, and even for the maintenance of their industrial units, with the resulsting significant expenditures.

To link between the small and medium sized industry and the research facilities and higher education institutions is practically non-existent. This means that industry and research centers have no awareness of the resources and needs of their counterpart. In turn, the linking mechanisms presently in operation, do not have an integrated promotion scheme to enable them to follow-up the activities comprising the research and development cycle.

The manufactures in Mexico have a tradition of innovation, invention and quality which should be taken advantage of, but the majority of the successful works and findings in industry are filed away and a significant part of the production of our scientists and engineers is unknown. The present scarcity of foreign exchange should represent a stimulus for the rescue of these works.

The absence of a mechanism for the generation-transfer-utilization of know-how inhibits the small and medium sized industry from using this know-how. Furthermore there are obstacles to innovation, both due to the lack of flexibility in the structure of our markets and supply systems, as well as to the strong risks and scarce financial compensation.

Among the principal technological problems the following are mentioned:

- Lack of capacity of small and medium sized companies to detect their technological requirements and evaluate projects, and low financial capacity to have access to consulting and engineering firms and research and development centres. 2650

- Lack of normalization, standardization and qualitty control mechanisms.

- Weak internal diffusion of innovations.

- Captive internal markets leaving much to be desired for this promotion of technological innovation.

- Faulty links between the productive sector and research centers and lack of capacity in the intermediate link of consulting and engineering firms.

- Lack of high level human resources in the productive sector and little research activity within the sector.

- Notorious concern for technological problems over the short term.

- Low level of technological modernization in the greater part of the country's industrial branches.

- Lack of full comprehension on the part of the industrial sector, in respect to the risk factor which involves every technological innovation process and an unawareness on the part of the researchers in respect of the requirements and limitations of the enterprises.

SCIENCE AND TECHNOLOGY POLICIES 1984-1988

Upon the end of the revolution, which began in 1910 and was followed by internal struggles, it entered a stage of institutional consolidation uninterrupted until now. Since the thirties, one administration has succeeded the other every sic years via a process of democratic elections. The first law on planning was issued in 1930 and the first six-year plan covered the period 1934-1940. For some time, the planning efforts were directed toward creating the material infrastructure needed to support the economic growth. Later, planning was directed toward creating the material infrastructure needed to support the economic growth. Later, planning was directed towards setting precise goals for economic development and defining objectives to induce the various social groups to attain the national goals.

The present administration, inaugurated on December 1st, 1982, issued a new planning law on December 19, whose main goals are: a) to ensure the coordination of government activities to avert unrelated objectives and actions and b) to guarantee social participation in the integration of the plan and its programs. Under this law, the term plan is reserved to the six-year plan; furthermore, two classes of programs are provided: Medium Term Programs (PMP) for priority activities set out in the Plan, and Annual Operative Programs (POA) of the various government bodies.

2650

The National Development Plan 1983-1988 (PND) was published on May 30, 1983. From it stem 20 PMP which specify, on a more detailed basis, the goals, strategies and lines of action for the period 1984-88. The PMP deal with priority goals such as: industrial development, health, energy, education, communications and transportation, rural development, etc. One of these PMP is the National Technological and Scientific Development Program 1984-1988 (PRONDETYC).

National policy on science and technology can not be separated from the national development policy expressed in the PND. Indeed, science and technology are key instruments in the attempt to achieve the structural change proposed by the Plan.

The policy on science and technology is constituted, essentially, by two elements: the goals and strategies to reach them.

The PRONDETYC has two general aims:

- To increase technological self-determination in the country

- To integrate scientific research into the foundation of national resources, toward a solution of the problems of all the vital sectors of the nation.

General Objectives

Technological and scientific development in the country is a task falling under the competence of both the scientific and technological system and the production system; the technoloigcal condition of a country is measured mainly by its production processes and the degree by which the technology employed in the same is generated or supported by research activities. Thus, the national development requires that the productive sector and the national scientific and technological system, have the capacity to attain the following goals:

- Offer scientific and technical solution to the economic and social problems of the country, contributing particualry to: a) reduce the dependenmcy on foreign technology; b) increase productivity in all national sectors and activities; c) achieve adequate supply of food, energetics, raw materials and production equipment; d) preserve, improve or restore the balance and natural beauty of the environment.

- Forecast social needs and technological changes in the future in order to decide on the technology for the production of goods and services required by the country, and give greater intensity to research in areas most promising for national development.

- Assist in regional development and decentralization of the productive activities of goods and services.

- Create a consciousness in all the strata of society in respect of the nature of science and technology and its importance in the economic, social and cultural development of the nation.

Strategies

The strategies are criteria or rules for decision making by which actions needed to lead the system of interest from its present state to the desired state are selected, as defined by the goals and objectives.

The general strategies of PRONDETYC answer the question of how to progress toward the fulfillment of the objectives proposed for the national development given the restrictions imposed by the present economic and cultural situation, and the advantages and potentials of the country. Sixe trategies have been defined:

- Technological and scientific development must be conducted on the basis of a pattern of participative planning, with the intervention of representatives of the public, private and social sectors. In particular, there must be a participation of the agencies and entitites of the public administration which have the most impact on science and technology, or which show the greatest demand for scientific and technological know-how, such as the scientific and technological community and the producers of goods and services, among which are included engineering, design and technical consulting firms.

- The instruments of scientific and technological policy must orientate the selection of mature, new or pioneering technologies for the productive apparatus, striving for a concerted development of the various branches, tending toward an adeaquate vertical and horizontal integration for optimum production, higher generation of employment and a better foreign trade balance.

- Economic and cultural relations with other countries will follow these criteria:

a) Regulate the flow of imported technology in order to acquire only such new or pioneering technology not being currently developed in the country and not to purchase obsolete technology, or technology that is harmful to the environment and that is not appropriate to local conditions.

b) Promote the capacity of negotiation, assimilation and adaptation in enterprises which import technology and of the technological agents that support the productive apparatus in those decisions, such as engineering and conulsting firms.

c) Orientate mechanisms of technical and academic cooperation with international, government and private bodies, to favour the attainment of agreements with the productive and academic sectors, which solve problems of national interest.

National spending for science and technology should be increased to attain the greatest possible growth of these activities without losing control of the quality of the national system of science and technology and its products. This strategy will be developed under the following criteria:

a) Promote the development of all the areas of basic and applied know-how, with greater importance placed on those most directly connected to meeting present and future national requirements.

b) Not to overdirect the national scientific and technological development. It is necessary to define programs for scientific and technological development directed toward the attainment of precise goals and to establish promotion mechanisms to induce members of the system to adhere to well defined programs.

c) Induce a greater participation of private, public and social enterprises in the financing of research projects linked to their own needs, with which we will also obtain an orientation of scientific and technological activities toward relevant problems.

d) Impel decentralization of scientific and technological activities in coordination with state governments, achieving greater attention to regional development problems.

e) Make very intent, so that the aggregate growth rate of the research subsystem does not exceed the rate of formation of top-level researchers, so as not to diminish the quality of the research.

- The formation of post graduate human resources will be promoted under the following criteria:

a) Fortify national post graduate programs, taking optimum advantage of the training capacity of squads represented by high quality research groups existing in the country and striving for new programs preceded by the consolidation of the respective research groups.

b) Orientate scholarship programs so that post graduate studies are carried out mainly in high quality national institutions, recurring to foreign institutions only in a complementary manner.

c) Fortify existing post graduate programs via the temporary incorporation of visiting national and foreign investigators, to complement the academic human resources; the incorporation of select ex-scholarship awardees of the CONACYT to the groups of professor-researchers; an improvement of bibliographic resources or information services, and the improved integration of experimental equipment; and the establishment of personal academic tutoring systems for students.

d) Make public within the productive system the availability of human resources formed through the scholarship programs; call on research institutions and companies in the public, private and social sectors to present candidates for scholarships in keeping with their requirements, and strive toward companies of the productive sector sharing responsibility in the formation of the specialists they need.

- Promote the supply and use of scientific and technological services and information, via:

a) Fortify and promote the optimum use of the existing infrastructure of services whose purpose is to capture and publicize scientific and technical know-how through information on patents, technical assistance and extensionism, metrology and specialized bibiliographic information services.

b) Formulate technical standards on the quality of the products offered on the market and the promotion of the creation of quality circules by productive branches.

c) Broaden the diffusion of scientific and technological knowledge through mass communication media, technological museums, botanical gardens and zoos, planetariums and other public information centers.

To achieve the proposed objectives and strategies, 36 programs were designed which are described below. These programs, which now form the rationale of PRONDETYC, will be carried out via the annual operative programs of agencies and entities of the federal public administration, with the participation of agents of the public, social and private sectors.

PROGRAMS FOR THE DEVELOPMENT OF THE SINCYT

The purpose of these 17 programs is to fortly the national capacity and infrastructure in scientific research and technological development. Special emphasis is given to the formation of top-level researchers and professionals for the productive system; the national capacity to adapt and assimilate imported technology, and the link between the national research and the production system; and the promotion of quality standards to favour the international competitive of national products. These programs are listed below:

1. Evaluation and updating of science and technology policies and programs to keep PRONDETYC updated at all times and to improve the procedures for the planning-programming-budgeting of sceintific and technological activities.

2. Inventory of human resources, to establish and keep an updated information bank in this respect.

3. Incroporation of post graduates into the labor market, to promote the adequate employment of specialized human resources.

4. Participation of the productive sector in the formation of human resources, to promote a greater participation of public and private companies in the financing and orientation of the formation of top-level human resources for the national productive plant.

5. Fortification of the national post-graduate programs and courses of study to contribute to the efforts of the Secretariat of Public Education towards the development of a better quality post graduate system, broader and with closer ties to the needs of the country.

6. Granting and administration of scholarships, to promote the formation of high level human resources, preferably in national institutions of higher learning.

7. Liaison of research-production, linking the research centers and the engineering and consulting firms with the productive enterprises.

8. Incentives to technological development, to promote the design and instrumentation of adequate incentives which may induce companies to invest in technological innovation.

9. Venture capital to promote the development of national technologies, sharing the financial risk inherent in the same.

10. Adaptation of technologies, to increase the capacity of engineering and consulting firms and the technical departments of companies in the identification, selection, assimilation and adaptation of technology.

11. Technical standardization, to strive toward a standardization of pieces and components and to stimulate the adoption of quality control systems adjusted to the productive system.

12. Technological assistance to upgrade the technological level of the productive apparatus and to foster the technological advisory and extensionism services via agreements with the productive sector.

13. Physical infrastructure for research, in order to allocate financial support and distribution of equipment in fair terms to all research institutions. 2650

14. Scientific and technological information, to promote the harmonious and efficient development of national data banks and systems for scientific and technological information.

15. Social communication of science and technology to aid in creating a scientific and technological culture inall the strata of society, publicizing the role of science and technology in the economic, social and cultural development of the country.

16. Study and tuning of the national transfer of technology system promoting the adjustment of the legal instruments relating to import and transfer of technology, to the current conditions and policies of national development.

17. International scientific and technical cooperation, to establish mechanisms for technical and academic collaboration to aid in national development, in coordination with the Secretariat of Foreign Affaris.

PROGRAMS FOR SECTORAL DEVELOPMENT

In this chapter are included the programs of the eight sectors of public activity that most greatly influence or require technological and scientific development. They propose actions tending to increase the supply of scientific and technological know-how and services demanded by the respective sectors. These programs will be carried out by the agencies, centers and research institutes, coordinated by the secretariats of State heads of the respective sector, and they are oriented to:

1. Agriculture and Hydraulic Resources, to generate and apply new scientific and technological know-how consistent with the ecological and socio-economic characteristics of the various regions of the country, and to develop technologies to improve the productivity of the agricultural and forestry production agents.

2. Trade and Industrial Promotion to create an ind strial technology base leading to agreements with industry regarding primary production and commercialization, strengthening the internal supply of technology, orienting local demand toward internal sources of technological supply, and setting the foundations for the operation of a National Standardization System consistent with the country's development scheme, promoting the quality control systems to offer products capable of substituting imports and penetrating international markets.

3. Communications and Transportation, to select research and technological development projects with a direct impact on the sector and to increase national participation in the generation of products or technologies utilized by the sector.

4. Urban Development, Housing and Ecology, to find an answer to the social demands for ordered urban and ecological development and increase the participation of society in the

handling of technologies for a rational utilization of natural resources.

5. Public Education, to form human resources in priority scientific and technological areas, promote research on education needed to upgrade academic quality, promote technological and scientific research in institutes of higher learning and increase the liaison between the research corresponding to the sector and its own needs as well as those of the socio-economic panorama.

6. Energy, Mines and Public Industry, to strive toward rational energy balance, improving the production, distribution and use of energy, to fortify technological development for the optimal use of conventional and alternate energy sources, to broaden efforts of exploration in the national territory in respect of iron, carbon, aluminum clays and non-metallic minerals, to develop the capacity of reaching technological self-determination in the iron and steel industry, to create the infrastructure needed for the assimilation, adaptation and inno9vation of technologies in this field, and to agree upon programmes of scientific research and technological development for the public industry.

7. Fisheries, to generate the information needed for the optimum use of water resources, the development of the national fisheries' technologies, and the know-how required to improve the fisheries' productivity.

8. Health and Welfare, to formulate an integral diagnosis of research in human health, to define a normative guideline for the establishment of priorities and the evaluation of research, to set mechanisms for inter-institutional and inter-sectorial coordination with the productive and service sectors, and to carry out investigations to foster an awareness of the physical, biological and social phenomena related to health.

Research and Development Programs to Meet National Priorities

These 11 programs propose specific subjects in which it is hoped that results will beobtained, which will enhance knowledge on the country's reality or that can be applied to the productive system of goods and services within the duration of the Program. The execution of these programs is entrusted to the National System of Science and Technology through concerted and inducive actions promoted by the CONACYT. The programs are:

1. Investigation of the nature of our society, to favour an awareness of the physical, biotic and social reality cf the country, and a generation of scientific and technical know-how that will contribute to a correct understanding of our current conditions, our resources and our natural legacy.

2. Investigation on nutrition and health, to link basic research work in with priority clinical and epidemiological work, set the scientific bases for a follow-up system of epidemics,

nutrition and contagious diseases in the highest risk population nuclei, and design diagnosis apparatus that may be easily acquired and handled.

3. Investigation on the use of natural renewable resources to generate adequate know-how and techniques for optimum employment and use, conservation and improvement of the nation's natural legacy.

4. Investigation on the use of non-renewable resources, to find methods tending to the rational handling and exploitation of our own non-renewable resources.

5. Technological development of the agro-industry, to improve processing technologies which will increase the availability of food products and the integrated utilization of farm products.

6. Technological development of the electronics industry, for the design of manufacturing technologies related to materials and components and the national production of certain raw materials, equipment and computer programs.

7. Technological development fo the chemical-pharmaceutical industry, to develop or adapt technologies for the national production of raw materials and medicines.

8. Technological development fo the petro-chemical industry, to improve the capacity to produce, assimilate and innovate acquired technology and favour the creation of new process technologies and their associated new products.

9. Technological development of the metal-mechanic industry, to develop metallurgical technologies and the manufacture of metallic materials the basic industry, the production of parts and components and the assembly of equipment and machinery.

10. Technological development of the construction inoustry, to ic rease the efficiency of the industry in the internal market and its international competitiveness and to promote the use of national inputs.

11. Top level research on other matters, to support outstanding research groups that constitute an example fo quality and that cultivate important areas not included in the previous top-priority programs.

The goals, strategies and lines of action of the 36 programs composing the PRONDETYC will be implemented in annual operative programs, which will specify obhjectives and actions over the short-term period and will allocate the necessary funds for their accomplishment. In these actions of the annual operative programs, there will be a participation of public, social and private agents involved through the four execution points defined in the Law of Planning: mandatory, for the group of actions to be carried out by agencies and entities fo the federal public administration; coordinated for actions to be carried out in unison by the federal public administration and the state governments within the framework of the Unique Development Agreements; concerted actions, grouping those to be agreed upon the public sector on one hand and the social and private sectors on the inducive actions including all government actions tending to promote, regulate, restrict or orient the bahavior of the social and private sectors towards accomplishment of the goals and objectives of the Programme.

PLANNING AND MANAGEMENT OF SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT IN THE MONGOLIAN PEOPLE'S REPUBLIC

INTRODUCTION

Close attention is being devoted in Mongolian People's Republic (MPR)to its scientific and technical progress, for it is one of the key areas of the development of the society. The government maps out the entire scientific and technical programme in the country, sets the general aims and the chief objectives, determines the ways of attaining them, and sees to the introduction of scientific and technical achievements in practice. As a concomitant, it marshals the efforts of the people at large, concentrating them on promoting scientific and technical progress.

Much attention is devoted to promoting research in the more important scientific fields, to verifying fulfilment and to selecting, posting and educating personnel, to controlling scientific and technical progress in various fields.

Government control over the development of science and technology in the MPR is based on the general administrative principles of serving the people, democratic centralism, socialist law and order, and planning.

ORGANIZATION

The top organs of state that exercise general governmental control over scientific and technical development in the country are the Great People's Khural, its Presidium, the Council of Ministers of the MPR, and such other bodies as the MPR State Committee for Science and Technology, the State Planning Committee, the State Committee for Material and Technical Supplies, and the State Committee for Prices and Standards which cut across the entire economy. At the level of the various branches and industries of the country's economy, control over the pgoress of science and technology is also exercised by

Presented by Tsagaanbaatar Myagmar

central administrations of specific jurisdiction -- the various industrial ministries and administrations of the Mongolian People's Republic.

FUNCTIONS

The Great People's Khural

The Great People's Khural of the MPR is competent to deal with all possible matters related to scientific and technical progress. It is the supreme organ of state power and exercises general guidance of all governmental organs, including those of science and technology, and defines the basic juridical principles governing the activity of these organs. Naturally, it also controls their activity. The Presidium of the Great People"s Khural exercises its function of improving the system of governmental control and supervision and this also in the field of science and technology.

Council of Ministers

In accordance with the Constitution of the MPR, the Council of Ministers exercises guidance and control of the national economy. It is within its competence to draw up measures promoting the development of science and technology. When necessary, it forms special committees and administrations, and sees to it that objectives in science and technology of economic importance are reached in time. It defines the competence of subordinate organs of control over scientific and technical progress, and draws up national scientific and tewchnical development plans, which it submits for approval to the Great People's Khural. The MPR Council of Ministers decides upon the procedure of financing scientific development, the development and introduction of new technology, and deals with all fundamental problems related to the training of scientific workers, the promotion of inventions and innovations, the adoption of standards, the dissemination of scientific institutions function effectively. It also exercises its powers to expedite the introduction of scientific and technical achievements in the economy.

State Committee for Science and Technology

But the body that conducts the single scientific and technical policy and that ensures the fullest possible use of the achievements of science and technology in the economy is the State Committee of the MPR for Science and Technology. Among its functions is that of evaluating the technical standard of production in specific fields of the economy, of drawing up recommendations in the main fields of scientific and technical development in the country, organizing study of scientific and technical problems that cut across several fields, supplying the economy with scientific and technical information, controlling the introduction of scientific and technical achievements in the economy, and maintaining ties with other countries in the field of scientific and technical cooperation.

The State Committee for Science and Technology has extensive powers in planning, control, financing, and organization. It draws up the country's five-year plans for scientific and technical studies and the use of scientific and technical achievements in the economy. It endorses programmes for basic scientific and technical studies included in five-year and annual plans, draws up draft plans for financing research and personnel training, and allocates funds in the field of science and technology.

Jointly with the MPR Academy of Sciences, the Committee recommends to the Council of Ministers and the State Planning Committee specific scientific and technical innovations for use in the economy, and informs them of the results of completed research relevant for the economy. This is done before the annual plan is drawn up.

The Committee engages in scientific and technical forecasting in fields of major importance for the country's long-term (15 to 20 years) economic development.

Apart from its plan functions, the Committee supervises the key scientific studies and measures ensuring timely use in the economy of the latest scientific and technical achievements. It is responsible for countrywide control in this field, and recevies reports of ministries, administrations, scientific institutions, and enterprises, seeing to it that assignments are filled and introduction of scientific and technical achievements in production is expedited. The Committee may award additional assignements to ministries and administrations in order to resolve major scientific and technical problems that concern several fields or industries. The Committee is in charge of funding research and designing, and has a reserve of budget funds for scientific research projects that are not provided for in the annual plan but are found to be necessary.

The Committee organises examinations by experts of the technical aspect of industrial or agricultural projects under construction or reconstruction. Such examinations are organized on an independent basis, enlising the opinion of scientists and experts regarless of their place of work. This practice helps the Committee to exercise effective control over the technical standard of enterprises that are being either reconstructed or built anew.

The Committee sees to the continuous improvement of the network of research instituions. It examines the requests of minsitries and administrations suggesting establishment of new science instituions. In pertinent cases, it draws up reocmmendations addressed to its superior bodies onclosing down scientific institutions or their divisions that have proved ineffective. The Committee is authorized to instruct ministries, administrations and other organizations to suspend or terminate research or designing projects that unnecessarily duplicate some other projects or are devoid of theoretical or practical significance, and to cut off funding.

The MPR State Committee for Science and Technology supervises dissemination of scientific and technical information in the country. It is authorized to define the chief trends in the development of the country's system of science-technical information outlets, to coordinate research in the field of science-technical information, and to supervise and control the work of science-technical information and promotion outlets.

<u>State Planning Committee</u>

Among the governmental agencies that cut across industry and agriculture and exercise certain functions in the field of scientific and technical progress, the State Planning Committee of the MPR holds a conspicuous place: it is expected to include in the five-year and annual plans specific assignments and measures envisaging the development and introduction in production of highly-effective machinery, equipment, manufacturing methods, and more economical materials, as well as projects introducing comprehensive mecahnization and automation.

Together with the State Committee for Science and Technology, the Planning Committee draws up and issues instructions on how to draw up state science and technology development plans, it finalises those sections of the plan that are related to the use of scientific and technical achievements in the national economy, and controls fulfilment of assignmenmts set in the state plan.

<u>State Committee for Material and Technical Supplies</u>

The MPR State Committee for Material and Technical Supplies, too, is involved in controlling scientific and technical progress. Its chief function, of course, is to ensure timely supply of technical resources for research, designing, and introduction of new machinery or equipment in production.

<u>State Committee for prices and standards</u>

State standards (standardization) play a prominent role in expediting scientific and technical progress. Standards based on the latest achievements of science and technology are an important factor promoting high technical levels and high quality. In charge of standardization in the country is the State Committee for Prices and Standards. It is responsible for the state and further advancement of standardization and metrology in the country, and for a single technical policy in this field. The Committee defines the main lines of development and the scientific, methodological, technical, and ecnomic principles of standardization, of unifying standards in industry and other fields; it standardises quality indicators, and exercises state supervision and control over the introduction and observance of standards and technical indicators, and over the state and use of measuring instruments.

As a body exercising state supervision and control over standards and technical indicators, the Committee is authorized to instruct enterprises and organizations, regardless of their administrative subordination, to eliminate spotted breaches of standards and technical indicators, and may forbid delivery or sale of products that are below the set of standrd or technical indicators.

The State Committee for Higher and Specialized Secondary Education

This Committee suprvises scientific research in higher educational establishments.

Ministries

Conduct of a single technical policy in their respective fields, ensuring introduction of the latest achievements of science and technology, and of the latest techniques, in production making for high technical and economic indicators, is one of the chief functions of the various ministries. They systematically evaluate the technico-economic standard of production and output in their specific field, define the most effective use of scientific and technical achievements at home and abroad to secure a high technical standard on enterprises in their branch.

The ministries supervise the work of subordinate research, designing, and devlopment organizations and enterprises, directing their efforts to resolving the most important economic and industrial problems. They promote improvements in planning and organizing research and desiging projects, in enhancing their efficiency, and in coordinating research and introduction of its results in production. The ministries draw up plans in their field for scientific research and introduction of new machinery, and promote improvements in the technical standard of production and output at subordinate enterprises. They organize work on subject-oriented plans at subordinate enterprises and control their fulfilment.

At branch level, ministries bear important responsibilities for financing scientific research projects and supplying them with requisite technical and other resources. They are also responsible for the timely introduction of new machinery in production, for the promotion of inventions and innvoations, for standarisation in their field, for dissemination of scientific and tehcnical information, for selection, positioning, and improvement of proficiency of ranking technicians and engineers, and for maintening international scientific and technical ties.

Academy of Sciences

The MPR Acadmey of Sciences holds a special place among the organizations that control scientific and technical progress, being a commonwealth of scientists. Its purposes, as set forth in its statutes, are: promotion of fundamental research in the leading areas of social and natural science; devising scientific preconditions for the practical use of the results of research; carring out promising research in key areas of scientific, technical and social progress that will work for succesful economic, cultural and scientific progress; research in the general aspects of technical progress and their linkage with the well being of people, and, last but not least, assistance in securing the fullest possible use of domestic and foreign scientific achievements in socialist construction in the Mongolian People's Republic.

The Acadmey of Sciences exercises over-all scientific guidance of research in key areas of natural and social science at institutes of fundamental research and at higher educational establishments.

PLANNING

Now a few words about the more concrete structure of planning scientific and technical development in the MPR.

The prevailing system of planning the development of science and technology is divided by duration into long-term, five-year (medium-term), and annual planning.

A long-term plan defines the main directions in the development of science and technology in close association with the material, labour, and financial resources needed for their fulfilment in line with the long-term objectives of the country's social and economic development. The long-term plans are the basis for the elaboration of five-year plans and act as the beacon for purpose-oriented scientific and technical development in the country, especially as concerns the priority fields.

The main form of scientific and technical development plan is that of five-year plans. These encompass all major steps in technical progress, determining its rate, scale, and results in the framework of the national economy as a whole, the various industries and other branches of the economy, and associations of enterprises and individual enterprises.

The planning of science and technology at the level of the national economy as a whole is meant to enhance the efficiency of social production and secure its further intensification.

It is these objectives, indeed, that essentially determine the structure of the scientific and technical development plan, that is, its differentiation according to the plan targets or types of work planned.

Our country's scientific and technical development plan consists of the following section:

1. Plan for fulfillment of research in the key scientific and technical problems.

2. Plan for the introduction of new items in production.

3. Plan for the introduction of advanced techniques, for the automation and mechanization of production processes.

4. Plan for the financing of scientific and technical research projects.

5. Plan for scientific and technical cooperation.

6. Plan of the basic indicators of scientific and technical development.

7. Plan for the standardization and the quality of production.

8. Plan for the dissemination of advanced production experience.

9. Plan for the training of scientific personnel with academic degrees.

Now, let us cast a brief glance at each of these sections of the scientific and technical development plan.

Fulfillment of research in the key scientific and technical problems:

The basis for the elaboration of the targets of the five-year plan as regards the key scientific and technical problems are the indicators of the long-term scientific and technical plan for the five years concerned, coupled with the proposals of subordinate echelons.

The State Committee for Science and Technology, jointly with the State Planning Committee and the MPR Academy of Sciences, list the key scientific and technical problems at the stage when the basic directions of development are still being determined, and recommend them for inclusion in the five-year plan. Ministries or administrations that are to handle each research or development project, or a separate assignement are thereupon named.

The named ministry is held responsible to the government for resolving the problem assigned to it, and is called upon to draft a plan for the problem in question, to exercise day-to-day guidance and coordination of the work of those handling the problem, and to endorse the results.

The plan lays down concrete assignments for each problem, which must, among other things, envisage the development and production techniques that will ensure comprehensive use of raw and other materials, a lower consumption of material per unit of output, a better quality of output, a higher productivity of labour, bette working conditions, more advanced control of production and a better organisation of labour, and the development and use of environmental protection techniques.

In addition to the list of assignments, this section of the five-year plan for scientific and technical development also contains the date when work on the problem is to be completed, the dates for completing intervening stages, and dates for producing an advance stock of research results. It names those who are to carry out the assignments and their co-executors, the estimated cost of working on the problem, including the cost of experimental samples of the item and the cost of acquiring the requisite experimental plant.

In addition to assignments of the five-year plan to resolve scientific and technical problems and over-all problems applying to all or most branches of the economy, there are also coordinative plans for work on these problems which help to link up "abutting" jobs that are to be carried out by different ministries, administrations, enterprises, or organisations.

The coordinative plans are drawn up by the ministry or administration responsible for the said project, in agreement with other interested parties, whereupon they are submitttted for endorsement to the State Committee for Science and Technology.

The coordinative plan may be said to concretise the assignments of the five-year plan.

Introduction of new items in production.

This section of the scientific and technical development plan contains assignments to launch production of new items and materials that had been developed earlier, chiefly under the state plan of basic science-technical problems. The section may also include assignments to develop production of new, advanced types of material or articles first produced abroad.

The plan indicators in this section of the scientific and technical development plan include (a) the envisaged output, (b) estimated cost, (c) the time schedule for launching production. The enterprises where the new items are produced, and the economics of their production, are also given.

Introduction of new, advanced techniques, the automation and mechanisation of production processes.

The purpose here is to promote broad use in the national economy of the latest domestic and foreign scientific and 2650
technical innovations.

The criteria by which techniques and plant are picked for inclusion in this section of the plan are threefold: technical, economic and social.

The technical criterion requires the technique or plan in question to be better or at least as good as those employed in other countries. Besides, the introduction of the said technique or plant is to secure a substantial rise in the technical standard of production.

The economic criterion requires the technique or plant in question to heighten the productivity of labour, improve the quality of output, save material and other resources, lower the cost of production, and, as a result, yield a higher efficiency.

The social criterion requires the technique or plant in question to improve working conditions and eliminate manual and monotonous operations. It must not present a hazard to workers' health or pollute the environment.

The following criteria are used in drawing up this section of the plan:

- reports and other documents concerning the obtained or expected results of research conducted in the country, and results of inventions or innovations in the various branches of the national economy;

- information relating to the production and use of new techniques or plant in the Soviet Union and other socialist countries, the capitalist states, and developing countries;

- concrete proposals of ministries and administrations in the country for improving the technical standard of production in their respective fields;

- results of technological examinations by experts under the auspices of the State Committee for Science and Technology of blueprints and estimates of industrial projects envisaged in the given plan.

Financing of scientific and technical research projects.

A plan is elborated to fund scientific research, based on the projects defined in the draft plan of scientific and technical development.

The funding plan provides for the financial, manpower and material resources required for the realisation of the various envisaged scientific-technical programmes.

Research projects are financed out of the single fund for financing scientific and technical development, run by the State Committee for Science and Technology.

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cientific and technical cooperation.

This section defines the main areas in which the Mongolian People's Republic is to cooperate with other member countries of the Council for Mutual Economic Assistance, and with other socialist and capitalist countries. This section of the plan sets the outlay for research and design jobs involved in the joint projects; names the organisations involved in the projects in the various countries, the place where the projects are to be carried out, the main expected scientific and technical results, the significance of the projects for the national economy, specifies the forms of cooperation and the main steps taken to secure completion of the projects. The plan enumerates the subjects of multilateral and of bilateral scientific and technical cooperation.

tandardisation and the quality of production

This section of the plan dovetails closely with the section of the plan for the introduction of new, advanced techniques, for the automation and mchanisation of production processes. When planning standardisation and quality of products it is envisioned to produce products of higher quality and higher standards than those of previously manufactured goods; also planned is higher efficiency. This section of the plan also calls for accurate forecasting of the demand for the product in question, definition of items of investment, and of expenditures in general, etc.

Dissemination of advanced production experience

This section envisages introduction of new proposals yielding stable results and bettering the average standards in the economic field concerned. These proposals muxg have proved economically profitable. They consist of advanced production techniques and innovations.

The section indicates the places where the proposals are to be introduced, names the authors of the advanced production experience, and estimates the economic advantages and the importance for the economy of the envisaged proposals

Training of scientific personnel with academic degrees

This section is meant to ensure that the needs of the natioanl economy in competent science workers and teaching personnel are fully met. The plan for the training of personnel with academic degrees takes into consideration the long-term objectives of scientific research, the number of students in higher educational establishments, the natural dynamics of the personnel, and the planned contingent of researchers and scientists and research and design organisations. This section of the five-year plan deals with five main fields of science: social science, natural science, technology, agricultural sciene, and medicine. The yearly plan enumerates the subjects in which the personnel specialises.

In recent years we have begun using the method of goal-oriented programme planning, which is a new, more advanced method. The substance of this method is that the end goal of the plan is taken as the chief component and point of departure, so that means of achieving this goal with concretely available resources become the object of planning and programming. Special attention is paid to concentrating resources on carrying out the priority tasks. The use of this method of planning requires development and implementation of various scientific-technical, purely scientific, and production programmes that would take account of all possible situations and consequences that may arise as the programmes are carried out.

Seven goal-oriented programmes are elaborated and implemented in our country at present: for expediting scientific and tehcnical progress, for rational use of manpower, for raising exports, for supplying the population with food and for advancing agriculture, for the priority development of the fuel and power industry, for the developmentof housebuilding, and for the development and location of the country's productive forces.

Those responsible for the elaboration and implementation of these programmes have been appointed, with hundreds of scientists, researchers and other spcialists taking part.

The measures envisaged in the programmes are provided separate andpriority funding under the five-year and annual scientific and technical development plans.

Control of measures provided for in these programmes is also separately organised. The State Committee for Science and Technology exercises overall guidance of the elaboration of such natioanl goal-oriented comprehensive programmes.

Alongside these nationwide programmes, it is planned to draw up and introduce goal-oriented comprehensive programmes at the level of eocnomic branches and for specific objectives, such as raising crop yields, breeding cattle with specific properties, and the like

When working out goal-oriented comprehensive programmes we make creative use of the general procedures and methods used in the Soviet Union and other socialist countries.

NIGERIA: POLICIES, PROGRAMMES AND PROJECTS FOR SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT

INTRODUCTION

Nigeria is a tropical African country located north of the Equator from Latitudes 4 N to 14 N and spanning from 3 E to 15 E, east of the Meridian. Its land area covers approximately 930,000 sq.km and the vegetation ranges from the mangrove forests in the South through the rain forests in the middle belt, to the Sahelian Savannah in the North. The country's topography is generally low lying and undulating and its soils vary from highly weathered sandy and acidic soils in the Southern portion, to clayey soils in the Northern part.

The population is currently estimated at about 85 million with an annual growth rate of 2.5 per cent. About 40 percent of the population is made up of children aged 15 years and below, while the economically active population is estimated at 50 percent; 70 per cent of the population subsist in the rural areas of the country.

The land resources of Nigeria is capable of supporting various types of agricultural activities including arable farming, animal husbandry, forestry and fisheries production and development. Of the cultivable land constituting approximately 75 per cent of total land area, only about 50 per cent is currently put under cultivation, another 10 per cent is afforested and the remaining 15 percent is made up of permanent pastures, built up areas and uncultivable wastes. The major food crops of the country include cassava, yams, rice, maize, sorghum, millet cowpear and plantains. The major tree crops are cocoa, oil palm, rubber and kolanuts; forest products include, timber and medicinal plants. The major livestock are cattle, sheep, goats, pigs and poultry. Nigeria is endowed with abundant deposits of mineral resources and these include:

i) fossil fuel (petroleum, coal, lignite);
ii) metals (uranium, tin, colombite, coal, iron ore, lead and gold);
iii) others, such as limestone, marble, clay and rock salt.

Presented by Richard Enlang

Much of the energy needs of the country are basically derived from both the mineral and forest resources. Fuel wood provide the main source of energy in the rural areas, while electricity generated from petroleum and coal resources as well as hydropower is utilised in the urban areas for domestic purposes, in transportation and industry.

Industrial development in Nigeria has witnessed some measure of progress in the past two decades. The era witnessed establishment of a number of indigenous industries that utilise local materials and technology. Such industries include textiles, metal works, food, ceramics (including pottery), tobacco, soap, pharmaceuticals, building and road industries. Also, in existence are some modern industries that produce a number of finished products from basic raw materials and a few others that merely assembly intermediate products into finished products.

There are cultural diversities in Nigeria, arising principally from the existence of several ethnic groups. These differences in culture and tradition are also reflected in the type of agricultural and industrial activities practised and the nature of the arts, crafts and housing, existing in the country.

BACKGROUND

The history behind past efforts made at evolving science and technology machinery for Nigeria, could be traced to the period immediately preceding independence in 1960. Events that took place during this period really provoked phenomenal changes that saw a re-orientation in the drive towards designing a suitable science and technology policy for Nigeria. The policy during the colonial era, was geared towards the production of local raw materials to feed industries abroad and whose products were then brought back to Nigeria, for sale and consumption. Therefore, only research activities that guaranteed the availability of the raw materials, were pursued. But most importantly, there was a widespread fear that a mass exodus of foreigners from the key productive and services sectors of the economy, namely, agriculture (including agricultural research), medicare (hospitals), transportation (railways, airways, shipping), construction, posts and telecommunication services, might harm the economic life of the Nations. Emergency measures were taken in order to train high level scientific and technical manpower to replace the departing colonial personnel, and to undertake necessary research and innovative adaptations, in the country.

In 1963, the need for a national machinery for the formulation of appropriate science and technology policy in relation to national development, became apparent when the United Nations Conference on the Application of Science and Technology for the Benefit of Less developed countries, was held in Geneva. During this conference, a good number of scientific papers were examined, some of which came from Nigeria. Consequently, in mid-1966, the official search for suitable and relevant science and technology policy machinery for Nigeria resulted in a legislation which promulgated the establishment of the Nigerian Council for Scientific and Industrial Research. Unfortunately, this Council could not take off due to the civil disturbances which took place in the country, during the period (1966-1970).

During the interval however, a new structure for science and technology became necessary. Consequently, a UNESCO mission was invited with the task to review the science and technology position and advise the government accordingly, on the appropriate science policy machinery, for the country. After extensive consultation, this mission recommended a 3-tier system for science policy formulation, coordination and execution. This invariably led to the establishment of a new Council known as the Nigerian Council for Science and Technology (NCST) in 1970, with the prime responsibility of advising and coordinating government efforts in science and technology in the country. Also established during the period, were four sectoral Research Councils, namely, the Agricultural Research Council of Nigeria (ARCN), the Medical Research Council of Nigeria (MRCN), the Industrial Research Council of Nigeria (IRCN) and the Natural Sciences Research Council of Nigeria (NSRCN).

After operating the 3-tier system for about six years, the entire machinery had to be restructured into a 2-tier system. Therefore in 1977, a National Science and Technology Development Agency (NSTDA) was established to take over the functions hitherto performed by the NCST and the sectoral Research Councils. By that arrangement, the NSTDA had to combine both the advisory and executive as well as the sectoral research coordination functions of the defunct bodies. All the Research Institutes (22 in number) then came under the direct supervision of the NSTDA (Annex 1).

REVIEW OF CURRENT DEVELOPMENT OF SCIENCE AND TECHNOLOGY IN NIGERIA

In apparent recognition of the importance of science and technology and the role they can play in the development of the economy, the NSTDA was transformed in 1979, into a Ministry with similar responsibilities and authority to formulate science and technology policies; direct, coordinate and monitor the implementation of science and technology activities. Thse S&T activities however include basic and applied research, technological innovation and discoveries, scientific and technology services, and scientific/technical manpower training and development.

Currently, these activities are performed by the following establishments:

i) Public-funded research institutes and centres

ii) Universities, polytechnics and other tertiary educational institutions

iii) Scientific and professional societies

iv) Manufacturing and services industries; and

v) Technical/engineering design and consulting organizations.

The Research Institutes and Centres undertake research in specific areas of agriculture (including fisheries, livestock and forestry) processing of local raw materials for industrialisation, medicine, etc., and the existing universities concentrate on basic discipline-oriented research to facilitate the production of scientific manpower in order to enhance Nigeria's capability to fully use science in her development. Contrastingly, the facilities of consulting organizations as well as those of manufacturing and services industries are often utilised to solve identified problems of development through collaborative research efforts. Professional bodies perform merely advisory roles and together with the other organizations, they provide a broad framework for the dissemination of scientific and technical information.

FUNDING OF SCIENCE AND TECHNOLOGY ACTIVITIES

Progress in science and technology depends to a large extent, on research and development activities which if adequately funded, could afford the country the opportunity to tap tremendous benefits from its abundant resources. It is in apparent realisation of this fact that the governments in Nigeria have strived over the years to undertake a progressive funding programme for scientific and technological activities. The objective here is to reach or even surpass the internationally accepted level of funding of 1 per cent of the Nation's Gross National Product, for research and development programmes.

In the 4th National Development Plan (1981-85) for instance, a total capital programme costing nearly N600 million was planned for the science and technology sector. Out of this amount, N543.45 million was set aside for research projects executed by the various agricultural, industrial and other research institutes. The projects are categorised as follows:

i)	Agricultural Research	N385.85m
ii)	Industrial Resarch (including Building and Road Research	N133.00m
iii)	Medical Research	N20.0m
iv)	Remote Sensing and Natural Resources Research	N5.50m

Comparatively, in relation to other sectoral alloctions, this figure represents a level less than 1 percent of total capital allocation envisaged for the Plan period. But in absolute terms, the funds seemed fairly modest judging, from the current level of the country's scientific and technological activities and progress. The breakdown of the plan allocations by establishment is provided in Annex II of this paper.

In addition, most industrial and commercial organizations operating in Nigeria are encouraged by way of incentives and tax reliefs, to contribute financially towards the research and development efforts and to undertake in-house reearch in support of their production activities.

CHOICE, ACQUISITION AND TRANSFER OF TECHNOLOGY

Nigeria accords high priority to technological invention, innovation and adaptations and all efforts are therefore directed at encouraging indigenous technology development, up-grading and adapting indigenous technologies in support of national development. But, with regard to the horizontal transfer of technology, a machinery for the selection of these technologies was established in 1979 to ensure that the technologies so selected, are relevant to the needs for self-sustaining development. The body responsible for these activities is known as the National Office of Industrial Property (NOIP) and is run by a Governing Council consisting of members drawn from a number of Ministries at the Federal level indicuing, the Federal Ministries of National Planning, Finance, Internal Affairs, Justice, Commerce and Industries; Works and Housing, and Education, Science and Technology. A few others members are appointed from the Universities, Polytechnics and other tertiary educational instituions in Nigeria. NOIP, whose secretariat is currently in the Federal Ministry of Education, Science and Technology (FME, S&T), performs the following functions, among others:

i) Encouragement of a more efficient process for the identification and selection and adaptation of foreign technology;

ii) Development of the negotiating skills of Nigerians with a view to acquiring the best contractual terms and conditions for Nigerian parties entering into any contract or agreement for the transfer of foreign technology;

iii) Registration of all contracts or agreement having effect in Nigeria; and

iv) Monitoring on a continuous basis, the execution of any contract or agreement so registered.

CONSTRAINTS TO PLANNING AND MANAGEMENT OF SCIENCE AND TECHNOLOGY PROGRAMMES AND PROJECTS

There are a number of constraints which tend to thwart the effective application of science and technology to development in Nigeria. One of such constraints is the severe shortage of trained high and medium level technical manpower, and a general lack of managerial and executive capacity in the country, to execute the scientific and technological plans, programmes and projects. Therefore, in an attempt to redress the situation, measures have been taken to effect some re-organisation in the nation's educational system to ensure adequate training for scientists and technologists on a continuous basis. For a start, it is now a matter of policy that a large percentage of fresh students intake into the Universities, must be in science-related fields. Moreover, more Universities and particularly, Universities of Technology have been established in the country, to provide additional opportunities and facilities for the training in basic sciences to support the national technological development.

Specifically, the curriculum in the basic sciences is being restructured in such a way as to emphasis the concept as well as the application of the knowledge to the solution of developmental problems. Additionally, interest in the basic sciences is being stimulated through a series of programmes to popularise science among the populace. These programmes embody the Young Scientist Competition which is designed to encourage students to develop and sustain interest in science and to prepare them for scientific engagements that will substantially aid in the socio-economic development of the country. Other programmes include; the Science and Technology Fairs and exhibitions used as fora for displaying creative abilities and innovations, support for production of scientific publications, films and other educational materials that aid directly, the teaching and learning of science.

There is also the problem associated with the development and use of Science and Technology Information system. A well documented system providing information on all facets of S&T, could enhance directly the planning and management of its programmes and indirectly the self-sustaining development of the Nation. Data currently available on S&T activities and manpower statistics are scanty and unreliable. This situation is partly caused by the fact that before now, the sole and statutory responsibility for the collection, processing, storage and dissemination of all data in the country, was vested in a central organization - the Federal Office of Statistics (FOS). Over the years, this office has had problems that tended to affect its activities and therefore, the reliability of surveys, from where the data are usually derived. The consequences leads to unreliable planning efforts and erode on projections on forecasts made. With the relaxation of the relevant legislations, surveys can now be conducted on a sectoral basis, to obtain more reliable data on all science and technology activities and manpower engaged in the sector. In this regard, the FMEST is conducting surveys to collect scientific manpower statistics and data on S&T activities in the country. Although these surveys are conducted at the instance of the FMEST, participation by FOS is necessary and useful to ensure the standardisation of data so collected.

Owing to the illiterate status of most of the users of research findings particularly farmers, problems are often encountered in transferring these results, quickly from the research stations, to the productive sector. So in an effort to overcome these problems, it was necessary to establish agencies to essentially translate the findings into forms and languages the users can easily understand and utilise. In addition, these agencies are expected to build up extension capability to help disseminate the findings to users and to provide feedback to the research stations and centres. One of such agencies is the Agricultural Extension Research Liaison Services (AERLS). The planned National Technology Development Centre is expected to perform similar functions, for the industrial sector of the economy when operational.

Lastly, there is a general reluctance on the part of both local and foreign entrepreneurs in Nigeria, to utilise results of local research in their productive activities. This situations could be attributed to a number of factors, some of which include:

a) The incomplete nature of research results, entrepreneurs are known to prefer packages that would provide them in one piece, with all relevant technologies for their production activities;

b) The use of local research findings often requiring other inputs that might not be readily available;

c) The long-term nature of investment associated with the utilisation of local research innovaitons; and

d) The financial risks involved in utilising results that have not been tested over time including unpatented results; and

e) Lack of confidence in the development potential of the research results or even sheer ignorance on the part of the potential users.

CONCLUSION

One of the main objectives of Science and Technology in Nigeria, is to create an enduring framework to accelerate growth in the economic well-being of Nigerians through the rapid assessment and optimum utilisation of the Nations' natural resources. To this end, an appropriate machinery has been evolved to coordinate scientific research in the country. The responsibility to operate this machinery is vested with the Federal Ministry of Education, Science and Technology, which as the policy making body, combines both the advisory and executive as well as sectoral co-ordination of research activities in the country. Within this framework, are 22 autonomous Research Institutes which carry out research in various fields of agriculture , medicine, industrial activities,etc.

The founding of this machinery therefore arose from the pressing need to undertake a balanced scientific manpower development, the selection of technologies, funding of science and technology, and elmination of constraints to S&T development. Therefore, to develop and sustain effective S&T programmes, a number of problems are being contained and tackled. These include:

) the improvement of science education both at the lower and higher levels;

ii) the orientation of scientific research and technology development and their relevance to the needs and priorities of Nigeria;

iii) the transfer and utilisation of research findings and technologies in the local production process; and

iv) the systematic acquisition of technoligical know-how and capability through foreign investment in the country.

The importance of science and technology was the foundation of meaningful and self-sustaining development, is widely acknowledged in Nigeria. What is being done is to formualte a systematic, coherent and comprehensive policy on S&T which would be responsive to the dynamics of Nigeria's social and economic development. It is also hoped that such a policy would pave the way for and facilitate the development of indigenous capacity to meet any challenges and be able to anticipate problems that come with technological advancements.

IMPLEMENTATION OF NATIONAL SCIENCE AND TECHNOLOGY POLICY IN PAKISTAN: PROBLEMS AND PROSPECTS

INTRODUCTION

National development may be viewed as continual movement towards fulfilment of the individual and collective aspirations of the people. Usually social and technological changes are brought about in the nation through various policies for realizing the goals of development. In the context of Pakistan, major goals are the achievement of self-sufficiency in food, equitable availability of basic necessitities like clothing, shelter, medical cover;and development of energy resources. Science and technology, internationally recognized as a major means of modernizing societies, must be extensively employed for the exploitation of the natural resources and expeditius achievement of the goals of national development. Such development programmes can only be implemented through building up an adequate and efficient endogenous science and technology capability. Science is also a cultural force, as the spirit of scientific method and the intellectual discipline inculcated in its pursuit to help build up an enlightened attitude that is a valuable asset to the society. Another aspect of science relevant to the developing countries is its character which makes it possible for them to enter upon a "planned future". In order, therefore, to achieve the objectives of national development and security, maximum advantages could only be derived from science by laying down a purposeful Science and Technology Policy.

SHORTCOMINGS

Although some progress has been made in Pakistan in the field of Science and Technology, yet there are numerous shortcomings and deficiencies in the effort to use science and technoloyg for national development. The present state of Science in Pakistan exhibits major problems such as:

a. Small sub-critical size in terms of manpower and meagre outlays on research and development;

b. Absence of well defined priorities for scientific research and imbalances in S&T effort;

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c. Dearth of research leadership;

d. Isolation of Pakistani Science from active centres of learning in the world;

e. Virtual absence of post-graduate activities in Universities;

f. Lack of systematic feed-back from users of technology and absence of intimate links of science with production;

g. Lack of effective coordination between scientific establishments;

h. Public ignorance of the potentialities of science and exclusion of the mass of the people from contributing to the innovation process; and

i. Undue dependence on foreign technology and technical know-how.

Sporadic efforts have been made to deal with one or more of these deficiencies but, in the absence of an overall well thought out science and technology policy and plan, as an integral part of national development plan, such efforts did not make desired impact.

Planning of science and technology for development itself is a relatively new concept. The preparation of an S&T Plan, as an integral part of the socio-economic plan, can only stem from a purposeful policy of science and technology which lays down directions for scientific efforts and identifies areas of technological improvements to subserve our national goals. An exercise to formulate a set of comprehensive proposals for the National Science and Technology Policy has recently been concluded. The principles outlined in the Vienna Programme of Action on Science and Technology for Development adopted at the UN Conference on Science and Technology for Development have been made se of while formulating the policy proposals. The policy has been framed after protracted discussion, deliberations and views of the concerned federal ministries, provincial governments, national scientific and technological community, economists, social scientists and users of science and technology. This S&T Policy has recently been approved by the Government of Pakistan in principle and it has been directed that an Action Plan for the implementation of the proposals included in the Policy be prepared for approval of the Government.

S&T POLICY - SALIENT FEATURES

The National Science and Technology Policy include proposals relating to Organization and Structure of Science and Technology, University Research, Technology Development, Scientific and Technical Manpower, Service Conditions and Incentives for Scientific and Technical Manpower, Promotion of Science and Technology in

Society, International Liaison and Financing of Science and Technology System. The principal aims and objects of the National Science and Technology Policy are:

i) to cultivate and promote science and technology in society and create physical and social environment conducive to the pursuit of scientific activities;

ii) to re-organize, activate and expand the science and technology system in the country with a view to making it more efficient, dynamic and self-reliant;

iii) to ensure that the science and technology system is directed towards the achievement of national goals and aspirations, in particular towards the welfare of the people, sustained growth of the national economy, and security of the country;

iv) to develop, strengthen and modernize the engineering and technological base of the country so as to achieve self-reliance in this field, reduce import of consumer goods and promote export of value added manufactured products;

v) to develop speedily the requisite level of technological capability in the country through planned promotion of indigenous technologies as well as import, assimilation and adaptation of advanced technologies for increasing gross national product and ensuring optimal exploitation of the country's natural resources;

vi) to ensure regular supply of adequate strength of high quality research manpower for the S&T sector and creating an environment providing necessary motivation for high quality performance;

vii) to develop an effective information networkfor science engineering and technology, having adequate links with international information services, for providing workers and other interested agencies speedy access to current knowledge in different S&T fields; and

viii) to popularize science and technology at the grass-roots level so as to mobilize the creative abilities of the entire nation and facilitate widespread application of S&T for socio-economic uplift of the urban as well as rural areas.

ORGANIZATION AND STRUCTURE OF SCIENCE AND TECHNOLOGY

As science policy interacts directly with the overall national development policy, and involves the priority allocation of resources, decision-making must rest ultimately at the top political level. Only at this level, planning and decision-making on a comprehensive national scale can be properly undertaken and coordinated.

In order to provide the requisite political will and authority for the promotion of Science and Technology and its application to development, the S&T Policy has proposed the constitution of a high-powered National Commission for Science and Technology (NCST) as the apex decision-making and coordinating agency for S&T in the nation. The Commission would provide leadership and overall guidance in the development of a strong well-integrated system of science and technology and its deployment for rapid socio-economic progress. The functions of this Commission which will meet twice a year would include inter-alia (i) submission of programme for the coming year (ii) half yearly review of progress indicating not only the achievements but failures with reference to targets clearly identifying the bottlenecks, (iii) coordination of inter-ministerial and inter-provincial S&T programmes, and (iv) ensuring proper linkage of S&T effort with the production sector and development plans. The NCST will be headed by the Chief Executive of the country and its membership will comprise of:

a) Federal Ministers in charge of:
   1. Science and Technology
   2. Finance
   3. Planning and Development
   4. Production

b) Three other Federal Ministers to be nominated by the President

c) A Provincial Minister from each Province to be nominated by the Governor

d) Chairman/President of the following Councils / Organizations:
   1. Pakistan Engineering Council
   2. Pakistan Medical and Dental Council
   3. University Grants Commission
   4. Pakistan Agricultural Research Council
   5. Pakistan Council of Scientific and Industrial Research
   6. Pakistan Atomic Energy Commission
   7. Advisory Council for Science and Technology
   8. Pakistan Academy of Sciences
   9. Space and Upper Atmosphere Research Commission
   10. Defence Science and Technology Organization

e) Four eminent scientists/technologists to be nominated by the President

f) Two representatives of user-organizations for S&T

g) Secretary, Ministry of Science and Technology (Member/Secretary).

The Ministry of Science and Technology will function as Secretariat of the NCST. In addition to the Federal Ministries and Provincial Governments, the NCST may seek advice, whenever necessary, from any of the various governmental and non-governmental scientific organizations in the country.

Recommendations also pertain to strengthening of Ministry of Science and Technology, establishment of Advisory Council for Science and Technology and creation of departments of S&T in provinces.

To bring about improvement at the level of implementation, the policy package proposes statutory base for all research councils, administrative and financial reforms in the existing research councils, establishment of research institutes where gaps exist and establishment of R&D units in all industrial enterprises. The measures for improvement in support services in the Policy package cover S&T information services, testing, quality control and standard services, scientific equipment, manufacture and support services, S&T statistics and consultancy services.

University Research:

Universities in the contemporary world are seats of learning and centres par excellence for the creation of new knowledge. The best universities are very active in research and teachers of renown work at the frontiers of knowledge, along with senior students who are candidates for advanced degrees, such as the Ph.D or post-doctoral work. The university model inherited by us from colonialism is, however, that of a diploma mill where an examining affiliating institute undertakes very little research and training at Ph.D level. Though the nation has established twenty universities, produces annually around a dozen Ph.Ds in the natural sciences, against 5,000 from the 20 British Universities we are still dependent on advanced countries for the training of all our high-level personnel. The country is consequently perpetually short of high-level professional and research human resorce for launching a viable scientific or high technology development programmes.

In advanced countries, support to applied research is provided by universities through the development of basic and fundamental research as well as the training of high-level manpower. Basic research, conducted mostly in the universities is, in fact, the foundation which supports the superstructure of advanced technological research. In Pakistan, though all the universities are vested with autonomy under their charters to undertake research, very little research is acutally carried out in them, partly due to the fact that the resources allocated for research have been extremely meagre. Only Rs. 3.2 million is set aside for research out of a total budget of Rs. 311 millions for the nineteen universities. The current allocations of about one percent of the budget of universities for research is insignificant. In advanced nations, it is around 33 percent in general universities and much higher in research universities. It has

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therefore been recommended that at least 15 percent of their budget should be spent on research by the universities.

For promotion of research at the Universities the policy package contains recommendations aimed at revival of the Board of Advanced Studies and Research (BASR) at each university, non lapsable separate funds for R&D, vigorous programme of training in various S&T fields at doctoral and post-doctoral levels, strengthening of the Univeristy library, documentation and laboratory facilities, advanced training of talented unviersity teachers, improvement of teacher to student ratio, etc. In fact a genuine transformation in the prevailing environment in the universities is required so that they can discharge their fundamental responsbility for training of high level research manpower and at the same time serve as a source of new knowledge.

TECHNOLOGY DEVELOPMENT

Development in various sectors of national life has been almost entirely dependent on the imported processes and technologies. In the recent past some progress has been achieved in unpackaging of imported technologies through enhancement of indigenous technological inputs. The basic aim of the approved Science Policy is to achieve greater self-reliance in the develoment and transfer of technology. In order to achieve a meaningful technological progress, it is imperative that all technological developments should be based on maximum utilization of indigenous manpower, material resources and techno.ogy and in the case of imported technology its assimilation/adaptation to national needs. In addition, vigorous measures should be taken to stimulate demand for domestic technologies and generate technologies indigenously. The three main routes by which new technology can be acquired, are:

a) importation of technology in "packaged" form (turn-key contracts);

b) importation of "unpackaged" technology with or without adaptation to local conditions, either directly to the users or through the national R&D system; and

c) up-gradation of the level and intensity of national R&D effort so as to strengthen the local S&T sector for technology development.

The basic strategy that developing countries, like Pakistan, need to adopt for achieving self-reliance is to move away from predominant reliance on the first (or turn-key) mechanism to an optimal mix of the second and third alternatives. In this way, it would be possible to ensure that while overall economic growth is sustained, the local S&T sector is strengthened and utilized for modernization through technology transfer as well as development of indigenous technologies.

As a follow-up of S&T policy recommendaitons on the subject, the Ministry of Science and Technology has proposed a three tier TECHNOLOGY TRANSFER NETWORK consisting of National Centre of Technology Transfer, Provincial Technical Advisory and Development Centres, and Technology Extension Units.

National Centre for Technology Transfer (NCTT):

NCTT primarily would be concerned with vetting of imported technologies, collection of relevant information on advanced technologies, patents etc. and will assist and advice all public and private sector agencies in the development/transfer of technology. An envisaged in the Policy Document it will provide advice on request regarding negotiating technology agreements and in "unpackaging" of technology. NCTT will also disseminate within the country information on local capability in the manufacturing field. It will have close liaison with the Regional Centres for Transfer of Technology and other concerned organizations.

Provincial Technical Advisory & Development Centres (PTADCs):

At the second tier of the technology network a number of provincial technical advisory and development centres (PTADCs) will be initially established by the Federal Government as part of the National Technology Network. After successful operation for a couple of years they would be transferred to the Provincial Governments. These centres will have direct linkages vertically with the NCTT and also horizontally to the industrial units in their areas. The functions of the PTADCs will be to provide facilities to industries in their areas for design development and improvement of products, provide essential common-user services like heat treatment, electroplating, manufacturing of spare parts, technical information and advanced practical training.

Technical Extension Units (TEUs):

At the third tier of the National Technology Network, it is proposed to establish Technical Extension Units (TEUs) at Divisional level to provide extension services to industry in the local areas. These units will operate under administrative and technical control of the PTADCs of thier areas and will comprise of experienced engineers capable of giving expert technical advice to small industrial units, handicraft centres etc.

Inter-Ministerial Coordination Committee:

A high level inter-ministerial Committee is also proposed to be constituted as early as possible to be chaired by the Minister of Finance/Science and Technolgy, with representation from Ministries, nominees from Chambers of Commerce and Industry, Agriculture and small entrepreneurs. The main functions of this Committee will be to:

i) lay down priority needs to achieve optimal import substitution in the shortest possible time; 2650

ii) recommend measures, where necessary, for review of prevailing policies to optimise the accruing advantages;

iii) orient the R&D endeavour to meet the country's priority needs;

iv) act as a vehicle for bringing together the local S&T institutions and user Ministries as well as the end-users;

v) ensure optimum commercial utilization of the indigenous processes and technologies and technologies developed in R&D insitutions, etc. and

vi) take measures for production of quality goods for export.

RESEARCH IN INDUSTRIAL ESTABLISHMENTS

Research in industry is almost non-existant in Pakistan. There is, therefore an urgent need to develop effective mechanism for providing S&T inputs for quality control, process improvement and development of new processes and techniques for increasing quality production. It is, therefore, proposed to establish R&D units in large industrial establishments both in the public and private sector as well as encourage formation of R&D associations to serve groups of smaller industries.

Establishment of R&D Units in Public Sector industrial organizations has been initiated by the Production Divison and it is hoped that all major industries in the public sector will have their own R&D facilities by the end of the Sixth Plan period. Production Divison proposes to spend one per cent of the sales revenue of their industries on R&D.

Incentives will be provided to the private sectors to establish R&D units within the industry for quality control and productivity improvement. R&D cess fund (equivalent to half percent of sales of industrial production) proposed in thr policy would be used to provide financial assistance in deserving cases, especially for the formation of R&D associations for groups of small industries.

Risk Fund for Research Development/R&D Corporation:

It is a well known fact that the funds spent on R&D to create new technologies and products are often only a small fraction of the amount required for taking the results of research upto industrial production. There is at least a tenfold increase in cost and effort after the R&D phase before the product based on a new invention/innovation can reach the market. Cash flow continues to be negative for a long while until full manufacturing capacity has been established and initial operational, marketing and financial difficulties are overcome. The cost of the commercial scale manufacturing project would vary over wide limits and the process often carries considerable financial risks.

Private capital, particularly in developing countries like Pakistan, is extremely shy regarding participation in such risky venture.

It is, therfore, proposed to establish, in due course, a statutory autonomous organization as has already been done in a number of progressive developing countries to be known as National Research Development Corporation, which would sponsor and support with necessary risk many development projects based on new inventions and innovation derived from indigenous research. This Corporation would also provide financial and technical assistance for projects aimed at improving existing technologies and strenghten capabilities of innovative entrepreneurs with limited resources.

SCIENTIFIC AND TECHNICAL PERSONNEL

High-level trained scientific and technological personnel is the most crucial resource of a nation for its development programmes. In fact, the quality of intellectual and professional talent brought into any system sets the ultimate limits of its attainment. Strengthening of domestic technologcial capability through high-level S&T manpower training and the creation of a strong research and development system is, therefore, vital for our future development and self-reliance.

The scientific manpower engaged in R&D in Pakistan totals less than 5,000 i.e. about 40 percent of the minimum required as per UNESCO yardstick for the developing countries. There is thus an imminent need to fill this gap. Presently, our universities are not in a position to meet the training requirements of high level S&T research manpower number of Ph.Ds trained annually in science is around a dozen only. As such launching of a foreign training programme is inescapable.

Conservative estimates of foreign training requirements for the R&D institutes of the Ministry of Science and Technology to fill the existing gaps in important areas and to man the new proposed research institutes for the period 1984-88 come to about 260 Ph.Ds, 270 M.S/M.Phils and 390 specialised courses of 3 to 9 month duration. The cost of training of these scientists in advanced foreign countries works out to approximately Rs.380 million with foreign exchange component of Rs.360 million. A project proposal in this respect, has already been submitted to the Planning Divison who are in the process of finding bilateral and international sources of cooperation for its implementation.

The Policy also recommends utilization of the expatriate nationals, retired eminent scientists and induction of women into S&T research.

SERVICE CONDITIONS AND INCENTIVES FOR S&T PERSONNEL

The successful implementation of the National Science and Technology Policy would depend critically on the competence, 2650 devotion and job satisfaction of the personnel working in scientific institutions and establishments. It is, therfore, essential to provide the R&D workers with an environment conducive to creative work and to accord them a status in society commensurate with their role in national development. Attractive career prospects and improved service conditions are also necessary to attract and retain the best talent and skill available in the country for R&D activities. Some appropriate measures keeping in view the national scenario and resources have been recommended in order to provide suitable incentives to the scientific manpower engaged in R&D work, prestigeous status in society and conducive environment for creative work.

PROMOTION OF SCIENCE IN THE SOCIETY

One of the important pre-requisites for massive and rapid technical change is the re-awakening of the creative faculties and impulses of the whole people. Social and cultural constraints which are characteristic of a static and reactionary society seriously impede the movement of science and assimilation of technology. The society must create demand for science which is possible only when there is enough awareness about the potential of the science among the masses. To create a science minded society, science has to be popularized, that is, interpreted and diffused to the whole population. A number of proposals have therefore been incorporated in the S&T policy to popularise science through mass media techniques, museums, science centres, science clubs and science exhibitions.

INTERNATIONAL LIAISON FOR S&T ACTIVITIES

Science is an international activity. By its very nature, it calls for international coopration and effective participation of all nations in its progress and development. No single country can ever afford to be independent of the rest of the world in pursuing the path of science and technology alone and by itself. It has to have a cooperative effort. The Policy proposals therefore call for strengthening of S&T cooperation with developed countries, developing countries, members states of the Organisation of Islamic Countries (OIC) and the United Nations agencies/bodies and organizations through bilateral and multilateral agreements. As freedom to exchange information and establishing peronal contact with eminent scientists in well established research organizations are essential factors for creating a favourable environment for S&T research, Pakistan Scientists will be encouraged to participate in international conferences and seminars. Institutional linkages between the R&D organizations of Pakistan and relevant institutions in advanced countries will also be established.

FINANCING SCIENCE AND TECHNOLOGY

As a result of the United Nations activities in science and technology especially the United Nations conference on Science and Technology for Development and the discussions, seminars and workshops held to thrash out the proposals for National Science and Technology Policy, the Planning and Economic Ministries have now a greater realisation of the importance of Science and Technology to National Development. A separate Science and Technology Section has been created in the Planning Division to process the S&T research proposals and projects. A number of proposals that emerged out of the above excercises have found a place in the Sixth Five Year Plan (1983-88) especially with regard to the strengthenig of the existing R&D institutes and establishment of new institutes in important disciplines and new emerging technologies.

However, the resources constraints still continue to operate even in respect of the agreed projects included in the Sixth Plan. This is due to the fact that mobilisation of the finances has not been achieved to the extent envisaged in the Plan and there are equally or more important competing demands for funds for providing basic facilities to the population like essential consumer goods, food, education, health, shelter etc. Nevertheless it is very encouraging to note that S&T section of the Planning Division is quite active in pursuing and pushing the S&T research projects. The Government by approving the S&T policy has made a commitment to the promotion of Science and Technology in general and it is expected that most projects will be funded sooner or later.

The funds requirements for beginning the process of S&T development in a modest manner has been estimated at about Rs. 5,500 million for the period 1984-88. Nearly 60% of this amount is allocated in the Sixth Five Year Plan. But these funds are not placed at the disposal of the Ministry of Science and Technology and the availability of these funds is not automatic. The funding of proposals and projects is subject to detailed feasibility of the projects and approval by the Planning Division, Centre Development Working Party and the Executive Committee of the National Economic Council. The allocation of fund is made through the mechanism of the Ministry of Finance. The qunatum of allocation to each Ministry is decided on the basis of their previous expenditure, competing demands and the resources availability.

Pakistan's national investment in Science and Technology has unlike that of some progressive developing countries, remained static for many years at well below 0.2 per cent of GNP, which is less than one-fifth of the minimum recommended (viz. 1 percent of GNP) for poor developing countries by the UN forums. On the other hand, the corresponding figure for developed countries is as high as 3 to 5 percent of their incomparably larger GNP. Apart from the gross inadequacy of our overall Research and Development investment, the sectoral distribution of research funds is badly skewed and, as a consequence, some vital development sectors have remained deprived of the much needed research support. To rectify this situation, it was proposed to effect a quantum jump in Science and Technology allocation during the Sixth Plan and ensure a proper balance in the distribution of available resources.

The allocation earmarked for Science and Technology activities in the Sixth Plan is Rs. 5,809 million (Rs.4,908 million under various sectors and Rs. 1,000 million block allocation for new programmes and projects not covered under sectoral allocation) which is about four times the outlays during the Fifth Plan period (Table 1). Furthermore, unlike in the past it is proposed that the development effort in each sector will provide for a matching input of Research and Development. Even with these proposed steps the level of Science and Technology investment by the end of the Sixth Plan will be about 0.5 per cent of GNP. The momentum generated through successful implementation of the programmes incorporated in the Sixth Plan will however enable further acceleration of R&D efforts in subsequent years so that the target of 1 percent of GNP is attained by the end of the next (Seventh) Plan.

SCIENCE AND TECHNOLOGY IN PERU

THE NATIONAL PLANNING SYSTEM

Established in 1961, the National Planning System has since developed into its present form. It is presently composed of a central office, the National Planning Institute (INP), agencies located in each Ministry called Sectoral Planning Offices, and regional bureaus.

The head of the INP is given the administrative position of Minister. The principle tasks of the INP under his charge are:

1. The devising of the development strategy.

2. The coordination of the sectoral planning process.

3. The forecasting of national economic variables.

4. The determination at the national level, of investment and the establishing of priorities amongst the major projects.

All these issues are medium and long term in scope. The short term issues, principally the ones referring the "stabilization of the economy" are administered by the Central Bank and the Ministry of Finance, Economy and Commerce (MLFC), which are responsible for the annual fiscal budget.

The planning process is carried out through the formulation, execution and evaluation of the global and regional plan of medium (4 years) and short term (1-2 years) duration. The short term plans detail specification of objectives, policies, and projects for the first years including the fiscal budget.

This scheme present two major problems:

1. Science and Technology is not included adequately in this process.

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2. There is an absence both of a sufficient administrative capacity to implement the development plans, and of a built-in decision process capable of self-correction.

Finally, it is necessary to say that presently the entire economic administration has a more liberal economic outlook than was true during the last decade when the planning system grew. As a consequence, the planning system, including the INP, has lost much of its influence and imporance. The plans are seldom consulted in the formulation of the government economic policy or the fiscal budget, thus the priority sectors established by the INP are largely ignored. For example the INP establishes the agricultural sector as of highest priority, while the government destines the greater part of its available fiscal resources to armament and transport infrastructure.

POLICY RESEARCH

There are several centres in Peru engaged in studies on S&T Policy (Annex).

THE SCIENTIFIC AND TECHNOLOGICAL SYSTEM

Unlike the planning system where hierarchial lines are clearly determined by law, and coordination is mandatory, the scientific and technological system does not have a formal organization. This system was not created with a global approach outlook and its many institutions developed historically.

UNIVERSITIES

The universities date back to colonial times and have exploded in number recently. During the 1950s there were 6, while today 33 exist, however the quality of learning has suffered considerably.

The progressive impoverishment of the university researchers has resulted in their abandoning their university posts. Many of them have been forced to emigrate.

The state universities have especially been neglected by the central government. This has been manifested in a lack of financial sustenance and funding for research and development activities.

Reflecting this neglect is the fact that between 1970 and 1980, the bulk of government resources granted to science and technology activities were destined to institutes created to replace the universities in research and development activities. Thus during the 1971-1981 period the growth rate of the budget for research in the universities was only 0.9%, and worsened to a -15.3% during 1981-1983. This despite the fact that the number of state universities with science and technology research activities rose during the same period.

TECHNOLOGICAL INSTITUTES

In various specialized technological institutes, all state owned today, have a long history. Some emerged soon after World War II, but the majority flourished during the 1970s. Their principal trait is that they are all sector or area oriented. There are institutes directed towards agriculture, mining, industry, sea and ocean research, health and regional research (such as for the Amazon Basin), etc. In all there are around 15 sectoral technology institutes.

These sectoral institutes born from the absence of a global policy of coherent science and technology development during the decade 1970-1980, generally suffer from a lack of a sufficient quantity or qualified personnel as well as from inadequate infrastructures and lack of financing.

Two of the more important of these sectoral insititues are the Institute of Industrial Technological Research and Technical Norms (ITINTEC) and the National Institute of Agroindustrial Research (IIA).

ITINTEC was created during the 1970s as the principal center of technology research. Its principal attributes are in the development of technology in the areas of industrial production declared to be of special interest.

- The approval and control of industrial technological research project presented by the industrial enterprise, to be financed by a 2% tax on the net profits of these enterprises.

- The elaboration of the National Technical Norms and quality certification.

- Regulation of and certification of compliance with the constitutive elements of Industrial Property according to legistation.

The progress obtained by ITINTEC is referred basically to the elbaoration of 2,200 National Technical Norms. It has likewise reinforced the area of quality control and measurements. In the technological development area, ITINTEC has done work principally in light industry, non-conventioanl energy, chemical industry, metallurgy, textiles, civil construction and industrial design. It should be underlined however that a significant amount of the research work has not been applied to the industrial sector, for various reasons.

Until recently ITINTEC played only a passive role, limited to revising and approving or rejecting the projects presented to it, and presenting the final results to the enterprises involved. This passive role has been overcome with the construction of laboratories and the decentralization of the areas worked with.

This has resulted in more cooperation with the rural areas, principally in non-conventional energy.

The Institute of Agroindustrial Development (INDDA) - formerly the National Institute of Agroindustrial Research (IIA) is a dependency of the Ministry of Agriculture.

Unlike ITINTEC up to 1984 INDDA did not obtain its resources from the enterprises of the sector, but solely from the government. Only recently has a 2% project tax been applied to the enterprises of the sector to benefit INDDA.

Thus it has been the lack of resources which has caused the poverty of results coming from this institute since, unlike ITINTEC, INDDA does own modern equipment, laboratories and experimentation plants which, however are being grossly underutilized.

Enterprises:

As for enterprises, the great majority do not have research and development departments, and of those which do have, they are poorly equipped and principally located in the public enterprises of the mining and metallurgy sectors. The majority of the private enterprises rely on imported foreign technology.

Independent Institutions:

There are also many independent institutions, specially in the social science area, being the favored themes of study on the agrarian reform and the present economic crisis.

Coordination:

The lack of coordinating mechanisms at the levels of the sectoral institutes, universities and Private Researchers have given rise to a great dispersion of investigative efforts. The mechanisms of exchange of experience and information hav been very weak and limited to the level of small groups of researchers. The formation and qualification of human resources for science and technology has been greatly neglected as well.

As a response to this need special offices of public administration, with normative attributions were created. Of special importance, then, are the National Council for Science and Technology (CONCYTEC) and the National Commission for Foreign Investment and Technology (CONITE).

CONCYTEC was created in June 1981 with the objective of conforming into an integrated system all the independent institutions mentioned.

CONCYTEC was created on the base of the former National Research Council (CONI), and has as its objective: to promote, coordinate and guide the science and technology research in Peru.

its principal aims are included in various documents, especially the Organic Law (Ley Organica) and Policy Outline (Lineamientos de Politica) documents.

The role of CONCYTEC within the National Programme of Science and Technology is to initiate, to organize, to support and to act as catalizer of the programmes.

Due to the scarcity of resources for research, CONCYTEC considered it necessary to establish areas of priority in which to implement the National Programmes of Science and Technology.

The process of defining these priorities is currently underway. Meanwhile CONCYTEC has begun putting into effect the organization of certain areas of special interest. The programmes are: Biotechnology, Recuperation of Native Technologies, and Agriculture in High Andean zones. In the future other Programmes are planned to be undertaken.

The National Commission for Foreign Investment and Technology (CONITE) is a multisectorial commission, dependent on the Ministry of Economy, Finance and Commerce which is in charge of regulating and assisting in the transfer of technology.

The principal laws concerning the transfer of technology are laws No. 18900 and No. 21826 which regulate foreign investments and contract for the importing of technology. Specifically they indicate percentages of allowed profit remittances, compel foreign firms investing in Peru to initiate joint ventures with national enterprises and so on.

The principal problems CONITE faces are:

1. Its insufficient capacity to evaluate the functioning and real economic situation of foreign firms, and thus its inability to prevent the irregular remittances of money through "transfer prices" and other maneuvers.

2. Its insufficient capacity to assess the technical aspects of technology import contracts, a result of limited joint work with the various sectoral technological institutes and universities.

Finally, the engineering and consultant services are not regulated, even when there exists the suspicion that this too is a channel for non legal money flight.

PRIORITY SECTORS

These are established at the highest level. The Peruvian Constitution itself assigns top priority for Agriculture and Regional Development, but, once again, these priorities are not fully present in all policies and investment programs. They have not been specified in greater detail. For example, Agriculture and Regional Developments are areas too broad to be useful in directing resource distribution.

With regard to the scientific and technological area, CONCYTEC has prepared a general policy document which was approved by the Government and, as a first step before organizing a mechanism to coordinate various related activities in some specific fields, is presently conducting a process to specify detailed priorities.

COOPERATION

CONCYTEC believes the follwoing are the more fertile areas of cooperation.

1. Human resource qualification.
2. Development of information systems.
3. Joint research in some new areas, such as genetic engineering and biotechnology, for example.

Cooperation among Developing Countries:

The Interchange of Technological Information in the Andean Group:

Decision 24 of the Andean Group regulates the process of technology transfer. To help in this process an Andean system of Information on Technology (SAIT) was established in June 1980.

The goal is to strengthen the negotiating capacity of each country so as to benefit from foreign investment and technology imports, exchanging among the five country members information on the conditions upon which foreign capital was accepted in each country and the procedures they have developed to import technology.

The system is developing as programmed and there are now four networks in operation for the exchange of information on:

- Foreign investment
- Importation of technology
- Industrial property
- International prices

Annex

STUDY CENTRES FOR S AND T POLICY

1. National Council for Science and Technology (CONCYTEC) Office for S&T Policy
   Director a.i.: Gerardo Ramos
   P.O. Box 1984, Lima 100, Peru
   Telex 25023 Lima
   Telephone 248175

   (Priority Studies, Methodology for Construction of National Programs on S&T. Demand studies. Diagnosis. S&T invetnory. Studies on financial resources for S&T. Qualitative methods)

2. Institute for Research and Industrial Technology and Technical Standards (ITINTEC)
   Director: Raul Fajardo
   P.O. Box 145, Lima 100, Peru

3. University of Lima
   Institute for Philosophical Research
   Director: Francisco Miro-Quesada
   Av. Javier Prado, Monterrico, Peru
   (Studies on scientific community)

4. Catholic University of Peru
   Department of Science
   Specialist: Prof. Ramon Garcia-Coglan
   Av. Bolivar s/n, Lima 21, Peru
   (Qualitative and quantitative models for S&T policy formulation. Research on global development of the country)

5. Analysis Group on Development (GRADE)
   Directors: Francisco Sagasti, Helan Jaworsky
   Los Olivos 1012-Residencial San Felipe, Lima 11, Peru
   (Several studies on S&T policy. Behaviour of S&T community).

DEVELOPMENT OF SCIENCE AND TECHNOLOGY IN THE SYRIAN ARAB REPUBLIC

INTRODUCTION

During the last 15 years great social and economic transformations have taken place in the Syrian Arab Republic under the leadership of President H. Assad. At present the whole of the large-scale industry, the most part of export and import operations, a considerable part of home trade, all the railways and motor vehicle pools are under the control of the Government. The land reform has been carried out and about 5000 cooperatives have been set up in about 2m. hectares of land.

Efforts are underway for increasing the area of irrigated lands. Dams and irrigation projects are being executed. The construction of the Euphrates dam, built up with the assistance of the USSR, has played a big role in these efforts. The dam provides additionally 640 thousand hectares of irrigated lands. The capacity of its hydroelectric station is 800 thousand kw. and the capacity of water storage is 730 sq.km. About 20,000 km. of asphalt roads and 2000 km. of railways have been built in Syria. The marine fleet is being expanded. The number of aircrafts in the national air company is being increased. A design for the electrification of more than 80% of small towns and villages has been completed. A great deal of work is being carried out in the country regarding prospecting, extraction, transportation and processing of oil and gas. The oil refinery in Homs has been considerably expanded. The new oil refineries have been set up in Baniyas and Tartus. Four big cement plants, processing plants of phosphorites, manufacturing facilities for electronic household appliances, refrigerators, glass, paper, sugar plants, etc. have been constructed.

PLANNING

The country's economy since 1971 has been developed on the basis of the long-term plan. The readjustment of such plan is done every year. There is a planning department at each plant or

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Presented by Mahmoud Warde

government enterprise whose function is to ensure fulfilment of current plans as well as to outline an original plan for the next year or five-year period.

A greater part of the budget of the Syrian Arab Republic is spent on the defence needs. Considerable damage to the economy of the country and destruction of infrastructure was caused during the 1973 war.

In spite of these difficulties, the allocations for the development of the public education and training of national personnel have increased each year. The government strategy in this field defines education as a productive sector which will help to increase future national income.

Education :

The allotments to the Ministry of Secondary and Primary Education has increased from 428 m. of the Syrian Pound in 1974 (6.6 percent of the country's total budget) to 3,550 m. of Syrian Pound in 1983 (9.5 percent of the budget). The number of students during the last 10 years has increased by 50 percent as also the number of schools. Several specialized schools and technical colleges have been set up. Primary education in the Syrian Arab Republic is compulsory. Work is being carried out to eradicate illiteracy among the adults. At present more than 10 thousand schools function in the country. The centre for vocational training has been set up in Haleb with the USSR assistance. About 6000 skilled workers and foremen finished the training.

There are 4 Unviersities in the Syrian Arab Republic (Damascus University founded in 1923, Haleb University in 1960, Latakia University in 1971 and Homs University in 1980). These Universities have faculties of medicine, civil engineering, energy, mechanics, physicomathematics, chemistry as well as the faculties of the humanities. There are also 83 high schools and intermediate institutes which train technicians. All the high educational institutions in the country are state-owned and the tuition fee is nominal.

Great attention has been paid in establishing improved facilities in the universities and high educational institutions.

For instance in Damascus University the allocations for the construction of new faculty buildings, laboratories, hostels and training and medical complex amounted to over 1 billion of Syrian Pound (US $250 m.) in the last five-year plan. Construction of the main buildings of the University in Latakia has been completed as well as the construction of the auxiliary buildings of the University in Haleb (including hostels and educational buildings). Branches of Universities are set up in small towns of the country such as Hama Deir Al Zor. A design of the complex of buildings at the University of Hums is being elaborated. The University of Damascus provides for more than 70,000 undergraduate students and more than 500 post-graduates.

RESEARCH ACTIVITIES

The general coordination of the research activity and publishing of works on natural and technical sciences are carried out by the Supreme Council for Sciences.

The Arab Academy of Sciences, founded in 1919, carries out research works on the Arabic language, literature and culture, as also the Damascus Academy, founded in 1919.

To each Ministry in the Syrian Arab Republic a scientific and research institute is attached to deal with the related problems of the public economy. They are equipped with the laboratories and computer centres. Instructors of the educational institutions take active part in their work for additional remuneration.

The largest among them is the Scientific and Research Centre of the Minsitry of Defence. A leading part is played also by the Scientific and Research Centre for Industrial products as well as the Agricultural Scientific Centre.

There are also scientific and research subdivisions at the universities. There is the agricultural scientific and research centre at the Haleb University, and the Supreme Institute of social activity , founded in 1961, at the Damascus University, where the economic and social researches are carried out.

Three agricultural scientific and research centres with laboratories and experimental fields in Latakia, Rakke and Kamyshli have been set up with the USSR assistance.

SHORTCOMINGS

All the universities do not carry out very active research work in spite of Government encouragement to promote the progress of the scientific and technical works.

The reasons are as follows:

- large number of students at the high educational institutions with insufficient number of instructors. At some of the faculties the teacher-student ratio is 1 to 50.

- Every student who succesfully finishes a 12 year secondary school is admitted to the Universities and technical colleges of the country.

- In spite of only 48% students in the secondary school passing the state examinations, nearly 70,000 students entered the Universities. 10,000 of them entered the technical colleges, 20,000 entered the pedagogical colleges and 40,000 were admitted to various faculties of the Universities.
- Instructors of the Universities who are high-qualified

specialists in the country are often occupied with multiple professional tasks as consultants in various constrcution, designing, state industrial organizations and in the private sector.

- Instructors often have to attend two Universities in different cities of the country.

- Education at the Universities of the Syrian Arab Republic is conducted in the Arabic language and the teaching staff is required to publish textbooks, educational aids and methods of teaching, particularly by collecting and translating special foreign literature.

- Instructors are required to teach additional post-graduate courses.

- Assignment of instructors to fraternal Arab countries which are in need of qualified personnel.

The following steps are being taken to deal with these problems:

1. Training of personnel within the country. This has stimualted interest in the scientific and research work in the higher educational institutions on national problems.

2. Training of number of post-graduates in friendly countries.

It is planned to send 5,000 post-graduates to other countries within the next 5 years period. 600 persons have already been sent to the German Democratic Republic. The greater part of them will be sent to the USSR and other friendly countries.

At present over 500 post-graduates study in various developed countries of America, Asia and Europe. There are also several thousand students and post-graduates who are educated at their own expense and are materially supported by the state through the Ministry of Education.

Incentives :

Professors from friendly countries are invited to provide assistance in teaching, education of post-graduates and to work at the scientific and research institutions, thereby reducing the pedagogical tasks for some of instructors occupied with the scientific and research work. Material incentives are provided for those who carry out scientific and research work. Young doctors on their return from overseas are provided with apartments at reduced prices and easy repayment terms. Once in every three years the instructors are sent to the advanced countries for carrying out their scientific and research work. 2650

THE EFFORTS IN THE UNITED REPUBLIC OF TANZANIA

INTRODUCTION

Planning and Management Science and Technology is an extremely wide and extensive topic covering various disciplines. Attempt is made to narrow this field by considering the educational aspects in the process of planning, managing and developing science and technology.

In order to understand the degree of achievement or failure of the country's efforts to develop science and technology it is necessary to take a brief look of its recent past, that is, the period before the advent of the colonialism. Before the colonial era the people lived a simple but dynamic and progressive life. They had traditions of science and simple technologies, enough to sustain their daily requirements. They needed instruments to aid them in tilling the land, to cut trees for building and fuel. They had to fight diseases, with the help of persons with enough seriousness and patience to study the curative properties of herbs. From cow's milk they readily made butter and ghee. Because of frequent tribal wars, people had to learn to manufacture weapons to defend themselves. They had learnt to identify iron ore and the art of smelting iron, a development which gave rise to the manufacture of arrows, spears, axe, various forms of knives, hoes, etc. Here was society of simple people but seriously determined, hard working and self reliant. While men were developing defensive weapons and other household mechanical gadgets their women were engaged in various homecraft such as making pots, plates, spoons, etc. All these things required adequate planning, intelligent implementation, dedication and industrious mind. In short they developed a culture for survival and advancement.

Educational Planning and Management after Independence :

Since independence in 1961, the United Republic of Tanzania had taken steps to reorganize its educational system inherited from the British administration. Two major education policies were introduced in the first decade. The 1961-66 period saw the

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Presented by Ladislaus Marijani

the integration of schools, introduction of uniform curricula and development of education for manpower requirements. In 1967 the country's political, educational and social activities were given new bearing by the announcement of Arusha Dclaration on Socialism and Self-Reliance. Immediately thereafter President Nyerere issued a paper on Education for Self-Reliance (ESR). This paper became the basis of all major educational changes in the country. In implementing Education for self-reliance the 1969 Education Act (now replaced by the Education Act of 1978) was introduced. In 1972 the Decentralization Policy affected the structure of the Ministry of Education by vesting the running of Primary and adult education in local authorities leaving the Ministry of Education cater for secondary, teacher training and higher education. Although there was no formal declaration of a science policy, the development of science and technology is implied in Education for Self-Reliance since a country can only be Self-Reliant if it can provide its own scientists, engineers, researchers, etc., who will be entrusted with the implementation of its development activities.

EDUCATIONAL ADMINISTRAION

At present, the Ministry of Education is divided into nine departments each headed by a director. These departments are: Primary Education, Secondary Education, Teacher Education, Adult Education, Higher Education, Inspectorate (headed by a Chief Inspector), Technical Education Coordination, Education Planning, Manpower Development and Admininstration. The National Commission of UNESCO headed by the Secretary General is also under the Ministry. Academically and professionally all the above departments are headed and coordinated by the Commissioner for Education who is responsible for the general management and administration of all schools for which the government makes a contribution. Related to and complementary to the Ministry of Education departments are six parastatals which are:

1. The Institute of Education: - entrusted with curriculum development and evaluation together with supplementing the writing up of textbooks for primary, secondary and teacher education.

2. The Institute of Adult Education: - is responsible for planning and research on adult education, training of adult educators, administration of mass radio group campaigns and running all regional adult education centres.

3. The National Examination Council of Tanzania: - is responsible for setting, conducting and marking examinations as well as awarding certificates to Primary, Secondary, Teacher training and technical colleges graduates.

4. The University of Dar es Salaam: - This is the highest institution of learning in the country and from it the

country gets its top scientists, teachers, engineers, doctors, researchers, etc. for both social and industrial development.

5. <u>The Tanzania Library Service Ltd</u>: - has a role of establishing libraries all over the country.

6. <u>The Tanzania Elimu Supplies</u>: - is responsible for procurement and distribution of school equipment and materials to all schools in the country.

Armed with these units, departments and parastatals, the Ministry introduced in 1973 what was called Diversification of Secondary Educatin. The launching of the programme was the outcome of many years of discussion as to how best to integrate education and work as well as laying the foundation for a system of supplying skilled persons particularly in the rural areas in such vital fields as agriculture, engineering and crafts. A diversified/vocationalized secondary school is an ordinary school with basic subjects such as English, Kiswahili, Mathematics, Biology, Geography, History and Politcal education but <u>biased</u> to one of the following subjects: agriculture, commerce, technical and home economics. Agricultural biased secondary school, for example, will have 15 periods a week of agriculture out of a total of 45 periods. Other basic subjects will have between 4 and 6 periods. The current bias in the curricula is as follows:

Bias	Number of Schools Public	Private	Total
Agricultural	41	18	59
Home Economics	6	3	9
Commercial	34	34	68
Technical	5	2	7
Special Schools	2	-	2
Total	88	57	145

Another 34 schools have not yet diversified their curricula.

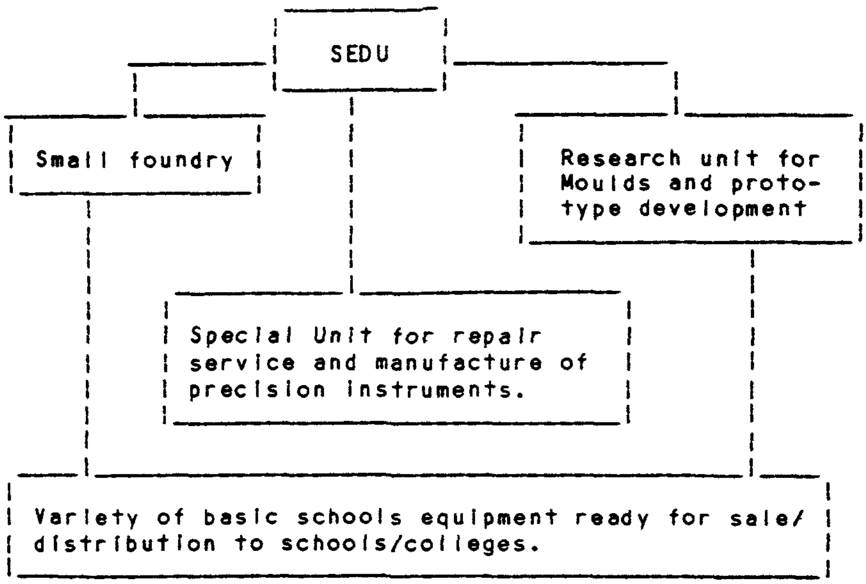
PROBLEMS

a) All Secondary Schools are faced with shortage of trained teachers required for the biases. At present there are 2307 teachers and the shortage is 888.

b) There is an acute shortage of teaching materials - textbooks, teaching aids, and scientific precision instruments in the fields of electricity, magnetism, electronics and modern physics. This is a serious problem because all technical teaching equipment are imported requiring foreign exchange or external aid or loan. The Ministry of Education made attempts at solving this problem by seeking external assistance for the establsihment of Schools Equipment Development Unit

(SEDU) (Figure 1). Implementation of this scheme requires external assistance from other countries or international organizations.

Figure 1.



Scholarships to academically and professionally outstanding techicians who will specialize in the repair, service, and modify vital precision instruments scattered all over the country in schools, colleges and universities is needed. Considerable quantity of advanced science equipment, donated by friendly countries are out of service because of poor maintenance, repair and replacement.

In order to effectively develop science and technology, a common language of communication becomes vital. The understanding and appreciation of science can set roots in any nation if it is popularized with simple literature and other aids understandable to the majority of the people. Reasonably literate people can assimilate simple research findings if they are written in the language they know. Social environments and attitudes are extremely vital for any language development.

SCIENCE POLICY AND PLAN IN THAILAND

GENERAL BACKGROUND

In Thailand, science and technology has gradually been realized to be the basis for economic development and emphasized in the National Economic and Social Development Plans. The First Plan (1961-1966) emphasized on the building up of the economic infrastructure, namely, construction of highways, irrigation dams and power plants. This orientation necessitated the introduction of new and advanced technologies from developed countries. In the Second Plan (1967-1971), the Applied Scientific Research Corporation of Thailand was set up to assist in the industrialization of the country. In the Third Plan (1972-1976), attention was called to the development of scientific and technological manpower. The Technology and Environment Planning Division was set up in 1975 within the Office of the National Economic and Social Development Board in order to formulate the science and technology development plan and the environmental plan as integral parts of the National Economic and Social Development Plan. The Fourth Plan (1976-1981), scientific and technological development were taken as one of the major development strategy. In 1979, the Ministry of Science, Technology and Energy (MOSTE) was established as the central policy making, planning, coordinting and promotion body in the government. In the Fifth Plan (1982-1986), there is for the first time a science and technology plan as an explicit part of the development plan. Planning has concentrated on three areas: aplication of science and technology in rural development, use of science and technology to increase efficiency in production leading to export promotion and import reduction, and strengthening of the national scientific and technological capacity.

NATIONAL SCIENCE POLICY MECHANISMS

The main agencies presently taking major responsibility for national S&T policy making in Thailand are MOSTE and the National Economic and Social Development Board (NESDB) in coordination with the Science Policy and Plan Committee. MOSTE has been established in 1979 as the main policy mechanism directly responsible for setting the national policy and plan in science, technology and energy, both on the macro and micro levels. MOSTE always works in coordination with NESDB in S&T formulation and implementation in various levels. NESDB is responsible for long term planning and assessment of long term implications of current economic and social situation. It also has the function of coordinating S&T planning with economic and social planning. The science and technology policy, a part of the National Economic and Social Development Plan, has to be approved by the cabinet committee before its implementation and operation.

Presented by C. Arthachinta

S&T POLICY

The present S&T policy is the statement by the Prime Minister presented to the Cabinet Committee on 20 May 1983 as follows:

Science, Technology, Energy and Environment Policy:

1. To accelerate scientific and technological research and service with emphasis on the promotion of agricultural and industrial development for economic and social stability.

2. To lay out the scientific and technological scheme in making use of natural resources to cultivate the country with regard to the environmental condition.

3. To promote the technical propagation which leads to the appropriate development and improvement of science and technology available inside the country and abroad for the resolution of economic, social and environmental problems.

4. To accelerate the survey research, and development of the utilization of all forms of interior energies in order to reduce the domestic oil consumption.

5. To hasten the energy cooperation for the purpose of proceeding the efficient management and continuous cooperation through the same destination.

6. To fix the price of energies which are now in use in accordance with the economic status and people's income so as to persuade the people to save energy for the production balance.

7. To control the supply, production and utilization of energy economically and beneficially so that energy is always available both in usual and emergency circumstances.

8. To conserve and improve the natural resources by organizing its use and reuse for the utmost benefit and impartiality in the society focusing on the cultivation and reuse of national forest and the utilization of mineral resources.

The targets of the governments are to develop S&T suitable for the use in raising agricultural production efficiency, particularly in respect to cultivation techniques, the utilization of land and water resources, the storage of agricultural goods, and techniques in substituting other production inputs. The government will develop industrial technology and mineral processing as well as technology related to the consumption and conservation of energy. Therefore, the ratio of expenditures on research and development (including the private sector) to GNP will be increased to 0.5 percent, and it will be necessary to increase S&T personnel in the above sectors by 10 percent annually.

In order to attain the above S&T targets, it will be necessary to implement the following policies and measures:

1. Information on existing technology will be extensively disseminated. The government will start to screen and adapt imported technology to suit the conditions of the country. Correspondingly, it is essential that we conduct our own research and develop our own technology in order to improve production efficiency and the efficiency in utilizing the country's natural resources.

2. The government will strengthen the country's scientific and technological base and capability by emphasizing manpower development, research institutes, technological transfer, and the establishment of a scientific and technological data and information centre.

3. Incentives will be provided for the private sector and state enterprises to extensively use science and technology in improving production efficiency. In addition, the general public will be encouraged to develop an awareness in using science and technology in everyday life.

4. The government will promote scientific and technological cooperation with foreign countries in order to exchange data and information, transfer technological know-how, and further improve the country's scientific and technological capability.

Problems and shortcomings in the implementation of S&T policy

Generally, problems and shortcomings in the implementation of S&T policy are posed by the lack of institutional frameworks or policy mechanisms in national level, the shortage of legal bases for providing incentives to promote S&T, and the insufficiency of qualified S&T manpower. In addition, during the period of post national development plans, key issues in the use and development of S&T are the limited use of S&T to increase production efficiency as well as the slow modification of imported technology to the rural population. However, after the establishment of MOSTE as the national S&T policy and plan mechanism, implementation and operation of S&T work will be improved.

Improvement of S&T policy formulation

As stated in the Fifth Plan, in order to improve the formulation of science policies, a Science and Technology Board will be established with the Prime Minister as chairman, with qualified members drawn from both the public and private sectors. The Board will consistenly formulate policies and operational plans consistent with national development efforts in other directions; promote and coordinate work; monitor and evaluate S&T developments; and provide advices to the Cabinet Committee on S&T policies.

Coordination of basic targets in S&T plan

Generally, each S&T institutions in major sectors of the economy e.g. agriculture, industry, energy, environment, national defense etc. have their own policies, plans and targets. However, they coordinate and cooperatively work towards the same major plan-the National Economic and Social Development Plan. Besides the governments S&T institutions, there are about 97 professional organizations, associations and societies whichalso play imporant role in implementing S&T plan in different subsections like health, natural resources, transportation, housing, computer, outer space, etc.

S&T RESEARCH AND DEVELOPMENT

Institutions conducting research and development

Most research and development are performed in the government agencies and universities. Among the government departments and institutions those of the recently founded MOSTE are the most important in the infrastructure. The main organizations are the Thailand Institute of Science and Technology Research and the Department of Science Service. The work allocated to this Ministry is mainly of general nature, while specific work in agriculture, industry, health and education is done separately by the relevant departments in various ministries and universities.

At present, promotion and financing of R&D are mainly done by the implementing institutions themselves. Therefore, the number of institutions having facilities for conducting S&T research and the proportion of S&T being carried out in universities, specialized research institutions, private and public productive enterprises are not accurately known. There are few data at present on the role played by the private sector in doing and supporting research and development. But it is expected that by 1986, Government:Private investment ratio for R&D will be 70:30.

Problems in strengthening R&D

The problems in strengthening R&D are the shortage of budget, manpower, coordination and equipment in laboratories. Unlike other activities, S&T activity, especially R&D, cannot be accurately predicted in terms of major results to be achieved per unit input. However, past achievements do give a trend to future productivity per unit input of an institution. Planning and budgeting for S&T in Thailand still does not take this special characteristic fully to account. Hence, budget for an institution would be typically based on budget in previous years irrespectively of the amount of output of innovative values. A mechanism is still lacking whereby the output from S&T activity can be objectively evaluated in terms of innovative values. This needs to be developed in Thailand and incorporated into the consideration for funding of various institutions.

In addition, the linkage between R&D projects/universities and the production system is not good. The reason is that very small portion of R&D is performed in private sector. Most industry or private organizations have a definite role and do not have close coopration with the government sector in producing their outputs. The industry which perform R&D will do only for their own interest and benefits. And for those which are not interested in performing R&D normally prefer buying technology from abroad in unpackaged forms.

One major problem still to be tackled is the gap between university, where most of S&T talent lies, and the private sector where much of this is needed. An encouraging trend is developing, however, whereby universities actively seek contracts for S&T work from the private sector. Because the major universities are in the civil service, a proper balance still has to be found between the traditional and the new role. Besides, the red tape in contracting and transferring of R&D results to the industrial production system is very slow and boring.

Policies to increase R and D capability

The following measures and operation plans are formulated to increase the country's S&T research and development capability.

1. Increase and improve the country's research and development efforts by increasing the country's R and D budget to 0.5 percent of GNP. To accomplish this, incentives will be provided to the private sector to spend 5 percent of net profits on R and D work by using the existing government or private research institutes.

2. In conducting R and D work, it will be necessary to find the right balance between basic research and applied research. R and D work must consist of a combination and coordination between these two particularly that research necessary to adapt and improve technology in the mineral dressing and processing industry, the agricultural and processing industry, and in the utilization of agricultural and industrial wastes.

3. Improve research management efficiency of various research institutes, which have rather low research budgets to yield higher benefits. The government will improve the capability in the selection of research projects and researchers, conduct economic cost/benefit analysis of research projects, and monitor the results of the research to determine whether they have really been used in businesses and industry.

4. Improve research management as follows:

4.1 Reform and strengthen the capability of the Thailand Institute of Scientific and Technological Research in order to solve technological problems for various industries. This includes its role as a leader in adapting and improving foreign technologies. The institutes is to undertake research for the private sector and closely coordinate its work with various industries.

4.2 Consider establishing an Energy Conservation Centre to be responsbile for conducting studies, providing training, publicizing data, and producing information and publications on energy consumption and energy conservation methods. Furthermore, the Centre will provide training for energy suprvisors in factories, study and collect information on energy conservation, conduct research, and develop and monitor other countries' energy conservation methods. The Centre will also encourage private agencies like the Technological Promotion Association which have already started work in this direction, to expand their activities.

4.3 Establish an efficient Institute of Material Science and Metallurgical Engineering to provide engineering consulting services for solving problems related to the use of materials in factories; in selecting suitable materials in the production and the adaptation of foreign technology for improving metallurgical resources utilization. The government must either provide for a research capability in the Department of Mineral Resources or establish an institute under the already reformed Thailand Institute of Scientific and Technological Research, or under either Chulalongkorn University or Chiangmai University.

In order to ensure the smooth and efficient operation of the above institutions, which are capable of providing advice, solutions and the timely development of new technology for local business and industry, it is necessary to consider the appropriate organization and the formulation of the necessary regulations and guidelines for the efficient operation of these institutions. The institutes must have freedom and flexibility in operations, have sufficient financial resources, and have a sound environment in which to conduct their research.

Programmes for promoting the use of local R and D

The private sector will be encouraged with proper tax and other financial incentives, to contribute substantially to foundations for support of S and T development in association with the National Research Council. Also, the government plans to set up the law for promotion of industrial technology. This law makes it necessary and provides incentives for industry to support R and D through tax exemption. It might stipulate that at least 5% of the net profit of large industrial companies must be used on a tax deductible basis, for support of R and D of their interest. Small and medium industrial companies could be allowed to form associations to arrange for joint R and D and promote the use of R and D institutions and results in Thailand in areas of their common interest.

FINANCING SCIENTIFIC RESEARCH WORK AND S AND T PROGRAMMES

Financial resources for S and T activities

Government funds for S and T activities were proposed and obtained by the relevant agencies through regular budget procedure, through the Budget Bureau and Parliament. The National Research Council (NRC) had both a screening role and a monitoring role for government research funds. The NRC allocated funds for research projects that it deemed relevant to the need of the country. It also awarded funds to research projects proposed by government agencies and universities. Some financial aids were provided from non-governmental foreign organizations in the form of technical assistance to Thailand in the fields of public health, population environment, agriculture, etc. The assistance also were in the forms of providing experts, fellowships, equipment and other items.

Expenditure on S and T

There is no specific target for expenditure on S and T in Thailand. The government fiscal budget is categorized into 8 sectors namely education, national defence, economic, public health and services, interior security, general administration, foreign borrowing payment, and others. For the fiscal year 1984, the government budget is 192,000 million bahts and categorized by ministries. Allocations for S and T related activities are included in the national budget of each ministry. So specific S and T budget is not known.

Financial sources for R and D

Proportion of R and D activities in Thailand which is internally financed is not known since various government and private agencies perform their own R and D activities. Generally, the private sector has had very little role in R and D and never inform their R and D expenditure to the government. However, it is estimated that the proportion of R and D expenditure between government sector and private sector are 100/0 in 1982, 95/5 in 1983, 90/10 in 1984. That is to say, the private sector is aimed to play more role in R and D. Data of external sources for financing R and D is not known. But if we assume that the amount of external finance for R and D activities varies to the amount of foreign grants and technical cooperation provided to Thailand. In 1984, the major sources of external financing in rank order are USAID, Colombo Plan, European Economic Community, United Nations, Third countries, ASEAN and other foundations.

TECHNOLOGY FORECAST, EVALUATION AND TRANSFER

Inflow of new machinery and technologies

Foreign technology rapidly flows into Thailand in various forms, mostly in the joint venture, especially during the last decades. In a joint-venture, the local partners usually provide a larger part of the capital, while the foreign partners supply the technologies, capital, market and in most cases, trademark. If the investment is purely local, the technology is normally purchased on a turn-key basis with or without licensing agreement. Experts are normally attached as a part of the deal, for a certain priod to train local personnel. Technology import can also appear in the form of engineering consulting service such as in the case of natural gas projects, or in the form of purchased unit technologies such as industrial machines and equipment.

Institutions dealing with technology forecast, evaluation and transfer

The national centre for technology transfer in Thailand is Technology Transfer Centre, a division of the Office of the Permanent Secretary, Ministry of Science, Technology and Energy. It acts as a promotional, advisory and training agency in the activities related to technology acquisition, development, adaptation licensing, negotiation, selection, forecast, evaluation and transfer. Besides the Technology Transfer Centre, the other institutions involved in technology transfer are Patents and Trade Mark Division (under the Ministry of Commerce). Board of Investment, Bank of Thailand and various research and development institutions in universities, private and government sectors.

The major constraints related to technology forecast, evaluation and transfer concern with the supporting infrastructure, raw materials, capital, manpower, environment, marketing and law.

Emerging technologies

At present, the emerging technologies in Thailand are in the fields of biotechnology, material science and metallurgy, as well as electronics and computer.

S & T HUMAN RESOURCES DEVELOPMENT

S&T Human Resources

As stated in the Fifth Plan, S&T manpower development has been emphasized and personnels in agricultural, industrial, mineral processing and energy sectors are expected to be increased by 10 percent annually. Measures and operation plans of the mobilization of S&T manpower development have been mentioned as follows:

1. Conduct a survey of the country's scientific and technological personnel at university and vocational levels according to each subject and occupational requirement. This will permit a correct evaluation of the manpower resources which could be fully mobilized.

2. Forecast the demand and supply for S&T manpower which is consistent with technological development in order to prepare for the expansion of production and the economy in both the short and long term.

3. Improve and formulate S&T educational system at all levels by upgrading the sylabus, teaching methods, quality of the teaching staff as well as the utilization of modern and technologically up-to-date equipment.

4. Set up a system and measures for mobilizing S&T manpower as follows:

4.1 Provide incentives for scientists and technologists in order to attract capable persons, for example by issuing permits for people with S&T occupations, by establishing appropriate salaries, and by requiring private business or industries of a certain size to employ scientists and technicians who hold these permits.

4.2 Improve the efficiency of those employment agencies engaged in employing technicians. These agencies are to more efficiently coordinate requirements between those seeking jobs, employers and training centres than at present.

4.3 Survey and formulate a mobilization plan for top Thai scientists and technicians who are working abroad to encourage them to return to Thailand to meet the country research requirements. It is also necessary to have S&T advisors stationed in developed countries in order to monitor the advances in S&T, determine the most appropriate method for transferring technology and seek technological cooperation with these countries.

<u>S&T personnel stock</u>

As of 1980, data given by NESDB indicate that Thailand had a total of 55,790 scientists and engineers (with university degrees) and 68,500 technicians (below degree level). With a total population of 46 million, ratios of 12 scientists and engineers and 15 technicians per 10,000 population were obtained. The total employed S&T manpower was estimated to be 286,000 about 1.2% of the total employed. The ratio of S&T manpower by category was :scientists and engineers excluding medical scientists 19.5%, technicians 24%, and craftsmen 56.5% According to NRC data, the number of researchers working in various sectors in 1981 are:

Government sector	2,092
University	2,893
State enterprises	170
Private sector	47

S&T personnel survey

In 1979, MOSTE conducted S&T personnel survey both in the private sector and the government sector in various educational levels. The purpose of this survey was to find out the accurate S&T personnel stock, demand and supply in order to formulkate the plan for the proper contribution and suply of S&T personnel to the needed agencies. However, difficulty has been encountered in surveying of the private sector since no effective mechanism exists for data collection. Therefore, the figures from the private sector was unavailable and the demand of S&T manpower categorized by industries was also not known. The result of the survey showed that in 1981, the numbers of S&T manpower categorized by sectors are government: state enterprise : educational institutes = 46:44:10.

In 1984, MOSTE has started the S&T personnel survey project in order to survey the present manpower stock, present and future demand as well as supply from both government and private sectors. This project has been sponsored by the International Development Research Centre, Canada. S&T manpower datas are categorized by sex, educational levels, sectors, fields of work, etc. Within three years, this project will be finished and then the overall long-term, medium term and short-term manpower development policies and plans will be formulated systemetically. Moreover, manpower datas will be compiled continuously via the triannual manpower survey.

VI. S&T INTERNATIONAL CO-OPERATION

Forms of S&T international cooperation

At present, MOSTE has been making rapid progress in S&T cooperation although some of it is regarded to be at the initial stage. Recently, the Ministry, under the cabinet"s approval embarked on the policy to promote industries based on advanced S&T. The concept is to prepare Thailand to compete in new expanding international market. Such venture can encourage private sector to invest in the sophisticated industries: microwave isolators and circulator, solar cells, microbial industries, and compujter software.

Concerning cooperation in the related fields with developing coutnries, MOSTE has performed cooperative programmes with Ministry of SCience and Technology, the Republic of Korea with respect of joint research and development program, interchange of research personnel, technical support and technical information when called for in specific problems with a view to further developing research activities of both organizations. The operation is on the basis of institutional one. MOSTE has it reviewed recently and is gearing to develop into higher level, between government to government in the course of time. 2650

Further, MOSTE has already taken up technical cooperation with the Philippines. The form of cooperation was agreed for the exchange of technical personnel on proposed areas of mutual interest. Yet, identification of proposed fields to be agreed upon has not been finalized.

Apart from bilateral cooperation, MOSTE has also participated in some projects at regional level, e.g. Asian Regional Cooperative Project on Food Irradiation implemented by the Office of Atomic Energy for Peace, Subregional Information Network on new and renewable sources of energy (NRSE) for Asia and Pacific (initial activities among the countries in the region) which is sponsored by UNESCO.

In addition, since the United States of America and Thailand agreed to have Cooperation in Science and Technology for Development lately, U.S.A. intends to help strengthen the Thai science and technology community and form long-lasting linkages betwen the two countries. The development of scientific centers of excellence which can serve as an incentive of an inducement for public or private investment in industrial enterprises will be encouraged as well.

Problems in S&T International co-operation

S&T cooperation with developed countries is needed in different sectors namely: biotechnology, electronics and computer, technology transfer, metallurgy and material science, information centre system, etc. The foreign assistance and fund which supports the implementation of technology development proejcts and providing necessary facilities are still inadequate. The requirement of foreign assistance for S&T cooperation are commodities or equipment, provision of experts, financial assistance, institutional linkages, information exchange and research coordination.

Policy relating to the promotion of S&T cooperation with foreign countries

The policy relating to the promotion of S&T cooperation with foreign countries was stated in the Fifth National Plan that a plan for S&T cooperation with foreign coutnries willbe formulated by emphasizing the following: reforming the Thailand Institute of SCientific and Technolgoical Research, improving the capability of the Technological Transfer Centre and the Institute for Material SCience and etallurgical Engineering, developing a revolving fund to promote technological utilization and development, and formulating appropriate studies. In addition, the government will encourage institutional collaboration, and promtoe joint development and research rpogrammes and training programmes for technical personnels.

2650

RECOMMENDATIONS

There should be close International S&T cooperation among all countries in order to formulate and implement the appropriate structure, policies and plans for the overall national economic and social development. In doing so, the financial and technical support from developed coutnries and S&T international organizations are needed. Academic meetings, seminars and symposia should be periodically organized by the Intergovernmental Committee on Science and Technology for Development so that many interesting countries can exchange ideas, experiences and solution techniques. Also, the S&T information network should be upgraded to render closer and better information services.

MECHANISMS FOR MANAGEMENT FOR SCIENCE AND TECHNOLOGY IN VIET NAM

INTRODUCTION

One of the important problems posed to the developing countries after their independence is to build a powerful and sovereign economy. This is a prerequisite to ensure their genuine independence in the international arena.

Inspite of many scientific conferences in recent years, due to the differences in their development and the social institution among these countries, it is vitually impossible to develop a standard development model for all countries. Though many of the developing countries are conscious of the role of science and technology towards the economic and social development, unfortunately the effectiveness of R&D activities and the introduction of advanced techniques into production in these countries remain low. Their levels of production largely depend on technologies imported from foreign countries. The national science and technology are still unable to adapt the imported techniques and to advance towards self-reliance at home. One of the fundamental causes is that importance has not been attached to the scientific and technological organization and management.

Nowadays the scientific research activities and the introduction of advanced techniques into production have become an important object of management. The tempo of applying the scientific inventions to production realities has rapidly increased. From the time when electric current was invented to the time when the first thermal power station was built, it took almost a century. It took only 15 years to apply the invention of radar. Laser beam discovered in 1960 took only four or five years to find extensive applications.

In such an environment for the developing countries, management for science and technology is still a very new experience. A better understanding of the true value of the management in general and the management for science and technology in particular, requires number of research works of the scientists representing the different branches.

Presented by Nguyen Dinh Tuyen

Firstly, there is a need to realize, at all levels, the decisive role of management towards the economic development in general and science and technology in particular in each stage of the economic-social development. In the Socialist Republic of Viet Nam, attention has been paid to the problem of improving the mechanism of management in general and science and technology in particular. The national policy on science and technology mapped out the tasks of improving the mechanism of management avoiding impediments to the research and development activities and introduction of advanced techniques into production. The Resolution 51-HDBT of the Council of Ministers on "a number of problems of scientific and technical work in 1983 and the years to come" pointed out: " The State Scientific and Technological Committee should co-operate with the State Planning Committee, the Ministry of Finance, the Central Economic Managing Institute and the branches concerned and should study the ways of building a complete mechanism of management in order to step up the rapid and wide application of the scientific and technical achievements to production and life"; The Resolutions of the Sixth Plenum of the Central Committee of the Communist Party of Viet Nam (Fifth Congress) on the improvement of the mechanism of the industrial management and circulation and distribution attached a special importance to the improvement of the mechanism of management for science and technology. Based on these important documents, the offices concerned have undertaken the improving the mechanism of management for science and technology throughout the country.

Secondly, it is necessary to set up the institutions for the organization and management for science and technology in the form of the Science Policy. Organizationally, these research centres should be affiliated to the State Scientific and Technological Committee or a corresponding office specializing in the scientific and technical management; this creates conditions for the measures on the improvement of the organization and management mapped out by the Research Institutes to have practical significance. The Research Institute for the Science Management affiliated to the State Committee for Science and Technology of Viet Nam was set up on September 15, 1978 on the basis of a Science Policy Unit. The function of the Institute is to help the State Committee to do research, to suggest and to prepare the decisions on the scientific and technical management on the national scale. The Institute has made practical contributions in the course of preparing and deploying the science and technology policy; and other important documents on the improvement of the mechanism of the economic management on the national scale.

The organizational experience and activity of the Institute for science management of Viet Nam shows that with only a few researchers and service personnel in cooperation with other scientific workers in R&D institutes, production, teaching, management, and other governmental agencies a mechanism of management for science and technology can be formulated.

Thirdly, it is necessary to carry on a comprehensive research on problems relating to the activity of science management in particular and economic-social management in general. A really effective structure for managing the scientific and technical activity can only be built on the basis of the results of such programme. In 1981, the Viet Nam State Committee for Science and Technology was entrusted by the Council of Ministers with a task of studying the State's key programmes of scientific and technical progress, keeping in view the programme 60-01. This programme comprises of nearly 50 subjects relating to the improvement of the mechanism of planning the system of the science management, the system of the research and development, the system of economic level, etc. The Research Institute for Science Management in its capacity as a permanent office for the 60-01 Programme has harmonized and co-ordinated the research activity among these subjects. Upto now, a number of scientific research studies have been completed and the results obtained thorugh these studies have helped to make an active contribution to the improvement of the mechanism of management for science in Viet Nam. Financially, expenditures for the 60-01 Programme take up only about 0.08 of the total expenditure alloted by the State for the activity, but its effect is extremely great.

The Research Institute for Science Management has also co-ordinated with the Economic-Planning College to organize a survey on sociology in order to collect the general information on the problems of necessary concern. The object of this sociological survey is nearly 500 under-graduates and post-graduates who are holding important responsibility and have experience in the economic management activity in general and in science and technology in particular, in all the four sectors viz. research and development, production and business, college teaching and management. The results of this survey is awaited as a basis for the improvement of the mechanism of management for science and technology in the coming years.

The periodical sociological surveys aimed at constantly improving the mechanism of management in the stages of the economic-social development is a good experience relating the science and technology management, but requires very careful preparations to be meaningful and effective.

SCIENCE AND TECHNOLOGY ACTIVITIES IN YEMEN

INTRODUCTION

Yemen, as an emerging developing country, after its revolution in 1962, realised the crucial importance of science and technology in solving or partial elemination of several socio-economic problems it faced for a long time.

Although the country is endowed with the basic and potential natural resources which qualify for a reasonable progress, these resources were not exploited nor even explored until very recently.

By 1970 and after the political stability which prevailed in the country, the government has assumed some measurable steps towards scientific planning of development programs. The establishment of the Central Planning Organization (CPO) as a national institution responsible for the mobilization of human, administrative, financial, and natural resources of the country towards development was crucial in adopting science and technology in the development of the country.

Education, as an essential element of real development, has received a particular emphasis from the government. Beside the enormous number of schools of different grades which now cover the whole country, the government did not ignore the role of technical high schools and university education in its development plans. In 1970, the establishment of the University of Sana'a represented the foundation of science and technology infrastructure in the Yemen Arab Republic.

The adoption of science and technology in development programmes necessitated international cooperation with many countries and agencies in different disciplines. Current research and development programs include the development of natural resources, energy resources, human resources, as well as development researchers in the fields of health, housing, transport and communication and industrialization.

Presented by Ali Gamaan El-Shekeil with the approval of
Dr. Abubaker Abdullah Qirbi,
Vice-Rector of the University of Sana'a.

Yemen had witnessed a major socio-economic and technological progress in the last decade. Nevertheless, and in spite of this success, we should not ignore challenges facing the country and the constraints in our long journey for development. These challenges and constraints require a comprehensive international cooperation together with our national integrated efforts to assimilate the increasing dependence on modern science and technology in the make-up of Yemen's modern civilization.

The University of Sana'a

The Yemen Arab Republic recognized the crucial importance of university education in establishing its science and technology infrastructure. The University of Sana'a started in 1970 with two faculties: Education and Islamic Law. In the academic year 1971/1972 the Faculty of Education had three branches: Education, Science and Arts.

By 1973/1974, the Faculty of Science emerged as a separate Faculty with Mathematics, Physics, and Chemistry Departments and a year later departments of Geology, Botany and Zoology were opened.

The importance of fisheries for economy initiated the start of the department of Oceanography in 1976/1977. The Biochemistry Department was opened in 1980/1981, and the Faculty of Science is in charge of graduating medical laboratories technicians since 1980, before the opening of the Faculty of Medicine and Health Sciences which started in 1983/1984.

To strengthen the Country's scientific and technological capability, two scientific faculties were established in 1983/1984: the Faculty of Medicine and Health Sciences and the Faculty of Engineering. A third Faculty, the Faculty of Agriculture is Scheduled to start this year (1984/1985).

Research and Development Organizations in Yemen:

For the time-being, and in the absence of science Policy-making body, the current institutional framework for science and technology in Yemen is made up of a number of bodies at the operational level mainly supporting the activities of some concerned departments or ministries. Nevertheless, the following is a brief account on some of such activities in different areas:

(i) Agriculture

According to the UNESCO publication (1981) on the establishment of a National Centre for Science and Technology in Yemen, there exist some 45 international working groups in agricultural development research projects.

The Supreme Committee for Agricultural Research is therefore established to coordinate different research activities in this field and to select certain programs of important priorities for the cause of the country's development. The headquarters of this committee is stationed at Dhamar, but with a central agricultural research station in Taiz and many other peripheral stations spread all over the country.

Yemen stands firmly behind all efforts to consolidate scientific and technological cooperation in different disciplines related to the application of technology in agricultural development through the exchange of experts and information.

(ii) Mineral Resources:

The Yemen Oil and Mineral Resources Corporation (YOMINCO) is in charge of research and development programs concerned with prospecting, exploration and exploitation of mineral resources and petroleum.

(iii) Water Resources:

The National Water and Sewage Authority (NWSA) is in charge of research and development programs concerned with groundwater.

(iv) Health and Human Resources:

The Medical Research Unit affiliated to the University of Sana'a and supported by the Ministry of Health is conducting Medical Research through cooperation with Sweden and Other International groups. There are three major areas of medical research activities: The Child Health, Maternal Health and the Primary Health Care.

(v) Building Materials:

The Ministry of Public Works with its Central Research Laboratory stationed in Sana'a is in charge of conducting applied research on building materials.

(vi) Basic Research:

Most of the fundamental research in the basic sciences is performed by the Faculty of Science, University of Sana'a. Research projects in different fields of Mathematics, Physics, Chemistry, Biology, Geology, Oceanography and Solar energy are going on. These research projects are normally done in fulfillment of a higher degree or as a part of the academic activity of the Faculty staff members and associates.

(vii) Social Research:

The Yemen Studies Centre is in charge of carrying out research activities applied to the Yemen Society, mostly social, historical and literature studies.

Table 1 shows the number of economic and social studies performed in Yemen as reported to the Central Planning Organization classified according to the economic sectors.

Table 1

Number of Economic and Social Studies Carried out in Yemen

Field of Study	English	Arabic	Total
Agriculture, Forestry and Fisheries	99	51	150
Housing and Construction	4	--	4
Electricity and Water	42	--	42
Finance	6	19	25
Manufacturing and Industry	42	25	67
Mining and Natural Resources	11	--	11
Trade and Catering	8	5	13
Transport and Communication	60	--	60
Economic Development and Planning	54	27	81
Health and Nutrition	12	4	16
Education	19	--	19
Population, Manpower and Employment	15	8	23
Other	--	51	51
Total	372	190	562

(viii) Education:

The Education Research Centre was established with the support of the World Bank to perform research in the field of Education.

Table 2 depicts the accelerated growth rate in educational programs in Yemen. Figures of 1973 before the adoption of the First Five-Year Plan (1976/77-1980/81) are shown against those of

1982. The net growth percent of each item clearly indicates the country's firm determination to bridge the gap created in the past and to establish properly the infrastructure of science and technology i.e. education.

Table 2

Educational Data

Particulars	1973	1982	Net Growth (%)
Number of students studying abroad	614	3531	413
Number of students enrolled in Sana'a University	950	5172	444
Number of pupils in first and second levels	165,184	567,207	243
Number of students in vocational and technical schools	1,345	2,958	120
Adult literization schools	5,700*	13,805	142
Current expenditure on education in million Yemen rials	10.7	879.2	810

* 1975 figure.

Investment in Development Programs in Yemen

According to the Second Five-year Plan (1982-1986), the government of Yemen estimated a total investment of some $6509 million dollars on development programs which covers the following areas:

- Agriculture
- Mining
- Industry
- Electricity and Water
- Constructional Materials
- Commerce
- Communication and Transportation
- Finance
- Housing
- Civil Service

To account for the government concern of development of the above mentioned areas, the research and development programs in mining activity is given in table 3 as an example.

Table 3

Total Investment in Research and Development in Mining

Project	Investment in million Yemen Rials
Metallic Deposits	365
Geologic Mapping	100
Geothermal Energy	10
Radioactive Minerals	10
Petroleum Exploration	85.5
Rock salt Exploitation	11.5
Constructional Materials Development and Evolution	95.0
Total	677

Source: Second Five-Year Plan (1982-1986) Central Planning Organization.

<u>Progress in Geoscience Research Activities in Yemen</u>

Yemen occupies a distinctive geologic position between the Red Sea and the Gulf of Aden Rift Systems. This world-wide recognized position promoted early research activities in all desciplines of geoscience since the 1980's. With the increasing importance of the need to understand the geologic make-up of the Arabian Peninsula especially after the discovery of potential reserves of oil, increased attention of many scholars of geology from different parts of the world was given to the geology of Yemen.

Although research activities in this field was rather limited as indicated by the limited number of publications during the period from 1900 to 1960 (Fig.3), it furnished relevant information on the basic geology of Yemen and included researches in geomorphology, structural geology, petrology, vulcanology, hydrology and mineral resources.

Recent revival in research activities in Yemen was stimulated by the establishment of the Geological Survey of Yemen within the Yemen Mineral and Petroleum Authority (YMPA) in 1974, which later was designated as Yemen Oil and Mineral Resources Corporation (YOMINCO).

By the establishment of this institution in Yemen, a National Organization was then created for the first time to integrate all geoscientific work and research to be carried out in the country. Through cooperation and technical assistance from international institutions of geology, YOMINCO had adopted an intensive research and development program in Yemen particularly in the field of geologic mapping using LANDSAT-1 imagery photographs which covered the whole country as well as in the field of prospecting, exploration, and development of mineral resources in selected prospective areas of Yemen.

Parallel with the establishment of YMPA (now YOMINCO) in 1974, the University of Sana'a Council realized the importance of education of geology and the major role of geoscientists in the development of National Economy. Commencement of the geology department, as one of the Faculty of Science departments started in 1974. Through research activities of its graduates and staff members, some contribution was given to the geology of Yemen particularly in the fields of mineral resources, groundwater, and petrochemistry. This is beside the contribution currently made by its graduates who are holding executive positions in YOMINCO and other institutions concerned with the development of natural resources of Yemen.

The role of YOMINCO, and the University of Sana'a accounts for the rapid progress in geoscience research and development of natural resources during the 1970's and continues for the 1980's as shown in Figure 3.

The National Centre for Science and Technology

The United Nations Conference on Science and Technology for Development (UNCSTD) was held in 1979 to strengthen the science and technology capabilities of developing countries. The conference was attended by delegates from 142 countries including Yemen. It adopted by consensus in 1979 the Vienna Program of Action whose recommendations in paragraphs 23 and 26 are relevant to objectives of the Yemen National Centre for Science and Technology.

The proposal of the President of the University of Sana'a delivered to UNESCO in September 1980 to establish the National Centre for Science and Technology in Yemen stated the following goals:

(i) Determination of priority objectives for science and technology compatible with the overall economic and social objectives of the country.

(ii) Contribution to the increase of endogenous capabilities in the fields of appropriate technology or adopting existing technology particularly those applied to rural sectors.

(iii) Carrying out programs to explain to the public in simple terms the interaction between science and technology and the social and economic development of the country.

(iv) Becoming on the long run an effective medium for promoting rural and industrial development.

Furthermore, the centre can benefit decision-makers in charge of development projects in both the public and private sectors through advice on the selection of technology appropriate for the country and at what cost.

Generally, Yemen is facing some scientific and technological challenges; among those is an economic water-tap to save water especially in the Sana'a Area, a stove to use wood effeciently especially in rural areas and a solar energy program for a low-cost energy.

The Centre will be mainly devoted to science and technology applications and technology transfer which aims at the development of the country. Special attention will be given to avoid duplication of functions and activities performed at Sana'a University or other governmental institutions.

The very important research areas should include:

- Materials technology (civil and mechanical)
- Food technology
- Bioresources (marine life, crops and foodstuffs, etc.)
- Biotechnology
- Electronics and Electromechanics
- Energy resources (solar, wind, biomass, etc.)

International cooperation during the establishment of the centre in different aspects like expertise, equipments, information, etc. is highly recommended.

CONSTRAINTS:

The following are some of the major constraints facing the promotion of science and technology in Yemen:

(i) Lack of qualified and properly-trained personnel at different levels especially scientific and technical manpower.

(ii) Lack of coordination and duplication of research work on the national level.

(iii) Shortage in funds.

(iv) Absence of a science-policy making body.

(v) Lack of efficient regional and international cooperation in science and technology for the exchange of experience.

(vi) The non-existence of an up-to-date inventory of the scientific and technological potential of the country.

(vii) Lack of technicians both in quality and quantity is a severe problem in scientific research.

(viii) Brain drain.

RECOMMENDATIONS:

The Yemen Arab Republic realized the crucial importance of science and technology and its role in national progress. Much effort is directed by several of the concerned governmental institutions in applying science and technology in development programs that are currently underway. However, more effort is required in this direction to bridge the gap created during the pre-revolutions regime. Solution or elimination of the aforementioned constraints is indispensable for science and technology advancement and application to national development. The establishment of a National Centre for Science and Technology in the Yemen Arab Republic with its goals mentioned in the proposal presented by the President of Sana'a University to UNESCO in 1980 certainly will influence the promotion of scientific and technological development programs in the country. Establishment of this centre may lead to subsequent creation of a policy-making body responsible for promoting scientific and technological researches in various fields in the Yemen Arab Republic. Obviously, international and regional cooperation in scientific and technological issues is strongly recommended.

REFERENCES

(1) NATIONAL PAPER OF THE YEMEN ARAB REPUBLIC
E/ECWA/NR/CONF. 2/CP.7.

(2) NATIONAL SCIENCE AND TECHNOLOGY
POLICIES IN THE ARAB STATES.
UNESCO No. 38, 1976.

(3) THE ESTABLISHMENT OF A NATIONAL CENTRE FOR SCIENCE AND TECHNOLOGY IN THE YEMEN ARAB REPUBLIC.
UNESCO No. FMR/SC/STP/81/195, 1981.

(4) THE VIENNA PROGRAMME OF ACTION ON SCIENCE AND TECHNOLOGY FOR DEVELOPMENT. THE UNITED NATIONS CONFERENCE ON SCIENCE AND TECHNOLOGY FOR DEVELOPMENT, UNITED NATIONS.
NEW YORK., 1979.

(5) INDEX OF SOCIAL AND ECONOMIC STUDIES (YAR),
CENTRAL PLANNING ORGANIZATION.
FEB., 1984 (ARABIC AND ENGLISH).

(6) STATISTICAL YEAR BOOK, CENTRAL PLANNING ORGANIZATION, 1982.

(7) BIBLIOGRAPHY ON THE GEOLOGY OF YEMEN.
COMPILED BY HAMED M. EL SHATOURY
FACULTY OF SCIENCE, UNIVERSITY OF SANA'A, 1984.

(8) THE FIRST FIVE-YEAR NATIONAL PLAN, 1982-1986,
CENTRAL PLANNING ORGANIZATION.

PART TWO

VIEWS AND EXPERIENCES IN THE UNION OF SOVIET SOCIALIST REPUBLICS

ADVANCES IN SCIENCE AND TECHNOLOGY

The development of the scientific and technological revolution has brought further advance in the international division of labour and specialisation and cooperation of production. In these conditions the developing countries particularly need utmost development of international cooperation on a bilateral and multilateral foundation, including cooperation within the framework of the United Nations and other international organizations. It stands to reason that in this brief communication it is impossible to discuss all these forms and the problems involved. We will therefore dwell only on some aspects of international cooperation, and, first and foremost, on the causes lending urgency to our work to raise the effectiveness of joint efforts of specialists from all countries in solving global problems of science and technology.

This question merits detailed examination; the developments of the last decades and the available prognoses for the future testify that international scientific and technical cooperation has become one of the most important tasks confronting all countries.

There is no doubt that the period of almost forty years since the end of the Second World War occupies a special place in the development of the world economy and in the history of science and technology. There is hardly any other period with so numerous and important, truly revolutionary discoveries. In these decades mankind has entered a period of the scientific and technological revolution connected with the rapid development of chemistry, biology, physics, automation of production and other achievements of science and technology.

In those years scientists connected with agricultural production have carried out research and development projects which made it possible to speak of a "green revolution". For most of the developing countries the results obtained in agriculture play, perhaps, a bigger role than any other achievements of the scientific and technological revolution. For they substantially contribute to solving the most acute problem of those countries - the food problem.

And it is clear that these successes of the biologists are only a start of radical changes. Biotechnology which has emerged in the last decade permits us to speak of giant resources of science and technology in changing entire modern agricultural production.

Presented by M.G. Kruglov

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NEED FOR CO-OPERATION

At present the developing countries can take an active part in solving scientific and technical problems and successfully apply in production the results of research and development projects. At the same time, it is noteworthy that the experience accumulated in the world shows that the rates of scientific and technical progress in a country does not depend on its own efforts, and on the size of research and development investments. Both nationally and in the world economy as a whole the dynamism of science and technology is directly dependent on the development of international cooperation. Autarchic tendencies, which have always damaged the advance of science and technology both nationally and on the scale of the world economy as a whole are particularly ruinous today.

Nowadays the road is opening for the peaceful uses of atomic energy and advance is being made in developing technological processes which ensure tremendous saving of energy resources. Generations of computers are being developed one after another, thousands of polymer materials are appearing, space exploration is gong on, laser techniques and optic fibres are being developed, separate factory shops and even whole enterprises are appearing where production is basically carried on by automatic lines and robot technology. It is hardly possible to find a single branch of industry where fundamentally new products or tehnology have not been introduced in the last decades. And in many cases such products appear every ten or even five years.

ACHIEVEMENTS OF DEVELOPING NATIONS

The breakthrough in the development of science and technology made in the last decades is quite logical. In the 1960s alone, funds invested into the development of science and technology exceed a half of all expenditures made for these purposes in the entire history of mankind. Today more scientists and engineers are working on problems of science and technology than in all previous centuries.

The developing countries are making their own contribution to this process. In the 1960s and the first half of the 1970s they were able every six years to double the number of specialists in research and development. A number of developing countries, among them India, Brazil, Argentina, Mexico, Egypt and Nigeria, created a scientific and technological potential enabling them to make a certain contribution to world scientific and technical progress. In some developing countries scientific and technical complexes were created whose performance is comparable with that of research institutes and design bureaus in industrially developed countries. Thus, in Malaysia a considerable research was done resulting in a noticeable advance in the selection of rubber plants. Exceptionally successful was the project for making newsprint from deciduous trees in the Philippines. Equally promising is research and development of a vertical kiln for producing cement carried out in India.

It may be presumed that the dependence of the rates of scientific and technical progress in this group of countries on the import of technology and technological processes will begin to decline already in the near future. Their economic, scientific and technical potential will be determined more and more by the effect of their own research departments and their cooperation in the elaboration of problems with similar organizations in industrially developed countries.

SOVIET EXPERIENCES IN CO-OPERATION

An example of successful international cooperation of a developing country which has already built up a substantial scientific and technical potential with other states is the practice of cooperation between Soviet and Indian specialists. Our country has not only provided assistance in building nearly 100 large projects many of which are key enterprises of Indian industry but also actively participates in creating scientific centres at a number of universities (in Delhi, Bombay, Hyderabad, Madras). At some enterprises built with Soviet assistance large research and development organizations have been set up, e.g., the Institute for Designing Metallurgical Enterprises in Ranchi, research and development institutes in Baroda and Dehradun, and the Organization for Designing Thermal Power Stations at the Central Power Commission of India. Soviet specialists have organised the training of about 80,000 skilled workers and technicians and over 4,000 Indian specialists have been trained in our country.

In recent years joint Soviet-Indian research and development projects have been growing in scale, in particular under the space exploration programme. This programme has not only contributed to the advance of space exploration in India, but has helped to solve a number of geological tasks and contributed to the solution of questions connected with the stimulation of agricultural production.

In organising cooperation with any country, at each stage of its economic, scientific and technical development, new organizational forms should be developed suited to the national specifics, with a specific mechanism of cooperation developed for the purpose.

A scrutiny of any of the thirty or so agreements on scientific and technical cooperation which our country has concluded with developing countries, including 21 inter-government agreements, shows that they take into account these specifics, and that our specialists take a creative approach to complex problems of international cooperation. Surely, their success is determined not by the happy results alone in the process of improving the mechanism and organizational forms of cooperation. The basis of the results already scored are the high rates of development of the national economy and scientific-technological potential of the USSR and its external economic ties, and our sincere interest in solving the problems of developing countries in eliminating their economic, scientific and technical backwardness.

The Soviet Union has accumulated enormous and in many cases unique experience in developing scientific and technological potential and implementing S&T policy. This experience is being continuously enriched. We are ready to share this experience with all interested countries, considering that it can be used in various forms by developing countries in elaboration and implimentation of their S&T policy taking due account of specific peculiarities of each country.

SOVIET APPROACH TO S&T POLICY

S&T policy of the USSR embraces a wide spectrum of problems, including management of science at all levels, determination of priority areas, combination with technical policy, formation of the State system of scientific institutions and internal structure of science, improvement of R&D planning and management, strengthening of material-technical basis of R&D activities, training and utilization of scientific and technical cadres, strengthening of interrelation in the "science-technology-production"system. By its content S&T policy is closely connected with other types of the State economic policy-investments, energy, agriculture, foreign trade, patents and licenses,etc. It is also inseparable from the USSR scientific and technological cooperation with foreign countries which constitutes one of the most important components of international economic relations.

SOME PROBLEM AREAS

To our mind it is necessary to deal in greater detail with specific nature of the task of international cooperation at the present time. It is connected not only with the present stage of the world-wide scientific and technological revolution. Appraising the role of international cooperation in the last decade, we should bear in mind that the scientific and technical progress of developing countries has slowed down considerably as a result of the aggravation of their internal economic problems, deterioration of general foreign-economic position and the continuing "brain drain".

The last phenomena poses considerable threat to the developing countries, for the studies carried out by now lead one to presume that up to the end of the current century the economy of all countries will require a still greater concentration of manpower resources to ensure optimal scientific and technical progress.

The difficulty also arises because scientific and technical progress, facilitates on the one hand, the development of industrial and agricultural production and the improvement of the production infrastructure, and on the other hand, often creates or aggrevates a multitude of economic, social and ecological problems. It is obvious that the overcoming of undesirable consequences of scientific and technological progress requires maximum development of international cooperation, for without international cooperation some problems become more and more capital-intensive and others become just insoluble.

Regrettably, it should be noted, the matter is often complicated by the resistance of some countries and corporations to the development of truly global cooperation in solving the most complex scientific and technical problems. Moreover, quite often a number of states and their corporations see the way to solving still unsolved problems not in cooperation in the solution of scientific and technical tasks but in the transfer of unsuitable production knowledges to the developing countries. The actions are presented sometimes as aid in establishing modern industry and as assistance in solving the problem of employment.

No doubt there must be a principally different approach to international cooperation. In this respect the Soviet Union is applying considerable efforts to promote really mutually advantageous international division of labour and all-round advance in the cooperation of countries in solving global as well as specific S&T problems faced by developing countries.

CONCLUSION

Today the effectiveness of the scientific and technical potential of any country and the world economy as a whole depends to a considerable degree on progress made in solving a most intricate complex of economic, political and social problems on the national and international scale, and on how successful is the struggle for international detente.

It is no secret that the fulfillment of the priorities in a national scientific and technological policy substantially depends on the international climate. The mounting of political tension compels many countries to make huge investments the aim of which is not at all fulfillment of projects accelerating the solution of economic and social problems. Militarization of research is particularly dangerous for the developing countries; the more limited the resources of a country the more complex it is for it to make simultaneous investments in two directions: work on civil research projects and execution of military programmes.

Moreover, the deterioration of the international climate complicates the prospects of international cooperation, of course, and without its accelerated development many countries would be simply unable to create the national scientific and technical potential so essential for them. Therefore the efforts for promoting international cooperation in the field of research and development are inseparably linked with our common efforts for alleviating international tension in the modern world.

THE VIENNA PROGRAMME OF ACTION AND THE CREATION OF INDIGENOUS RESEARCH AND DEVELOPMENT CAPABILITIES IN THE DEVELOPING COUNTRIES

INTRODUCTION

The aspects of the present-day development problems linked with science and technology have a very important role of their own to play. On the one hand, the modern scientific and technological revolution enables the developing countries, mastering its achievements, to build their economies on an advanced technological basis from the very start bypassing the past historical stages of technological development. On the other hand, however, the young countries' backwardness and dependence in the sphere of science and technology are greater than the general economic development gap. While accounting for 70 percent of the world population and 18 per cent of the world GNP they used to spend just 5 per cent of the world's total expenditure on research and development and owned approximately the same share of the world patent funds(1).

Therefore the problems of science and technology are assuming growing importance in the socio-economic activities of the United Nations and its agencies. A case in point is the Vienna Programme of Action in the sphere of science and technology for development purposes (2) adopted in 1979. Five years have passed since then. The United Nations is preparing a mid-decade review of progress in carrying out the Programme. Accordingly, it would also be of use to exchange opinions on the results of its implementation and prospects at our seminar.

Creation of indigenous research and development capabilities in the developing countries:

The Vienna Programme was correct in describing the technological development of the newly-free countries and the creation of indigenous research and development capabilities in them as the main long-term task. All the countries now in the lead in science and technology, including the Soviet Union, did the same in the past. Among other things, it was the development of indigenous science that helped the Soviet Union, once a backward country, to turn into an industrial power and hold it out in World War II. It is on this basis that we have built the economy of developed socialism and are thwarting any attempts to declare a technological boycott of the USSR. The conditions the developing countries now live in also dictate the need for them to create research and development capabilities of their own.

Presented by I.D. Ivanov

Firstly, as has been pointed out, they lag behind the advanced countries in the sphere of science and technology most of all and, as a result, this requires priority efforts to overcome this backwardness. Secondly, the import of technology, vital as it is, offers only a temporary solution and at a certain stage it begins to slow down indigenous scientific and technological progress. This happens particularly often when technology is supplied by multinational corporations using it to set up their subsidiaries in the key economic sectors of the developing countries, to impose restrictive business practices on them. Thirdly, the new, research-intensive production of the future is taking shape before our very eyes. Evidently, we should take seriously the conclusion of the recent 4th general Conference of UNIDO which predicted that in the future the watershed between the developed and developing countries would be determined first of all by the possession of the indigenous scientific capabilities (3). These capabilities are necessary, among other things, so that the developing countries could independently get access to such modern, frontier achivements as biotechnology and microelectronics. Otherwise they will have to import those achievements again. And the technological imports are already approaching, it seems, the limit of payback possibilities. The developing countries have to spend annually about 35,000 million dollars (4) on it together with technical services, and this begins to tell noticeably on their balance of payments.

Logically, the question arises as to what the indigenous research and development capabilities mean and where the reasonable limits lie of combining them with imports. Evidently, the notion of the capabilities embraces the research and development infrastructure, scientific personnel, a substantive scientific and technological policy, an authoritative body ensuring its implementation, sufficient financing, and scientific and technological plans closely co-ordinated with general development programmes. It is also important that in the social aspect those plans and policies should take into account the interests of all the sections of population, including rural and urban marginal groups and women, and help the developing countries restore their intellectual heritage. As for the combination with imports, what is needed is not autarky but, as the Vienna Programme points out, "the attainment of a frontier beyond which their (developing countries') knowledge and resources will enable them to ensure growth and overcome dependence" (5), and the ability to make and carry out technological decisions independently. Of course the structure and composition of the indigenous research and development capabilities would differ from country to country depending on their specific problems, resources and interests.

So what has been done in this field over the five years since the Vienna Conference?

NATURE OF PROGRESS

Achievements

Soviet scholars are inclined to agree with the assessment of the UN Advisory Committee on Science and Technology for Development that this period "has not passed in vain" (6). And most of the progress in carrying out the Vienna Programme has been achieved precisely at national levels.

For example, there has been considerable headway in national legislation in the sphere of science and technology. According to UNCTAD experts, about 30 legislative acts in this field are currently in force in the 17 developing and Andean Pact countries (7). Anti-trust legislation aimed at fighting the restrictive business practices of the monopolies has been either introduced or strengthened in Argentina, Venezuela, Ghana, India, Nigeria, Pakistan, Peru, Sri Lanka, Thailand, and a number of other countries. Many states have changed legislation on foreign patents and investments which now makes it possible to carry out the depackaging of offers from multinational corporations and purchase technology without allowing foreign capital in or within the framework of non-equity arrangements. National bodies for the management of science and technology have also come into being.

It is fair to say that a number of developing countries (e.g., Mexico, India, Algeria) are shaping out their own national scientific policies. More money is being earmarked for research and development and personnel training. A number of developing countries such as India, Brazil, Mexico, Malaysia, Algeria, Venezuela, now appear on the world market as exporters of technology and technical services. They have set up their own firms and organizations for the construction of industrial facilities and the share of locally-produced parts in machine-assembly have increased. About 25 developing countries manufacture machines and equipment and approximately 10 export them (8). The public sector laboratories and enterprises have made a decisive contribution to this progress.

The Vienna Programme gave an impetus to the activities of international organizations. IGCSTD and ACSTD play a considerable role in putting its provisions into practice. They have started working out indicators to measure the impact of science and technology on the objectives of social and economic development, the optimal blending of traditional and emerging technologies, and creating a global network of scientific and technological information (9). UNIDO has done a great deal at enterprise levels and in the sphere of technological information to help the developing countries build their own research and development capabilities. Some of the problems which remained unresolved at the Vienna Conference were dealt with at UNCTAD while working out the draft of an International Code of Conduct on the Transfer of Technology. Among other things, it concerns principles governing the shaping of national scientific policies, the selection and assessment of technology, criteria for revising legislation, national technological information systems, and increasing local contents in the work of foreign contractors (10). Work has begun at WIPO to reform the international patent system. Finally, steps are to be taken under United Nations auspices to promote technological cooperation among the developing countries (TCDC) at subregional, regional and inter-regional levels.

Shortcomings

At the same time one can also agree with the opinion that progress in carrying out the Vienna Programme of Action is far from being sufficient as far as the part under review is concerned. It seems to us that this is due to a number of both endogenous and international reasons.

As for the endogenous factors, the point is that most of the developing countries are still paying more attention to importing technology than to building their own research and development capabilities. According to UNCTAD experts, only a few of those countries have drawn up comprehensive programmes for the development of their own science and technology as part of a general economic development strategy. On the contrary, a number of governments believe that the free play of market forces can speed up scientific and technological progress to a much greater extent. However, it is apparent that, firstly, local business stands little chance of winning in this game against transnational corporations. Secondly, in this situation scientific and technological policy becomes uncoordinated with imports. As a result, the competing firms make more and more parallel purchases of similar technology and create a host of different technological standards as was rightly pointed out by the UNIDO experts (12). Finally, the bodies for the management of science and technology already set up in most of the countries remain administrative and not research-oriented in their functions. Among other things, they still fail to bring closer together in national interests science and higher schools in their countries. They spend most of their time on supervising the import of technology (13).

Financing S&T

These shortcomings in the organizations of scientific policy show once again that the provisions of the Vienna Programme should be accepted in their totality without isolating any of its aspects including financial ones. Of course, it is necessary to expand the financing of science in the developing countries. But it is no less necessary to manage the available resources in a rational manner by planning and programming research and development. It is only then that the return from science will be greater than the expenditure on it. This is evident from the experience of all the leading powers in the realm of technology, including the USSR. For instance, the Soviet Union does not merely increase its spending on research. This spending is coordinated with the national plan as part of the Comprehensive

Programme for promoting scientific and technological progress in the USSR in the period up to the year 2000 and with 170 concrete government scientific and technological programmes included into the 11th Five-Year Plan (14).

It is also worthwhile considering rechannelling part of the money to science and training of scientific personnel from other items of expenditure in the developing countries. For instance, their military spending already topped 80,000 million dollars in 1981. What is more, their share in world military spending has exceeded their share in the world GNP (15). Apparently, in a number of countries this already goes beyond the reasonable effort to defend national sovereignty and assumes the features of an arms race, particularly, because a large part of armaments is exported. World experience shows that militarisation is both harmful and dangerous. On the contrary, its containment would promote the development of national science and education since it costs more to train one officer than one scientist and the upkeep of one soldier is more expensive than that of one student.

Cooperation

Regrettably, the potentialities of TCDC are still not being realised in full. The technological exchange between Western and developing countries is still growing faster than between the latter although "Group 77" and the non-aligned movement hoped that it would be just the other way around. Regional centres for the developoment and use of technology set up, for instance, in Dakar and Bangalore have proved their usefulness although more had been expected of them (16). As for inter-regional ties in this field, they are still in a very formative stage (17). Therfore, for example, the UNCTAD annual report on trade and development for 1983 in analysing progress in carrying out a collective self-reliance programme for the developing countries fails to single out TCDC at all and progress in this sphere begins to lag behind overall progress in putting this programme into practice (18). For example, many developing countries are already in a position to manufacture power equipment with a capacity of up to 150 megawatts for heat-and-fuel power stations and up to 100 megawatts for hydro power plants. However, the manufacturing enterprises do not cooperate in any way and the market is still dominated by a Western power equipment cartel (19).

As for the external conditions, one unfortunately will have to agree with the assessment made at the latest session of ACSTD which described them as "unfavourable" for carrying out the Vienna Programme of Action (20). International tension and the economic crisis have worsened the climate of international cooperation and reduced its potentialities. What is more, we can see attempts to revive the position-of-strength policy in economic diplomacy of some countries and as a result, this has led to deadlock in the negotiations on restructuring international economic relations on a just and democratic basis.

For instance, contrary to the well-known resolutions of the United Nations and its specialised agencies, efforts to help set up indigenous scientific and technological potential ties, especially, the research and development infrastructure, practically fail to figure in some official development assistance schemes. As a rule, subsidiaries of transnational corporations and enterprises being built in developing countries on a contract basis are not equipped with laboratories. There has been much talk in recent years in academic and business circles about transferring some of the primary processing industries to developing countries which might help their industrialization even though on a limited scale. However, instead of redeployment, transnational companies, on the contrary, have begun to modernise the obsolescent home industries. As was pointed out at the 4th General Conference of UNIDO, "the redeployment of industries to developing countries was accepted in principle, but in practice no readjustment took place". As a result, everything is again reduced to the same import of technology "considered to be the transfer of capital equipment and rarely considered in terms of helping to create an endogenous technological capability" (21).

Brain Drain

In this policy a refusal to give help goes hand in hand with the infliction of direct damage. A striking case in point is the practice of luring specialists from developing countries, known as the "brain drain". It literally causes devastation among scientific personnel in the newly-free countries. According to UNCTAD experts, the brain drain has resulted in luring away a total of 500,000 people or 50 to 70 percent of all specialists trained in the developing countries every year. The losses of the young states from this brain drain totalled about 100,000 million dollars between 1961 and 1980 (22). It is clear that in such conditions the developing coutnries are unable to accumulate the "critical mass" of personnel necessary to ensure the progress of their science. And some countries fail to comply with the UN resolutions aimed at restricting the "brain drain" and have been openly boycotting talks on such issues of late.

Technology and Investment

The position document on the review and assessment of the effort to implement international development strategy for the 3rd UN Development Decade submitted by UNCTAD was not explicit since it was brought under the category of "investments" (23). However, the assertion that subsidiaries of the transnational corporations act as leaders of scientific and technological progress in developing countries is disputable, to say the least. Of course, they do make up part of the local industries. But for the most part the subsidiaries function as enclaves in them staying outside the national development programmes. The technology given to them by parent companies is kept by them only and is closed for the use by local industries. Subsidiaries hardly do any research on their own. For example, in India and

Brazil local companies, even smaller than the subsidiaries, have spent noticeably more on research and development in percentage of turnover than the subsidiaries of the transnational corporations, turned out more new goods, had better contacts with local science and employed larger numbers of researchers, etc (24). In other words, the influx of foreign capital does not necessarily entail technological progress and gives almost nothing for strengthening domestic scientific capabilities.

THE NEED FOR NEW INITIATIVES.

It is apparent that the world community cannot be satisfied with the present state of affairs in the implementation of the Vienna Programme of Action. New, daring initiatives and constructive work are needed in this sphere at national, regional, inter-regional, and international levels. A number of such initiatives have been put forward at IGCSTD, ACSTD, UNCTAD, and UNIDO.

For instance, the work of IGCSTD and ACSTD on setting up an advance technology alert system in of undoubted interest. It deals with new technologies vital for development and with perspectives on science and technology for the same purpose as well as with improving contacts between science and industry. In summary form, these initiatives are to be reflected in the review of the implementation of the Vienna Programme over the past five years which is now being prepared (25).

An interesting idea was also advanced at UNCTAD which has begun to work out a strategy for the technological transformation of the developing countries. UNCTAD experts see this strategy as an inalienable part of the long-term development strategy of each of the newly-free countries. Taking into account their specific features, transformation implies working out plans and policies in the sphere of technology, stimulating scientific and technological progress in the key sectors of the economy, expanding research and development capabilities and resources allocated for these purpose, improving national legislation, and encouraging scientific and technological co-operation among the developing countries themselves and special measures to help the least developed countries, etc.(26). Although such transformation is possible due to the import of technology, it is expected to rely on domestic scientific and technological capabilities for the most part. The idea has already been discussed at the Special Session of the UNCTAD Committee on Technology. The draft submitted by the socialist countries (27) was taken as a basis for the discussion at the 5th session of the Committee in October 1984 (28).

The UNIDO Secretariat has proposed that the developing countries should set for themselves the goal of raising the share of spending on science in their gross national product to 1.5 per cent by 1990 and to 2 per cent by the year 2000 (29). Evidently, this proposal should also be given due consideration.

At the same time Soviet scholars believe that other ways could also be found of speeding up the creation of domestic research and development capabilities in the developing countries. At national level that could be helped by more closely integrating plans for the advancement of science and technology with general economic development programmes, by bringing industrial and scientific policies closer together, and by building up the research capabilities of the public sector. National technical services such as consulting and engineering also deserve strengthening. They should be in a position to make substantiated assessments of technological solutions, ensure their optimal selection, and help introduce them into production. At present there are just about 30 such national firms operating in developing countries, and they are vital for rationalizing the import of technology and for a linkage between local science and industry. The task is to train not only researchers but also managers of scientific and technological progress. All that taken together would make it possible to increase subtantially the contribution of national science both to the development of local industry as a whole and to increase the share of "local contents" in the projects carried out on contract by foreign company. Programmes for TCDC should envisage special measures for exchanging specialists among the developing countries so that even in the areas of their migration the latter should not go beyond the boundaries of the developing world. To this end it would also be expedient to strengthen contacts between science and the schools of higher learning in those countries and between their science and industries.

At international level the top priority should be to stop the "brain drain" from the developing countries. This can be done by either organisational or economic measures or by a combination of both. In this context it would be fair if the countries admitting skillful migrants paid a compensation to those losing them. A halt to the arms race and a changeover to stage-by-stage disarmament with the release of part of the saved money for development needs would also help a great deal to build scientific capabilities in the developing countries. However, in any case the Western countries should honour their commitments on the net transfer of capital for development needs agreed upon at the United Nations. As for the Soviet Union, it is already doing more than any other power in giving assistance to developing countries (30). It is also important that a considerable amount of this assistance is earmarked specifically for building local scientific capabilities in developing countries.

THE SOVIET UNION'S CONTRIBUTION TO THE DEVELOPMENT OF NATIONAL SCIENTIFIC CAPABILITIES IN DEVELOPING COUNTRIES.

The Soviet Union knows from its own experience the importance of advanced science for development and appreciates the problems and needs of the developing countries. So it is helping them first of all in building the infrastructure of science-laboratories, research and designing centres, and experimental industries. As of 1983, more than 20 research 2650 centres and laboratories have been set up in developing countries with Soviet assistance. Another 20 are under construction. As a rule, laboratories are also attached to enterprises being build with Soviet assistance and to the schools of higher learning training scientific and industrial personnel for those countries. Fifty-two institutes built in developing countries with Soviet assistance are already functioning and another 34 are under construction in 18 countries (31). The total of trained specialists is now about 1,250,000 taking into account those trained in the USSR and on construction sites (32).

Significantly, the research and designing centres set up with Soviet assistance are not only doing a good job in developing countries but also helping to boost their technological exports. Besides that, the Soviet Union in giving technical assistance makes a point of attracting local sub-contractors to construction work and it is expected that the latter will make not only a purely material but also intellectual and technical contributions to the projects. For instance, in Argentina they have supplied equipment for the Pedro Aguile heat-and-fuel power station, for pipelines in Nigeria, and for steel plants in India (33).

Since the Soviet Union has vast experience in planning, it consults many developing countries working out their own scientific policies both in general and in regard to specific industries. Such assistance on national levels has been given to the People's Democratic Republic of Yemen , the Congo, Ethipia, Guinea-Bissau, Angola, Mozambique, and Nicaragua, and also in the oil and gas industries to India, in the gas industry to the Libyan Arab Jamahiriya, in the fishing industry to the People's Democrative Republic of Yemen, in water supply to Tunisia, the Syrian Arab Republic, Madagascar, etc. (34).

Finally, all that work is regulated within the framework of inter-governmental agreements on scientific and technological co-operation (35) concluded by the USSR with more than 20 developing countries. Among other things, they provide for joint research either on the spot or at Soviet scientific centres which expands scientific capabilities in the young states beyond the existing boundaries. Such joint on-the-spot research is being done in India. (MHD-generators, turbines, high-voltage transmission lines), and Iran (transformers) (36). A striking case in point is the Soviet Union's co-operation with India in space exploration. As a result, Soviet rockets were used to launch Indian satellites into near-earth orbit and a Soviet-Indian crew has orbited the earth in a spaceship. This arrangement has helped India a great deal to push ahead for "Terra" research programme providing for the study of the Hindustan peninsula from outer space (37).

This policy of the Soviet Union was reaffirmed once again at the Economic Summit of the CMEA member-countries in Moscow in June 1984. And this remains and will continue to be our concrete contribution to carrying out the Vienna Programme of Action.

List of Sources

1. Report of the UN Conference on Science and Technology for Development. Vienna, 1979, p.58; UNCTAD. Handbook of International Trade and Development Statistics,1983, p. 433.

2. Doc. UN. A/Conf. 81/16, p.56-101.

3. "Fourth General Conference of UNIDO. Special Report of the Executive Director," Vienna, 1984, p.14.

4. "Asien, Afrika, Latinamerika", N 10, 1982, p.402.

5. Report of the UN Conference on Science and Technology for Development, Chapter VII, paragraph 14.

6. Doc. A/CN.11/47, June 8, 1984, p.13.

7. DOC. UNCTAD TD/B/C/.6/81, August 4, 1982.

8. DOC. UNCTAD TD/B/RBP/14, September 9.1983; "World Economy and International Relations", No. 12, 1983, p.72.

9. Doc. A./CN. 11/47, June 6, 1984.

10. Doc. UNCTAD TD/B/C.6/73, March 20, 1981.

11. Doc. UNCTAD TD/B/C.6/92, September 30, 1982, p.5,6.

12. See Doc. UNIDO TD/B/318, March 8, 1984, p.6.

13. Doc. UNCTAD TD/B/C.6/92, p.6,7.

14. N.A. Tikhonov. The Soviet Economy, Achievements, Problems, Prospects. Moscow, 1984, p.78.

15. F. Castro. The World Economic and Social Crisis. Havana, 1983, p.229.

16. Doc. UNCTAD TD/B/C.6/12, p.8.

17. Doc. UNCTAD TD/B/946, April 3, 1983.

18. UNCTAD. Trade and Development Report, 1983, Geneva 1984, Part II.

19. Doc. UNCTAD TD/B/C.6/65, October 10, 1980, p.14; UN Centre on Transnational Corporations. Transnational Corporations in the Power Equipment Industry. N.Y., 1982.

20. IGCSTD. A/CN.11/47,p.13.

21. "Fourth General Conference of UNIDO", P.6.

22. Doc. UNCTAD TD/B/969, September 20, 1983, p.5.

23. Doc. UNCTAD TD/B/984, Add.1, February 22, 1984, p.40.

24. Doc. UNCTAD TD/B/C.6/AC.7/2, May 3, 1982, p. 78-82.

25. Doc. IGCSTD. A/CN.11/47. p.

26. Doc. UNCTAD TD/277, January 25, 1983.

27. Doc. UNCTAD TD/B/C.6/L.74, February 25, 1984.

28. Doc. UNCTAD TD/B/C.6 (S-I)/Misc.3, March 8, 1984.

29. "Fourth General Conference of UNIDO", p.16.

30. "Pravda", June 17, 1982.

31. I. Kapranov. Built with the Soviet Union's Economic and Technical Assistance. Moscow, 1983, p.153, 195,277,278. "Foreign Trade", No. 13,1983, p.9; "Economic Co-operation Among the CMEA Member-Countries", No. 7, 1983, p.61.

32. "International Affairs". No.1, 1983, p.25.

33. "Foreign Trade", No.2, 1982, p.26; No. 3, 1984, p.30.

34. "Foreign Trade", No.2, 1982, p.25; "Economic Co-operation Among the CMEA Member-Countries", No. 5, 1983, p.70.

35. "Foreign Trade", No.3, 1984, p.25.

36. Ibid., No.9, 1982, p.26; No.3, 1983, p.28.

37. "Pravda", April 11, 1984.

ELABORATION OF POLICIES AND PLANS FOR SCIENTIFIC AND TECHNOLOGICAL PROGRESS IN THE USSR

INTRODUCTION

The concrete conditions and perspectives of modern S&T revolution have made it possible for the Soviet Union to formulate the strategy in the field of S&T progress.

The basis of the strategies is formed by the realization of a single S&T policy which constitutes one of the most important functions of economic and planning agencies. The possibility of carrying out single S&T policy is conditioned by the public ownership of means of production and planned system of the national economy. Centralized management of S&T development as well as of the national economy as a whole makes it possible to carry out their planned development, determine the long-term possibilities of S&T progress, and its economic and social consequences.

PRINCIPLES OF SINGLE S&T POLICY

The principles of single S&T policy have been formulated by V.I. Lenin. Its essence consists in ensuring all-round acceleration of S&T progress by all branches of the national economy, and by all organs of management.

In his speech delivered in February 1984 Comrade K.U. Chernenko underlined: "As far as the major directions of development of our economy are concerned they are clearly defined by the party. Intensification, accelerated introduction of S&T achievements, realization of large complex programmes - all this in the end should raise the productive forces of our society to a qualitatively new level".

The realization of single S&T policy means accelerated development of fundamental and applied scientific research, wide introduction of S&T achievements, creation of favourable conditions for a continuous growth of social production

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Presented by A.I. Chubarenko

efficiency, its intensification. The planning system is a means of justification and realization of single S&T policy ensuring the development of the country's economy and acceleration of S&T progress. That is why the realization of single S&T policy is carried out through a system of state plans. Here it is necessary to single out two aspects:

1) planning of the development of R&D activities in order to create a scientific stock;

2) planning of S&T progress via. indices of all the sections of the state plan of economic and social development of the country which determine the increase of social production efficiency at the expense of S&T development measures.

This means, on the one hand, the necessity of elaboration of a separate section of the state plan of economic and social development of the country dedicated to S&T development, and, on the other hand, coordination of principal assisgnments of this section with other sections of the plan with due account of specificity of planning S&T progress.

It is not possible to manage the socialist national economy otherwise than through the planning system. Under conditions of S&T progress this system is subjected to the impact of several important peculiarities or initial principles:

1) As it is known, the state planning is carried out to assure the most important objectives of socialist society - growth of welfare of the people. On this basis the state plans are elaborated based on the final product for consumption or which ensures development of production. At the same time creation of every final product, especially to ensure continuous improvement to its quality through the results of S&T depends on decisions taken at various management levels.

This requires elaboration of S&T development plans at various levels, including the All-Union level comprising the state plans of economic and social development of the USSR; at the level of republics, ministries and departments; and at the level of enterprises and organizations.

2) Under conditions of accelerated S&T progress it becomes necessary to ensure the integration of S&T planning and production planning in the so-called life-span cycle of manufactured product. This, in turn, calls for the necessity of elaboration and coordination of fundamental and applied research and development plans and the plans for mastering and introduction of new technology. On the other hand, it is necessary also to elaborate the plans of various duration (long-term plans covering 10 and 20-year periods, medium-term plans covering five-year periods and short-term plans covering one-year period) taking into account the necessity of timely identifiction

of perspective directions of S&T development and creation of scientific stock in the duration of the life-span cycle.

3) *Given the fact that plan objectives are mainly oriented* towards the creation and manufacturing of new product and creation of new technologies whereas the tasks of accelerated of S&T progress are connected with the solution of large national economy programmes, it becomes necessary to elaborate also S&T programmes (All-Union, republics, branch and regional) simultaneously.

4) The tasks of acceleration of S&T progress and the *ensuing intensification of social production* must be solved taking into account the peculiarities of territorial siting of the production forces and development of various regions of the country. This requires the elaboration and coordination of not only branch but also territorial aspects of S&T development plans as well as the introduction of measures for S&T progress. This includes the plans of the republics and economic regions of the country.

These features are reflected both in the structure of the state plan sections and in the structure of S&T development plans.

STRUCTURE OF S&T DEVELOPMENT PLANS

Single S&T Policy :

Planning of S&T development represents the most important link of the state system of management of S&T progress and the whole system of state plans since these plans determine principal directions of realization of single S&T policy. Such a policy is oriented towards the shortening of time necessary for creation and introduction of new technology, raising its technical level *and reinforcement of mutual ties of sciences and production* as well as of the material base of science.

The variety of forms of impact exerted by scientific-technological measures on the national economy development is reflected by the structure and content of S&T development plans.

In compliance with principal features of planning S&T progress the S&T development plans are structurally differentiated by managment levels, life cycles stages and duration of a planned period.

At management levels, the S&T development plans are subdivided into state plans (the national economy plans); branch plans *(ministerial and departmental plans); territorial plans* (republics of the union and economic regions); and plans of amalgamations, enterprises and organizations.

The totality of these plans serves as an instrument of 2650
realizing the basic principle of socialist planning-democratic

centralism which makes it possible to combine in a centralised manner the implementation of single S&T policy of the country with the initiative of working collectives, special features of Union republics and economic regions.

The structural subdivision of plans by management levels allows to differentiate the problems of S&T progress taking into account of their significance and scales.

Thus, the state plans envisage solution of the most important intersectoral problems of S&T progress, mastering and introduction of new products and technologies produced or applied in the USSR for the first time.

The branch plans are oriented towards the fulfillment of assignments of the state plan, solution of branch level problems, mastering and introduction of new products and technologies typical for a given branch. The plans of amalgamations, enterprises and organizations include the assignments of hierarchically higher agencies and the assignments of S&T progress implemented on their own in the interests of scientific and technological development.

Plans of various stages of life cycle ("research - production- application" cycle) include, on the one hand, a definite stage of the process of realization of S&T progress measures, and, on the other hand, serve to ensure interrelation between these stages.

Such plans include: development of R&D activities; mastering of new types of industrial products; introduction of advanced technology and means of mechanization and automation of production processes; removal from production of obsolete types of product and backward technological processes; basic indicators of technical level of production and major types of manufactured products.

Programme targeted method :

Planned interrelation of measures of S&T progress by stages of "research- production- application"cycle is done through programme-target methods of planning.

The use of these methods has found its practical application in S&T programmes which represent by themselves a complex of scientific-technological, production and other measures coordinated by resources, executors and time factor planned in the framework of "research-production-application" cycle.

S&T programmes make it possible not only to combine all the measures necessary to obtain and realize a scientific result but also to concentrate the resources on principal directions of S&T progress.

At present depending on final objectives, target-complex S&T programmes; and programmes aimed at solution of important S&T problems are being elaborated and realized.

The target-complex S&T programmes are elaborated for introduction of the most significant scientific and technological achievements whose utilization would ensure in the near future a considerable increase of efficiency of social production and quality of product.

Programmes aimed at solution of important S&T problems are elaborated to ensure further development of R&D activities in the most perspective directions of science and technology in order to create a scientific "stock" as well as to solve separate problems related to creation of completely new technology and bringing it to practical introduction.

Besides, depending on the significance of problems being solved the S&T programmes are subdivided into All-Union, republican, sectoral and regional according to management levels.

Plan duration :

A particular role in the implementation of single S&T policy and S&T development planning is played by the plans of various duration: long-term plans (10-20 years), medium-term (5 years) and short-term (annual) plans.

The system of S&T development plans of different duration makes it possible, on the one hand, to coordinate integrally long-term objectives of socio-economic development of the country and those of S&T policy, and, on the other hand, to ensure realization of these objectives through the structure of the state plans taking into account of time required for the solution of S&T problems.

The long-term planning is based on the complex programme of S&T progress for a period of 20 years. Estimates of this progrmme for 15-20 year duration have a forecasting character whereas 10-year estimates serve as the initial basis for the elaboration of the principal Guidelines of economic and social development of the country.

Proceeding from the long-term objectives of a single S&T policy which are specified in the Complex Programme the Principal Guidelines for a given planning period define principal assignments of S&T progress, technico-economic level of development of the national economy branches, list of the most important scientific and technological problems and directions of R&D activities.

These assignments for the USSR ministries and departments and those of Union republics are defined in the form of target figures for basic indicators for the perspective period broken down by years of the next five-year period and brought to the notice of amalagamations, enterprises and organizations which elaborate on their basic five-year and annual S&T development plans.

Plan indicators :

The composition of S&T development plans is determined by their principal elements: objectives, means and resources. Their basic technical level of production and major types of manufactured product.

Indicators of objectives (target indicators) include the economic effect of S&T development measures and technical level of production and major types of manufactured product.

Indicators of means include: indicators of R&D activities; mastering of new types of industrial produce; introduction of new advanced technology; mechanization and automation of production processes; purchase of foreign licences and samples of new articles and their utilization in the national economy; standardization and metrological activities; scientific organization of work; indicators of basic assignments in S&T problems which are elaborated together with foreign countries.

Indicators of resources include: financing of scientific research activities, training of research and scientific-pedagogical personnel; development of pilot experimental base and material-technical logistics.

FORMATION OF BASIC DIRECTIONS OF S&T POLICY

In the 1970s the Soviet Union developed a new form of substantiation of single S&T policy, namely the Complex programme of S&T progress for a period of 20 years, "On further improvement of planning and reinforcement of impact of economic mechanism of raising production efficiency and quality of work" which has become an integral part of long-term planning, its first stage.

The ellaboration of the Complex Programme makes it possible to take full account of potentialities of scientific and technological revolution.

The central methodological problem of elaboration of the Complex Programme consists in coordination of its scientific-technological and socio-economic aspects. The major goal of the acceleration of S&T progress is the intesification of production. The Complex Programme determines the ways of solving major scientific and technological problems proceeding from the objectives of socio-economic development and, simultaneously, provides substantiation of scales and time of solving socio-economic tasks which presupposes evaluation of possible results of the acceleration of S&T progress. That is why two approaches are used for the elaboration of the Complex Programme: assessment of socio-economic effects of S&T progress and identification of tasks posed by the national economy development in terms of S&T.

The major tasks of the Complex Programme of S&T progress in the system of long-term planning are as follows:

- forecasting of principal directions of S&T progress, definition and substantiation of priorities of separate directions of S&T development, selection and formulation of a list of scientific and technological problems which should be solved in a given planned period;

- assessment of impact produced by achievements of S&T progress on solving socio-economic problems, scales of introduction of S&T achievements in the national economy, determination of structural shifts and production efficiency due to S&T progress;

- elaboration of measures which are included into the plans of the coming five-year period and which promote realization of long-term S&T policy (proposals on distribution of resources, improvement of economic mechanism and organizational structure of science and production spheres, list of new S&T programmes to be elaborated, etc.).

The Complex Programme up to the year 2005 has been elaborated by the Scientific Council of the USSR Academy of Sciences and the USSR State Committee on Science and Technology on the problems of scientific-technological and socio-economic forecasting under the chairmanship of a vice-president of the USSR Academy of Sciences. The Council was composed of 63 commissions in 5 major directions (principal directions of S&T development; principal directions of S&T progress in the national economy branches; S&T progress and major problems of socio-economic development; regional problems of S&T progress; world economy and S&T progress). More than 500 organizations engaged in scientific research, design and other activities took part in this process.

Planning of S&T progress is a means of realization of a single S&T policy which is carried out through the indicators of all sections of the state economic and social development plan.

PRINCIPAL DIRECTIONS OF PLANNING S&T PROGRESS IN THE USSR

The Principal Guidelines of the USSR economic and social development for 1981-85 and for a period up to the year 1990 have set the task of further acceleration of S&T progress as a decisive factor of shifting the economy to the intensive way of development and raising the efficiency of social production. As outlined at present, the major ways of realizing single S&T policy are as follows: it should be oriented first of all towards the elaboration and coordination of key directions of S&T development, sharp reduction of time spent for creation and mastering of new technology, further increase of its technical level, reinforcement of interconnection between science and production and of material base of science.

PROGNOSTICATING THE BASIC DIRECTIONS OF SCIENTIFIC-TECHNICAL PROGRESS

INTRODUCTION

Success in the development of the productive forces in the society depends decisively on accelerating the rate of scientific-technical progress. This rate, in turn, is specified by the productivity of world and national science and technology. Planning the development of the national economy, the basis for rational scientific management, necessitates analysis of rapidly changing trends and their factors and versions. In view of these complexities, the development planning of the national economy requires the creation of a tool that would enable the most expedient solutions. Thus, the necessity of optimizing managerial solutions under conditions of increasing complexities, including technical, economic, socio-political and natural factors, by the end of the 1950s, led to the evolution of a new scientific direction, namely, prognostication. Prognostication relates to the study of laws and methods of developing prognoses that are probability judgements of the future, on the basis of special scientific research, which has prospects for the development of a given phenomenon. Prognostication of future events permits to improve the entire system of plans: long-term, medium-term and annual plans. This is extremely important for socialist economy, whose development is of planned character. One of the major laws of a functioning socialist economy, which is based on a planned-organized system of production and social property of means of production, and is free of labour exploitation, is the law of planned control of production.

The law of planned development of the national economy is put into effect through planning. Hence, great attention is given in USSR to the problem of increasing the effectiveness of planning.

Each stage of the economic and socio-political development of the Soviet society sets its requirements to planning, its content, forms and methods of solving national economic problems.

Presented by V.F. Leontyev

The main idea in planning is directed chiefly toward increasing the effectiveness of production by utilizing scientific-technical achievements and production, thereby, maximising final results.

EXPERIENCES IN PROGNOSTICATION

The purposeful policy, pursued in our country beginning with the middle of the 1960s, resulted in the appearance of dozens and then hundreds of scientific groups, dealing with the elaboration of scientific-technical and socio-economic prognoses. Several hundred theoreticians and several thousand practical workers continued elaborating such prognoses. Several thousand articles and reports on the theory of prognostication and on concrete elaborations were published in USSR. Seminars, conferences and other meetings are held regularly on exchange of experience. The All-Union Council of Sceintific-Technical Societies renders great assistance in organizing and developing the service of prognostication.

A Commission had been set up in 1973 in the system of the All-Union Council of Scientific-Technical Societies which in 1979 was transformed into a Committee for prognostication of scientific-technical progress. The Committee unites a considerable number of Soviet prognosticators, and comprises several branch and problem commissions. Branches of the Committee have been set up in the majority of union republics and in some districts of the country. The Committee carries out work on mobilizing the efforts of the prognosticators for the solution of state tasks, experience exchange, dissemination and further development of prognostication.

There are a number of decrees and decisions of the government comprising a whole complex of measures for increasing the effectiveness of planning and management of the national economy. Special attention is given in these documents to the problem of prognostication. Thus, the decision "On measures for increasing the effectiveness of work at scientific organizations and accelerating the application of the achievements of science and technology in the national economy", adopted in 1968, recognised for the first time the necessity of elaborating scientific-tehcnical prognoses for 10-15 years and more on the problems of developing the national economy and some of its branches. It was proposed to employ these prognoses to select the most prospective directions for the development of the national economy and some of its branches.

This decision proclaims the significance of prognosis to the state. Prognostication has been affirmed as a scientific-analytical stage of the process of national economic planning. It recommended the determination of the technical level of prospective production, machines and equipment by means of prognosis, and elaboration of plans for scientific research, with the aim of developing new machinery and technologies that would excel the best available at home and abroad.

Extensive work has been carried out in the country in accordance with this decision in order to create a machinery for the development of prognostication. Dozens of concrete prognoses have been elaborated on different directions for the development of science and technology.

Prognostication has turned into an integral procedure of planning, pursuing the following goals:

- analysis of social, economic and scientific-technical processes and tendencies, objective ties of socio-economic phenomena under concrete historical conditions, assessment of forming situations and detemrination of major problems of economic development;

- estimation of the action of these tendencies in the future and foreseeing new economic situations, new problems, requiring their solution;

- determination of possible alternatives of development in the prospective for a substantiated selection of one or the other possible development and adoption of an optimum planned solution.

Prognosis is used for outlining the area and possibilities, within whose framework realistic tasks and targets may be set, and for determining directions, that become the object of development and later turn into an object for adopting planned solutions. Prognosis assists in considering versions of rendering active effect on the objective factors of future development. Despite the fact that prognoses are of preliminary, variant character, it is valuable that their horizon is not restricted by the planned period. The date of prognoses serve as the initial material for the next stage of planning: selection of the targets of development in a certain planned period, elaboration of a national-political concept of the prospective plan.

Thus, practice has demonstrated that the elaboration of a prognosis and the development of a plan are interrelated stages of planned work in the general process of national-economic planning. The essential distinction of the plan is that, as a result of all the types and stages of planned work, it should be qualitatively synonymous and directed toward achieving the earlier selected targets, and in essence, assist in determining the best version for achieving them, the most acceptable (optimum) one under the given concrete economic conditions with consideration also of the requirements of effective development in the prospective period that follows the planned one. As a result, prognosis may be considered as a preliminary stage in planning work. Concrete tasks were not set at first to prognoses and only the material was used, that was contained therein for their elaboration. However, the development of prognostication, the appearance of normative prognostication has made it possible to analyse different versions of development, that increased greatly the truth of prognoses.

Practices of Prognostication

On the other hand, any plan, and especially the medium-term and long-term ones, represents a prognosis of development, determines development as a certain probability process. Therefore, considering the system "prognosis - plan", it is possible to state that prognosis is a long-term plan with a lesser probability of realization owing to the greater uncertainty of the initial information and the longer terms of realization.

Simultaneously, a certain narrowness of some prognoses and their disconnection has been manifested. Uniting has been established in the process of practical utilization of the prognoses with the aim of elaborating a better plan. Disconnecting individual prognoses, and lack of coordination with the final targets of development of the national economy has been a source that impeded their application and cause of errors. Hence, the decision of 1979 "On improving planning and intensifying the effect of the economic mechanism on increasing the effectivenss of production and quality of work" envisages a new stage in the development of prognostication in our country. The decision has legalized closer coordination of prognostication with the tasks of planning in individual branches as well as in the development of the national economy proper.

The document set the task of elaborating a complex prognosis of development of the national economy in the form of a "complex program of scientific-technical progress for 20 years (by five-year periods)". Besides, the principle of complexity enables us to avoid lack of coordination that reduces the probability characteristics of prognoses. The principle of continuity has materialized by introducing corrections into the program two years before the beginning of the next five-year period.

Thus, the complex program of scientific-technical prognosis became the major pre-plan document, specifying the trends of development of the national economy proper in a variant form.

The practice of elaborating and utilizing the Complex program, developed for the period up to the year 2000 and then up to 2005, has manifested in its profound usefulness and the necessity of this document for elaborating the Basic directions of economic and social development of the USSR for 10 years, as well as substantiated selection of major scientific-technical problems that ought to be solved in the all-union scientific-technical programs. Prognoses on individual scientific-technical directions, as well as concrete prognoses of development of individual branches of the national economy have been used as the basic materials for the Complex Program. The methodological instructions for the development of the Complex Program envisage consideration of different variants that, depending on the concrete factors of the external medium, permits the selection of the optimum variant of development. Economic-mathematical models have been used on a wide scale in the elaboration of the Complex Program, permitting to estimate by simulation of the effect of individual scientific-technical solutions on the final results of development of the national economy.

The entire scope of work in the country on the elaboration of the Complex Program is headed by the USSR Academy of Sciences and the USSR State Committee for Science and Technology. Several hundred institutes, including institutes of individual industrial branches, and about 3000 scientists participate in this work. Thus, a state service of prognostication has been created in the country, whose activities are coordinated by the Scientific Council of the USSR Academy of Sciences and USSR State Committee for Science and Technology.

Problems of scientific-technical and socio-economic prognostication are solved within the framework of the program, because the major goal of the Complex Program of scientific-technical progress for the 20-year period is the investigation of the results of the effect of scientific-technical progress on the socio-economic results of development of the Soviet society.

The experience of elaborating the Complex Program of the USSR has been thoroughly studied by other CMEA member-countries and it is possible evidently to expect the appearance of similar programs in these countries in the next few years. In essence, it will be a new stage in the development of scientific-technical and socio-economic prognostication in the socialist countries. The appearance of such programs in these countries will make it possible to utilize more efficiently the existing scientific-technical potential in the stated countries, and, in the final end, to reach the goals, set by the society, in a shorter period of time.

Further Applications

The positive experience of elaborating the Complex Program in our country, demonstrates the ways of increasing further the effectiveness of this tool of long-term prospective planning, in particular, as a result of utilizing global prognoses for 50 years and more. One of the major directions of increasing this effectiveness is to improve the methodological base, which is employed for elaborating the Complex Program and scientific-technical prognoses in general.

National economic, socio-economic and scientific-technical prognoses may be short-term (up to 3 years), medium-term (5-7 years) and long-term ones (more than 10 years). The time horizon of each particular prognosis is determined, depending on the character of the investigated task; complex prognoses of economic development are leaborated in conformity with the horizons and the dates for elaboration of national economic plans. The process of planning includes elaboration of prognoses of the fulfillment of the existing prospective plan, whose results provide the base for planning the next prospective period; also prognoses for the next planned period, whose results are used as scientific material for elaborating the next plan; prognoses for terms exceeding the next planned period, that estimate the consequences of the adopted planned solutions and determine new conditions and problems in the long-term prospective.

Besides the stated prognoses, there exist, as mentioned earlier, global prognoses for a term of 50 years and more. These prognoses make it possible to follow the development of certain tendencies and phenomena, and to consider them in the elaboration of a long-term plan. For example, a demographic prognosis, prognoses of anthropogenic changes in the climate, city growth, consequences of ambient pollution as a result of scientific-technical progress, etc. The USSR Academy of Sciences has accumulated experience in elaborating long-term prognoses in the sphere of utilizing prognoses for elaborating the Complex Program of scientific-technical progress and its socio-economic consequences. The Academy of Sciences of the Ukrainian SSR has gained experiences in utilizing prognoses in the area of welding and welding equipment and the development and utilization of computer facilities. The USSR Ministry of Higher and Secondary Special Education has gained experience in elaborating prognoses of the development of scientific research in higher educational institutions. A series of ministries and departments have accumulated experience in elaborating long-term prognoses. All the prognoses elaborated in the country are registered at the All-Union scientific-technical information centre. Beside registration, the Centre performs acquisition of prognostic developments. This work has been started in 1969. A substantial collection has been accumulated of prognoses on the development of enterprises, branches, and regions. By 1977 the collection comprised of about 3000 prognoses, reports on prognostic scientific-research work. Analysis of the collection indicates that the researchers pay maximum attention in the prognoses to investigating the prospects of development in the next 15-20 years (up to 1990-1995). About 10-12% of the collection deals with the elaboration of methods or correction of those elaborated earlier.

The extensive attention given to the problem of methods is due to the fact that the quality of the prognoses, elaborated for the national economic plan and the development of science and technology depends decisively on the level of theoretical-methodological developments. Institutes of the USSR Academy of Science, the Academy of Sciences of the Ukrainian SSR, also the Committee on scientific-technical prognostication of the All-Union Council of Scientific-Technical Societies and the Institutes of the USSR Ministry of Higher and Secondary Special Education deal with the elaboration of methods of prognostication in our country. The wide scope of research in this area has made it possible to provide all the prognoses, elaborated in the country, with the required methodological materials.

<u>Research Potentials</u>

A considerable number of prognostication methods exists currently, as well as a great number of their classifications. The latter depend on the basis or feature laid down in the base of the classification. The methods, used in our country for prognostic research, may be divided into 3 big groups in accordance with the method of research employed.

The first group includes all the methods with simulation in the base. The research, carried out by this means, employs analogy for building a model. These methods are used for investigating complicated phenomena, consisting of interrelated events. The stated methods are employed for investigating operations by means of digital and analogue models. More precise digital models are used in case of more complete knowledge of the dependences and interrelationships between individual components of the phenomenon. These methods include also those that employ system analysis. The development of economic-mathematical models has made it possible to create a series of models of the national economy, whose application in the elaboration of the Complex Program of scientific-technical progress enabled to judge the final effectiveness of different scientific-technical measures by large-aggregate blocks.

Future models, considering several thousand parameters, are developed at the Institutes of the USSR Academy of Sciences. This type of research is carried out also in the commissions of the Committee of scientific-technical prognostication of the All-Union Council of Scientific-Technical Societies.

The second group includes methods of prognostication that use statistical data in one or the other way, called a group of methods of statistical prognostication. The basis of these methods is extrapolation of tendencies and regularities of development in the future. The following methods are characteristic representative of this group:

- direct extrapolation;

- extrapolation by a logistic curve;

- the methods of analysing patents (publications).

The first and second methods practically extend the character and the tendencies of current development into the future. In the first case it occurs along a straight line, and in the second - by the logistic curve. The first method is good owing to its simplicity for medium-term prognoses. The second one uses practically the existing model of development, which has a dialectical character. This method can be used also for long-term prognoses. However, it is clear that the first and second methods are designed for prognosticating individual phenomena that are not complicated. In this sense the second group of methods is a certain source of information for the first group.

The third method is a certain variety of the first two ones. The third group, which is a group of methods of heuristic prognostication, includes a tremendous number of methods that are founded on intuition.

In essence, all these methods are varieties of expert estimates. The following methods are the most characteristic ones in this group:

- the Delphi method,

- the Glushkov method,

- the Pattern method.

Whan analysing the phenomena, prognosticated with the aim of elaborating the Complex Program, we observe their sense difference and different complexity (in the system-technical sense). Hence, when doing this analysis, it is ncessary to employ different methods of prognostication. It is possible by means of the three groups of methods listed earlier.

The most strict scientific methods are the simulation methods that enable by means of computers to consider a great number of factors in the models, rendering effect on the final results of the investigations. These methods permit to change one or the other factors in the model and to produce different variants of the prognosis. The state of the development of these models is characterised by the model of global development up to the year 2025, elaborated by Mesarovich and Pestel. This model comprises more than 100,000 equations.

The second group of statistical methods is used to extrapolate the existing regularities for the future. These methods produce considerable errors in the presence of factors, changing the established tendencies. The stated methods can be used effectively for medium-term prognostication.

The third group, heuristic methods, is used usually for investigating complciated and poorly studied problems. They can serve as one of the sources for building a model.

The time depth of the prognoses depends not only on the terms of the plan. It depends also on the subject of prognostication. There ought to be differences in the depth of prognostication between the scientific-research, experimental-design and production prognoses, owing to the various time lags in the realization of these investigations. For simplicity it is possible to assume that the depth of the prognosis for scientific-research developments shall be 10-20 years, for experimental-design development - up to 10 years, and for serial production - up to 5 years. In other words, the depth of the prognosis should be greater or equal to the term of realization of or the other event. Only in this case shall we deal with the final results of prognostic investigations.

CONCLUSIONS

It is quite evident that prognostication of science and its individual directions should be performed with the participation of scientists; prognostication of the development of engineering with that of scientists and designers; and prognostication of production and of the scientific-technical base with that of scientists, designers and managers of production. The truth and value of the prognoses decrease greatly if specialists of these categories are not attracted to the elaboration of the prognoses.

The current development of prognostication in the capitalist world is associated primarily with the attempt of individual companies to prognosticate the business situation in order to gain victory over a competitor. Effective prognostication of scientific-technical progress turned into an essential element of management. Prognosis is used to specify the future commodity, its development and manufacture. According to the approximate calculations of Erich Yanch, 500 big United States corporations spend about 1% of all the expenditures for research and development annually on prognostication. Attempts have been made on developing state prognoses. However, the non-planned, market economy will not permit effective application of the results of these investigations for managing the national economy. Prognoses, associated with the problems of economic growth, are developed most actively, because they are associated with all the problems of further development of the entire world community. These problems are considered in different aspects: global and regional, national and international, etc. Despite the certain eclecticism of the research, the class partiality of the researchers, the great scientific value of these researches, as to their content and methodological sense, is indisputable.

The development of prognostication in our country has occurred and continues to occur in cooperation with prognostication in foreign countries. Soviet specialists in prognostication participate in different symposia and conferences, their works are translated into different languages of the world. Most close ties have been established by our specialists with their colleagues in the CMEA member-countires. These ties come true not only by the forms stated earlier, but also by joint work at methods and concrete prognoses.

The highest form of scientific-technical cooperation in this area has been the creation of a "Working group on cooperation in the area of scientific-technical prognostication" by the decision of the Committee on scientific-technical cooeration of CMEA. This historical act has been adopted in the Hungarian People's Republic of the 12th meeting of the Committee on scientific-technical cooperation.

Being an organ of the CMEA Committee on scientific-technical cooperation, the Working Group on cooperation in scientific-technical prognostication carries out considerable work on improving the organization of cooperation in prognosticating the development of science and technology on problems of mutual interest for the CMEA member-countries. Simultaneously, the Working Group coordinates the elaboration of prognoses for individual and most actual inter-branch and complex problems of science and technology, which are done jointly by the interested CMEA member-countries.

Beside that, the Working Group elaborates proposals for the Committee on scientific-technical coopration related to the Basic directions, the content and form of cooperation in prognostication, forms of cooperation for the elaboration of research in the methodology of scientific-technical prognostication.

When elaborating prognoses, temporary collectives of scientists and specialists are organized, if necessary. The results of the elaborated prognoses are used by the countries jointly.

As a result of almost a decade of joint work the Working Group has elaborated prognoses up to the year 2000 for the development of computer facilities, machine-building, the utilization of secondary raw materials, automization, computerized networks, etc.

Beside that, the Working Group has organized and convened a series of international symposia on the problems of scientific-technical prognostication.

Great attention is given to the training of specialists in the sphere of prognostication, especially young specialists. Thus, two international schools have been organized for young scientists of CMEA member-countries on prognosticating science and technology.

The efforts of the Working Group in the area of methodology have resulted in the elaboration of different methods, for example, "Methods of joint prognostication", "Methods of problem-oriented estimates of the scientific-technical potential", etc.

The adoption of the proposal for elaborating a Complex Program of scientific-technical progress in CMEA member-countries is a great success of the Working Group. The work on this problem, that continued for almost two years, ended by adopting a decision at the top-level Economic Conference of CMEA member-countries in Moscow in 1984 on the elaboration of a program that will be of major significance in revolutionizing the productive forces in our countries.

It is necessary to mention in conclusion that prognostication of scientific-technical progress is still far from perfection. Profound scientific and organizational work are required for improving it and transforming it into a reliable tool of long-term planning. The role of prognostication will increase constantly and it is extremely important, therefore, to utilize the possibilities of international scientific-technical cooperation with CMEA member-countries as well as with other countries for the development of prognostication and the elaboration of concrete prognoses on the major directions of scientific-technical development.

SYSTEM OF SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT PLANS AND METHODS OF THEIR ELABORATION

INTRODUCTION

Scientific and technological progress plays an increasingly important role under modern conditions of economic development. The creation and wide utilization of advanced new technology and resulting transformation of the technological basis of production is a major factor of more rational utilization of resources and greater improvement in the efficiency of the national economy.

Management of scientific and technological progress represents a process which utilizes various instruments for achievement of targets. Among them the plan occupies a central place. Plan specifies many parameters of scientific and technological progress (from technical to social characteristics of technology), dates and scope of their achievement and participants (researchers, designers and producers).

SINGLE S&T POLICY

It is also significant that plan ensures many aspects of actual implementation of a single S&T policy, elaborated and adopted by supreme directive organs. This is very important for planned development of the national economy, proper utilization of resources alloted for scientific and technological progress and for the efficient functioning of the economic structure. A single S&T policy is considered to be one of the most important advantages of socialism in managing the national economy and forming the country's scientific and technological potential.

The principle of a single S&T policy signifies the pursuit of the same single policy approved at supreme directive level by all organs(from ministries to enterprises) independent of their departmental structure and territorial situation. This policy must correspond to the objective laws of scientific and technological progress and actively promote the realization of social developoment laws under socialism taking into account real development conditions of the country.

Presented by A.S. Gusarov

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Conceptual Basis

The single S&T policy is an important instrument of carrying out socio-economic policy of the socialist state. It gives an active support to the realization of social and economic tasks faced by the socialist society. The greater the difficulties with the available resources, the more thorough and detailed is the elaboration of the Single S&T policy and its strict implementation.

The conceptual basis of scientific and technological revolution and the rapid growth of new S&T achievements offer many possibilities of solving various technological problems. On one hand, every problem demands definite resource costs (labour, power and fuel, raw materials, machines, equipment, etc.). On the other hand, every problem has definite economic effect and social consequences such as for employment conditions, environment, etc. Hence it is important to elaborate optimum S&T policy which would ensure the best solution of economic and social task faced by the society within a given amount of resources.

The socialist society is interested, first of all, in those directions of scientific and technological progress that give the highest returns in solving major socio-economic problems. In the end, this is connected with bringing labour productivity to the advanced world level and even surpassing it. This task is transformed through elimination of manual, physically hard, unqualified and monotonous labour. Naturally, this requires a relatively high level of means of production (machines, equipment, etc.), technological processes and manpower (general education and specialized training).

Implementation of the Single S&T policy does not mean that the solution of all problems of scientific and technological transformation of production and service sectors is done only in a centralized form. Here one should not confuse the Single S&T policy with the mechanism, forms and methods of its practical implementation.

Mechanisms

A uniform approach to the solution of economic and social problems of the society is ensured by target decisions. For example, if it is decided to eliminate manual labour and improve conditions of work then at any place of work (either in industry, or agriculture, or services), at any level of management (enterprises or ministries) one can and should implement only those production improvement measures which do not contradict the given decision and help actively to translate it into practice.

In their general form the most important target decisions and orientations of S&T development are embodied in the conception of economic and social development of the USSR. They are elaborated in a more concrete form and addressed to the 2650 ministries and territorial structures in the document named "Principal guidelines of economic and social development". The above documents cover a strategic period of 15 years. Further detailing is done in five-year and annual plans. Various programmes represent important planning instruments of details elaborating the problems of scientific and technolgoical progress and their interrelations.

The Single S&T policy allows the society to concentrate its resources on the most important direction of the country's economic development and solution of the existing tasks. This raises the efficiency of scientific and technolgoical progress. Hence it is important to define correctly, observe and implement skillfully the given policy.

Major forms of Management of S&T Progress

The documents on the system of S&T development planning is rather complicated. Before considering them, it is useful to recognize the following aspects. S&T development alone is not adequate to scientific and technological progress. It represents only an initial stage related with the mastering of innovations (machines, technological processes, scientific organization of labour) and their introduction in the national economy.

On the other hand, scientific and technological progress in its full scope is reflected in different degrees in many sections of the plan. The transition to preferential intensive economic development and the increasing role of scientific and technolgical revolution in this process require a more concentrated presentation of the main problems of scientific and technological progress in the plan as distinct from the presentation of the stage of developments in science and technology.

Currently the following documents of directive character are used in planning major measures of S&T development in the USSR:

-Conception of Economic and Social Development of the USSR (elaborated for a long-term period up to 15 years);

-Principal Guidelines of Economic and Social Development of the USSR (elaborated for a long-term period up to 15 years);

-State Economic and Social Development Plan of the USSR (covering a five-year period);

-State Economic and Social Development Plan of the USSR (covering one year).

-Target Scientific and Technolgoical Programmes and Programmes for the Solution of the Most Important Scientific and Technological Problems are also included in the category of major planning documents.

These documents are enumerated proceeding from:

a) their directive subordination - from a higher to a lower rank;

b) the degree of their concrete elaboration with reference to executors, projects and dates - from general to more detailed.

Approach

The Complex Programme of scientific and technological progress of the USSR covering a period of 20 years occupies a particular place in planning. It is a pre-plan document elaborated by scientific organizations and leading scientists. It considers the tasks relating to the most important social and economic problems of development of the national economy for the indicated period; directions and ways of achieving scientific and technological progress; possible variants of solving the above-mentioned problems on the basis of scientific and technological progress, etc. Planning bodies use this Programme widely at all stage of planning.

While working out the Conception, Principal Guidelines and Five-year Plan of economic and social development particular attention should be paid to ensuring:

a) methodological uniformity of elaboration and compilation of these documents. This is an important condition for bringing together all different components of each document which are elaborated for various levels of management and territorial structures as well as for further stipulations of a higher rank document in a subordinate document.

b) determination of their elaboration dates so that the planning bodies, the USSR ministries and departments, the Councils of Ministers of the union republics have enough time for thorough examination of the planning documents in their graded order - from the Conception to the Principal Guidelines and then to the Five-year Plan which in turn consists of Annual Plans.

The experience shows that a thorough examination of each of the above documents under the USSR conditions requires 1 to 1.5 years. Thus, the dates for elaboration and submission of a respective planning document are defined on a basis of reverse counting. For example, if 1986 is the initial year of the direction period (1986-2000) then the work on the five-year plan should start in the middle of 1984 and on the Principal Guidelines - in the beginning of 1983. Naturally, these dates are conditioned by many factors among which the most important are the scope of national economy, professionalism and experience of planners, complexity of problems facing the country, etc.

Characteristics of the documents

By its nature the Conception of Economic and Social Development of the USSR is a programme document. It comprises only large-scale problems of scientific and technological progress having a through character for all branches and spheres of the national economy, or main complex problems (fuel and power, machine-building, agro-industrial, etc.).

The targets of the development of scientific and technological progress and the dates of their implementation specified in these documents are not addressed to the USSR ministries and departments and represent initial stipulations for their detailed elaboration in other planning documents.

It contains single scientific and technological strategy which receives a detailed and concrete elaboration in all other planning documents. It forms the basis for the elaboration of the Principal Guidelines of Economic and Social Development of the USSR which, in turn, is for the elaboration of the state five-year economic and social development plan.

It is necessary to indicate that the Conception document does not consider scientific and technological progress as such from the point of view of technological and scientific problems but rather as a means for solving large-scale tasks of the developed socialism including raise of labour productivity to the highest world level, elimination of manual, physically hard, low qualified and monotonous labour alongside simultaneous creation of such working conditions which would lead to harmonious personality development of a worker, etc.

The Principal Guidlines of the USSR Economic and Social Development are elaborated on the basis of the Conception document considered above. By its nature Principal Guidelines is a planning and directive document of a large-scale strategic character addressed to the executors. It is the first stage of detailing the Conception document.

This detailing is done along the following three lines:

a) directions of economic development (e.g. a more d tailed elaboration of ways and means of improving the quality of product technological transformation of production, development of eocnomic complexes, etc);

b) identification of deadlines by periods (by five-year periods with the first five-year period detailed by years);

c) specification of responsible organs, specific ministries and departments, Councils of Ministers of union republics).

The elaboration of the Principal Guidelines is carried out in compliance with the methodological instructions and "indices and forms for the elaboration of the draft Principal guidelines and state plan of economic and social development for 1986-1990" approved by the USSR State Planning Committee.

It must be pointed out that the indices and forms, mentioned above although worked out on a uniform basis, are not identifical for the two planning documents - the Pricnipal Guidelines and the STate Five-Year Plan. A part of forms and indices designed for the five-year plan is not used in the elaboration of the Principal Guidelines.

Prior to the elaboration of draft Principal Guidelines, Five Year and Annual Plans the planning body engaged in this work (State Planning Committee in case of the USSR) determines their structure (sections, sub-sections and so on).

The structure of a planning document of higher order should be elaborated in greater detail in other planning documents. This constitutes an important requirement for their unity and succession, further detailing of the Principal Guidelines targets in five-year plans, and the five-year plan targets in annual plans.

The unity and succession of structures of the planning documents is supplemented by the unity and succession of forms used for the elaboration and approval of the above-mentioned planning documents.

A five-year plan is most comprehensive from the point of view of its structure. It is the major state plan given the fact that the five-year period forms the basis of planning in the USSR. During the indicated period it is possible to solve cardinal problems, including social life and scientific and technolgoical progress. A longer period would pose certain problems for elaboration and decision-making.

It is possible to forecast with a greater degree of reliability and take decisions for longer periods (10-15 years) when tackling the most outstanding problems, such as radical qualitative transformations in technology, territorial siting of productive forces, social and economic development of the society.

The annual plan is based on a five-year plan and constitutes its integral part. This is an instrument for planning and managing the process of implementation of five-year plan targets.

Annual plan is a current plan. Its targets are often elaborated on 6-month or 3-month basis. However, in doing so it is necessary to avoid shifting of the major "load" to the end of the year. The same terms are used by the ministries, departments and the USSR Central Statistical Board for reporing the implementation progress to the USSR State Planning Committee as well as for controlling the implementation process.

During a given year, the implementation of scientific and technological programmes is carried out in their full scope and not by major items envisaged in a five-year plan. In this connection all measures which are to be carried out during a given year are selected from the problems and included in plans of different order. This is done by the USSR State Committee on science and technology with the participation of ministries and departments.

The same procedure is applied in case of standardization, unification and metrological activities. Annual targets for these areas are approved by the USSR Standardization Committee.

Planning forms for S&T development

All plan subsections and their supplements are elaborated and submitted for consideration and approval. The aprpoval is done according to previously established forms. This is an important methodological requirement for correct planning. Without it, it would be impossible to ensure the uniformity of draft targets which are elaborated by various bodies.

Due attention is given to the elaboration of forms. The forms should be established in a clear-cut manner and understandable for all who fill them in. They should exclude any possibility of misinterpretation of instructions in filling them.

In spite of a great variety of forms for planning S&T development, all of them have obligatory attributes such as the following:

a) form title which identifies in a clear-cut manner the object of planning (e.g. "Mastering of new types of produce", "Complex standardization of major types of produce", "Introduction of scientific organization of work");

b) time horizon of plan - annual (e.g. 1984), five-year (e.g. 1986-1990);

c) executor of plan (name of ministry, department and so on);

d) plan index (e.g. title of new product or new technology being introduced or mastered, title of a measure for scientific organization of work);

e) measuring unit of a given index (expressed either in value or in kind - pieces, articles, tons or kilometers of produce, etc.);

f) target volume for each index broken down by periods within planning cycle (by years in a five-year planning cycle, by half-years and quarters in annual planning cycle).

To facilitate their use each form has its ordinal number.

All forms have a unified character that are based on known scheme and all explanatory notes use standard terminology.

Considerable efforts are being undertaken in the USSR to mechanize the planning work. Consequently all planning forms are elaborated bearing in mind their computerized processing.

Indices play a particular role in preparing the S&T development section of the plan. Their correct selection determines not only the quality of planning but also actual scientific and technological progress.

The management of scientific and technological progress is carried out using two groups of indices.

The first group comprises the so-called "through" indices common for all executors. They reflect the dynamics of certain directions scientific and technological progress as a whole (e.g. dyunamics of general quality level of produce or dynamics of general technolgical status of production). The share of super quality product in the total volume of manufactured products is an example of the index of products quality used in the USSR.

The second group comprises specific indices characterizing a certain phenomena of scientific and technological progress inherent to a particular branch. For example, every branch uses a technology which is not used in other branches. Or machines of a given group have their particular qualitative characteristics (speed and accuracy of operation, sphere of application, etc). The plan can envisage a specific technology or manufacture of a machine (machines) of the given group with equal or better parameters. The dynamics of this index cannot be used for determining its influence on the general dynamics of scientific and technological progress. However, if a machine is accepted then it is possible, to a certain degree, to assess its influence on scientific and technological progress through the index of super quality produce share.

When planning and managing scientific and technological progress it is necessary to pay due attention not only to each index but also to the whole system of indices. In this process an important role is played by the "through" indices.

While going further in perspective (from annual to five-year and then to 10 or 15-year planning) certain details and nuances of scientific and technological progress become less clear. In some cases there may be no need for great details, and in others it may be difficult to forecast them. This poses some difficultues in aggregating the indices characterizing a certain area of scientific and technolgoical progress in various planning documents, such as the Principal Guidelines and Five-Year Plan.

There are three approaches to this problem.

The first approach in solving the problem of index aggregation consists in using the index characterizing the existing technology which will be also used in the perspective period.

The second approach is realted to the case when the perspective direction of scientific and technological progress is already identified and its prospects are more or less clear, even if it has not yet materialized in industries.

The third approach is applied when a new phenomena is not clear but the area of its possible appearance is known. In this case among the aggregated indices they introduce a future index without the title, like other new processes or products.

While elaborating the planning documents of different orders and time horizons it is necessary to ensure aggregation and detailing of their targets and indices. Without this the directive character and continuity of a higher order document are lost or become weaker.

SCIENTIFIC AND TECHNOLOGICAL PROGRAMMES

Scientific and technological programmes represent an important instrument for managing scientific and technological progress as well as science and technology. These programmes differ by their importance, scope of problems of scientific and technological progress, duration, executors, etc.

Currently there exist about 200 programmes in the Soviet Union out of which more than 170 are scientific-technological programmes. Thus, it seems expedient to identify major programmes and consider their classification.

Among all scientific-technological programmes the first place is given to the Complex Programme of Scientific and Technological Progress which is elaborated for a period of 20 years (by five-year periods). Every five years necessary changes are made in the Complex Programme extending its time horizons for the other five-year period. The Complex Programme is elaborated in such a way that it is distributed among the planning bodies not later than 2 years before the beginning of the next five-year plan in turn. This allows its use in the process of elabo ation fo the Conception, Principal guidelines and next five-year plan.

By its nature the Complex Programme of scientific and technological progress is a pre-plan non-directive document. It is elaborated by the USSR Academy of Sciences, the USSR State Committee for Science and Technology and the USSR State Committee for Construction. Then it is submitted by these bodies to the USSR Council of Ministers and the USSR State Planning Committee. Subsequently, it is used for the elaboration of the planning documents.

By its contents the Complex Programme of scientific and technological progress represents elaborated forecasts and recommendations for long-term development of science and technology. They include the most prospective directions and major changes in the field of technology, energetics, raw and other materials, technological processes, production organization and so forth.

This Programme includes:

- forecast of principal directions of scientific and technological progress and their influence on socio-economic processes;

- priority justification of certain directions of S&T development in the branches of the national economy, scope of introduction of new scientific and technological achievements by branches and allocation of resources by directions of scientific and technological progress;

- assessment of possible socio-economic consequences of scientific and technological progress;

- justification of major principles of target scientific-technological programmes, their number and necessity;

- justification of directions of improvement of national economic mechanism and organizational structure of the national economy management ensuring practical implementation of the proposed measures;

- elaboration of urgent measures to be included in the five-year plan and ensuring implementation of long-term S&T policy.

The elaboration of this Complex Programme allows wide participation of scientists and scientific research organizations in the process of planning thus raising its scientific level. It is particularly important, in view of a rapid development of scientific and technological revolution, to ensure the increasing role of scientific and technological progress in all spheres of social life, including the development of industry and agriculture.

Five-year plans of economic and social development envisage major targets for the implementation of scientific-technological programmes.

Scientific-technological programme is a peculiar form of inter-branch planning representing by itself a complex of various measures tied up by common target as well as by resources, executors and implementation dates planned within the framework of a single cycle "research - production - application". Such programme is designed to ensure a considerable improvement of the existing technological and economic level in certain branches of the national economy.

These programmes are used for solving major scientific and technological problems as well as utilizing the newest achievements of scientific and technological progress in the national economy. Alongside with the creation and mastering of new prototypes of machines and technological processes these programmes envisage their large-scale utilization in the national economy together with the supporting measures (department of productive capacities, construction of new and reconstruction of the existing enterprises).

Proceeding from the final targets, status of work and composition of measures it is possible to specify two types of scientific-technological programmes: Target Scientific-Technological Programmes and Scientific-Technological Programmes for Solving Major Problems.

Target Scientific-Technological Programmes are elaborated for a large-scale implementation of the most important achievements of S&T the utilization of which ensures immediately a considerable increase of production efficiency and quality of products. In this case a scientific problem is already solved, ways of its practical materialization are found and tested, and the whole matter consists in a rapid large-sclae utilization of the given scientific innovation in production. Consequently, the final targets of these programmes are expressed in volume of production and industrial mastering of new machines, technological processes and materials created within the framework of these programmes.

Beginning with the XII five-year plan several major types of scientific-technological programmes will be used in the USSR, namely:

- all-union scientific-technological programmes whose principal targets are included in five-year and annual plans of economic and social development;

- republican (inter-republican) scientific-technological programmes whose principal targets are included in republican five-year and annual economic and social development plans;

- branch (interbranch) scientific-technological programmes whose targets are included in plans of the USSR ministries and departments;

- scientific-technological programmes of regions and territorial-production complexes whose targets are included in state and republican five-year and annual economic and social development plans and plans of the ministries and departments respectively.

It is necessary to point out that a scientific-technological programme allows to see in their interrelation all components required for the solution of a certain problem. However, in order to give the programme the strength of the plan and its directive character it is necessary that the programme components are included in the plan thus becoming its targets. In this sense scientific-technologcial programmes become the plan instrument. This shows that scientific-technological programmes are elaborated and used when there is a significant problem requiring a special instrument for its all-round solution.

Programmes for the most important scientific and technological problems are elaborated by individual problems of the national economic significance which are to be solved. This refers to the problems of creating entirely new types of technology including their practical realization, as well as of developing R&D activities in the most perspective areas of S&T to form a "stock" for the coming period.

The list of programmes whose major targets are to be included in the state economic and social development plan is determined by the USSR State Committee for Science and Technology, the USSR State Planning Committee, the USSR Committee for Construction and the USSR Academy of Sciences with the participation of the USSR ministries and departments and the Councils of Ministers of union republics at the stage of elaboration of the Principal guidelines of economic and social development of the country. This list as well as the order and terms for the elaboration of programmes should be approved not later than 1.5 year before the next five-year plan in turn. The list comprises those programmes whose implementation produces a determining effect on the solution of the national economy tasks which, as a rule, have interbranch and multiprofile character and new approach to technological, organizational and other decisions.

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USE OF THE PROGRAMME-TARGET METHOD IN SOLVING SCIENTIFIC AND TECHNOLOGICAL PROBLEMS

INTRODUCTION

The course adopted in our country for a preferably intensive development of the economy is supported primarily by accelerating scientific-technological progress, wide-scale utilization of scientific-technical achievements in all the branches of the national economy. This causes the necessity for complex resolution of wide-scale S and T problems associated directly with the re-equipment of production on a qualitatively new technical base.

Realization of major S and T problems embraces fundamental and applied scientific research, technical developments, mastering in production. Each of these stages represents a sufficiently independent area of activities with an established mechanism of management, planning and financing. The executors of the work at the different stages are organizations and enterprises of different departments. The ties are most diverse and complicated with developing principally new machinery and technologies, requiring the organization of new and reorientation of existing scientific and designing organizations, productions, branches, management organs at different levels, alloting considerable financial and material resources, high-skilled scientific and production cadres. S and T programs have been elaborated and are being realized for coordinating the activities of a large number of organizations-executors, participating in the solution of the most important problems of S and T progress.

The scientific-technological program envisages a complex of measures coordinated with the resources, executors and dates of fulfilling the planned work, referring to different areas of activities (scientific, project-designing, production, construction), the implementation of which is necessary for solving major scientific-technical problems and wide-scale introduction of the achievements of science and engineering in the national economy.

Wide-scale application of the program-target method permits to concentrate efforts and material resources for achieving the final goals, provide complex solution of the targets and

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Presented by V.A. Disson

continuous implementation of the required measures, accelerate the advance of the results of research and developments up to the stage of practical application.

The application of the program-target method in our country is based on accumulated practical experience, beginning with the GOELRO (State plan for the electrification of Russia), which was elaborated on the initiative of V.I. Lenin and which is a classifical example of the program approach to the solution of the major national economic problem of electrification as a most important condition for developing the large-scale machine-building industry. The solution of the problems of mastering atomic energy and the development of cosmonautics are only a few of the accomplished major S and T programs.

System of S&T Programs

A system of scientific-technical programs, approved by the government is in effect in the USSR.

The primary basis for elaborating S and T programs is the Complex program of scientific-technological progress, which is a preplan, nonapproved document, which is elaborated for 20 years, specified and prolonged every 5 years. This program substantiates single science and technology policy, the basic directions of scientific-technological progress, and their effect on socio-economic processes. It a single concept of the development of science, engineering, production in the form of a system of mutually coordinated prognoses, and determines qualitative shifts in engineering and technology with a socio-economic estimate, priorities in the development of individual scientific directions, whose development shall be provided first and foremost. Major scientific-technical problems of a long-term character as well as those providing return in a relatively short time are determined proceeding from the targets for the development of the economy and those of social progress.

Elaboration of the Complex program of scientific-technical progress is organized by the USSR Academy of Science and the USSR State Committee for Science and Technology. A Scientific Council has been set up on problems of scientific-technical and socio-economic prognosing for continuous work at this program.

Numerous scientific collectives, outstanding scientists, and specialists of the state organizations participate in the elaboration of the Complex program. About 3,000 scientists, specialists, practical workers from numerous research, projecting and designing organizations were called upon to work at the program for the period from 1986 to 2005. This work was finished by the end of 1983.

The Complex program has been formed for this period comprising about 30 major directions and national economic complexes, in particular, fuel-energy, machine-building, constructin transport, metallurgical, agrarian-industrial, and a number of other complexes.

The conclusions and proposals of the Complex program are used for elaborating the draft Basic directions of economic and social development of the USSR for 10-15 years. This major document determines in particular, the basic targets of S and T progress, targets for raising the level of technical development of the national economic branches, directions of most perspective research and technical developments. The lists of S and T programs are formed at this stage for inclusion in the five-year plan, which are approved at all the levels of management.

Program target method

The USSR Academy of Science elaborates and realizes long-term programs of complex research in the focal problems in the area of natural and social science. Each such program envisages all the inter-related stages of its accomplishment, beginning with the origination of a scientific idea and ending with concrete realization of the results of research and development in the national economy, in social development and cultural construction. Coordination plans of joint work of the USSR Academy of Sciences and the respective ministries and departments are elaborated for accomplishing these programs.

The Siberian branch of the USSR Academy of Sciences has elaborated target scientific programs associated with the utilization of the fuel-energy and mineral-raw material resources of Siberia, the development and formation of territorial-production complexes, economic mastering of the area around the Baikal-Amur railroad, etc. They make up a constituent part of the general scientific program "Siberia". A large number of scientific programs has been elaborated for scientific and technological problems solved at higher educational institutions.

The results of scientific research carried out at the scientific organizations of the USSR Academy of Science and higher educational institutions, as well as inventions and discoveries are thoroughly analyzed as to their effectiveness and readiness for mastering in production. The most effective ones are included in the proposals that the USSR State Committee for Science and Technology and the USSR Academy of Science send to the USSR State Planning Committee, ministries and departments. They consider these recommendations when drawing up plans as well as scientific-technical programs, wherein the required measures are predetermined for practical introduction of scientific achievements.

The program-target method is most efficient for solving complex inter-branch problems of S and T progress of general national economic significance, becuase this method provides the possibility to determine and consider the association between the individual branches participating in the solution of such major problems. To this end, all-union S and T programs are elaborated and realized. The latter are approved in the State five-year plan of economic and social development of the USSR, constituting a major component of the plan.

The State five-year plan comprises only a part of the prgram, namely, the basic targets which determine the objects of new machinery and technologies to be created and mastered in production with indication of their technico-economic specifications. The basic targets envisage:

- elaboration and introduction of highly efficient technolgoies into production, providing the development of low-waste methods of production, complex utilization of raw materials and materials, improvement of product quality, reduction of material expenses, raise of labour productivity and conditions;

- creation and commissioning of projects of new machinery and new productions on the basis of advanced technologies, elaboration and introduction of new types and systems of highly efficient machines and automated equipment, new types of buildings and structures, efficient means of mechanization and automatization for complex equipment of all the branches of the national economy, as well as new more economic materials, building constructions, products and articles;

- elaboration and mastering of serial production of industrial articles in accordance with the major nomenclature with improved technico-economic specifications for renewing the products, as well as completing articles, materials and highly efficient technological equipment for maintaining the planned technico-economic level of articles;

- elaboration, introduction and wide-scale utilization of new machinery and technologies on the basis of purchased licenses and samples, application of foremost scientific-technical home and foreign experience, most important inventions, and those of inter-branch significance in the first case;

- elaboration and introduction of automatic control systems of different purposes, automatic control systems for technological processes and information processing on the base of utilizing economic-mathematical methods, new means of electronic computing and microprocessing equipment, managerial aids and communication;

- elaboration and introduction of methods and means for rational and complex utilization of natural resources, environment protection against pollution, and systems for observing and controlling the state of the environment and the sources of its pollution;

- experimental-industrial trying out of principally new types of machinery and technologies having no home analogues, wherein a new technological diagram is employed, altering the basic operating principle of the machinery. 2650

Ministries, responsible for the formulation and accomplishment of each program and major task, are appointed.

Enlarged programs, comprising all the measures for accomplishing the targets, are elaborated and approved, considering that the number of organizations-participants fulfilling all-union scientific-technical programs reaches on the average 50-60 and sometimes up to 400-500. The enlarged programs are elaborated for coordinating and organizing the work of all the executors.

Elaboration of all-union S and T programs is organized by the USSR State Committee for Science and Technology, which is responsible for the Single State policy in the area of scientific-technological progress and all-round application of the achievements of science and technology in the national economy. It carries out this work together with the USSR Academy of Science and the USSR State Planning Committee, providing, thereby, determination of the most significant achievements of science that can be set to the service of the society, the objective requirements of the economy in scientific and technical products, and the possibility of supporting the programs with the necessary resources.

The following types of State S and T programs are elaborated depending on the final targets, the state of the work and the composition of the measures:

- target S and T programs;

- programs for solving major scientific-technological problems.

Target S and T programs are elaborated for wide-scale realization of the most significant scientific-technical achievements the utilization of which will provide in the near future an essential raise of the effectiveness and technico-economic level of production and product quality on the b sis of utilizing progressive energy-saving and low-waste technologies, complexes and systems of machines and equipment, high-efficient means of meachanization and automatization, introduction of inter-branch unification of assemblies, units and parts, economic materials.

In order to accomplish the stated targets the programs envisage tasks for elaborating and mastering new types of machinery and technologies in production, as well as expanding the scale of production and the utilization of earlier mastered or advanced technical means and efficient methods of production being mastered in volumes required for the solution of the stated tasks.

In particular, programs, setting the task to raise the level of mechanization and automation of the major production processes and, on this basis, to raise labour productivity and eliminate hard manual labour, envisage the creation and production of new technical means required for the development of machine systems, as well as further improvement and expansion of the production of machinery being already manufactures.

The programs, which are aimed for improving the tecnico-economic indices of production (for example, reduction of material and energy consumption, raise of complex character of utilizing raw materials and materials, etc.) comprise measures for the development and mastering of new technolgies and equipment, as well as expanding the scale of utilizing earlier mastered advanced technologies, improvement of technological means and increase of the output.

Programs, envisaging improvement of the structure of manufactured products, increase of the specific weight if advanced products in the total volume of production, and improvement of the qualitative specifications of the products, comprise elaboration of new types of articles with essentially improved parameters, as well as expansion of the production and utilization of already manufactured goods and materials of high technico-economic level.

The assignments of the target S and T programs provide for rendering effect on the process of developing and mastering novelties as well as on the volume of production and utilization of these novelties in the national economy. This intensified influence on expanding the scale of introducing high-efficient new machinery in the national economy is extremely significant because there are many examples illustrating that new designed machines, equipment, devices, materials, technologies are not mastered for a long time or are mastered in very little volumes.

<u>Programs for solving major scientific-technological problems</u> are elaborated for individual problems of major national economic significance and associated with the development of principally new technologies and types of machinery, and raising them to practical realization, as well as with the development of scientific research and technical development along the most prospective directions of science and technology for carrying out work in anticipation of the forthcoming period. These programs lack the aim of wide-scale introduction of new machinery and technologies. They are fulfilled mainly up to the beginning of mastering the novelty in production, and they are restricted frequently by research and developments required for the selection and scientific substantiation of optimum ways of solving the problem and determining the future work, by experimental and experimental-industrial testing, manufacturing and all-round investigation of the demonstration samples and objects. The programs for solving scientific-technological problems render no direct effect on the current economy but they create our future scientific-technical and industrial bases. It is necessary to note that target S and T programs may comprise also individual assignments for expanding research and developments for work in anticipation of the near future. 2650

The content of the final targets of the all-union scientific-technical programs can be clearly illustrated by the example of programs realized for 1981-1985. The State five-year plan of economic and social development of the USSR for the XI five-year period comprises 170 approved all-union S and T programs. They have been selected as a result of thorough analysis of hundreds of major scientific-technical problems, proceeding from long-term targets of developing the economy and social progress of the country, that have been specified in the Basic directions of economic and social development of the USSR in 1981-1985 and for the period up to 1990. When selecting these programs, the prognoses were considered of the most significant directions of science and engineering.

Application of the method

The majority of S andT programs are designed to provide intensification of production. As a result, the final targets of the stated programs are aimed at elaborating, mastering and utilizing machinery and technologies on a wide scale that will provide a certain economy of labour, material and fuel-energy resources, a raise of the technical level of production and the quality of the products.

It is planned to create in compliance with the S and T programs of state significance more than 5,000 new types of machines, equipment, devices, materials, technologies. More than 60% of the latter will be introduced into production in the current five-year period. Realization of the state S and T programs will economize in 1985 the labour of more than 3 million workers, transfer 400,000 workers from manual to mechanized labour, reduce the consumption of ferrous metal by 4 million tons, and fuel - by 50 million tons conditionally. The economic effect will exceed 16 billion roubles.

A major direction of technolgoical progress is complex mechanization and automation of production to provide a raise of labour productivity and liberate workers from manual and physically hard, low-skilled, harmful and monotonous labour. Hence, the all-union programs envisage the elaboration of high-efficient means of mechanization and automation for cargo and materials handling, storage, falling and hauling timber, underground coal mining, road repair and other work. In particular, new models are manufactured today in accordance with the problem for mechanizing materials handling, namely, cranes with automatic grabs, cranes-stackers and conveyers for storehouses, lift-trucks, and some other machinery. Machinery is being mastered for the lumbering industry that permits to eliminate hard physical labour at timber falling, for removing snags, and haulage.

The elaboration and wide-scale introduction of automatic manipulators (industrial robots) is performed at an accelerated rate. The latter liberates the worker of manual, low-skilled labour, raise labour productivity 2-3 times on the average. They are used widely inmachine-building, in automatic lines, sections and productions servicing metal-cutting, press-forging and foundry equipment, for welding, assembling and painting operations, for displacing heavy objects. It is envisaged to create robots for underground coal mining and its transportation, in metallurgy for high-temperature processes, in the light industry - for eliminating the tear of yearn, for packing foods. Already are created and introduced improved models of robots, including self-training ones with elements of adaptive control.

Resilient (readjustable) production is created on the base of robots, program-controlled equipment and microprocessor technique. Their wide-scale utilization in different branches of the national economy will raise labour productivity, increase the number of working shifts of the equipment, provide also rapid change of manufactured goods, accelerated mastering of new products of higher quality.

Programs for the creation of automatic control systems for complex technological processes and equipment on the basis of computer engineering are of especial significance. They make it possible to optimize the production process, that renders a major effect on raising labour productivity, the quality of the product, on reducing the consumption of fuel, energy, raw materials and materials. Mini- and microcomputers are widely used in these systems, and as compared with the means of computer engineering employed earlier, make it possible to reduce considerably the dimensions of new systems and their cost.

Computer engineering is used evermore widely in different economic areas, as well as for the elaboration of new machinery. In accordance with the new and more efficient automatic systems for automation of scientific experiments, projecting and designing, are being introduced that will provide accelerated development of innovations, their high scientific and technical level. In particular, realization of the targets in the program for creating automated systems of project-designing work in construction will permit to save, in accordance with calculations, about 700 million roubles from the reduction of the estimate cost, also 700,000 tons of metal, 1,300,000 tons of cement and 500.000 m3 of timber.

A considerable number of S and T programs is aimed at reducing the metal capacity of production. In particular, these are programs for developing new economic ferrous and nonferrous sections for utilization in machine-building and construction, new construction polymeric materials and other chemical and synthetic materials, that replace completely metal and natural raw materials. Great attention is given to the development of powder metallurgy and composite materials, that raise considerably the qualitative specifications of the articles at a decrease of labour consumption and metal capacity in production.

The methods of powder metallurgy are employed for applying corrosion-resistant coatings, especially on parts of equipment and machinery operating in aggressive media. Considering, that the losses from corrosion are very great, a special scientific-technical program has been elaborated and is being realized for creating efficient means for the protection of parts and constructions against corrosion.

Intensive work is carried out on the program which envisages developing the production of principally new polymeric materials with a high content of cheap fillers that provide a considerable economy of oil raw material in the manufacture of pipes, sheets, tare, building constructions characterized by high specifications.

A considerable economy of natural fibres and metal is anticipated from the utilization of very strong fibres on the basis of flexible-chain polymers, which are characterized by a 1.5 to 2 fold higher strength. They are utilized today in the capacity of haybinding twine, and will be used as cord for tyres, reinforcing elements in different constructions, etc.

A raise of the strength properties of chemical products is provided also by irradiating them by means of charged-particle accelerators. It is planned, in particular, to employ this method to increase the resistance of cable products, improve the quality of some types of textile products.

A series of programs are aimed at improving machine-building technologies in order to improve the utilization of metal. The programs envisage new types of castings, welding, stamping, and other methods of treating metal. Installations are developed for employing powerful lasers in welding and cutting oprations as well as for reinforcing metal. Plasma methods are highly efficient as they provide a sharp increase of the cutting speed when processing large forgings and castings, as well as for reinforcing the surface of the articles by surfacing and spraying.

Intensive work is carried out in accordance with programs for developing wasteless and low-waste technologies in chemistry, petrochemistry and oil refining, in ferrous and non-ferrous metallurgy, in the pulp-and-paper and other industries with the aim of most complete and complex utilization of the basic and associated components, and secondary resources.

More than 20 state scientific-technical programs are associated with the fuel-energy complex. The accelerated development of nuclear power envisaged in our country is supported by the elaboration andputting into operation of 1 and 1.5 million kW reactors. Nuclear power will be used also for maintaining central heating in big cities. The construction of a nuclear power station has been started for the combined production of heat and electric power, and a powerful nuclear boiler for supplying a city district with a population of

300,000-400,000 people. These stations are economic and require practically no expensive deliveries of fuel. Beside that, they will not pollute the atmosphere with harmful exhaust when burning mineral fuel. The utilization of fast reactors at power stations is highly prospective, making it possible to use uranium-238, the content of which is much higher in natural uranium raw material than of uranium-235, which is used today in reactors at power stations.

The program is very important for the futher development of the Single electric power system of the USSR. The program envisages the construction of power lines from the East of the country to its Centre and to the Urals of 1.150 kV a.c. and 1.500 kV d.c. Electrotechnical equipment has been developed for these lines with the use of transformers based on power semiconductors, that considerably reduce the weight, overall dimensions and cost of the equipment, and raise its reliability.

The electric energy, that will be supplied via these lines, will be generated in the East of the country with the use of cheap coal from major basins, namely, the Kansk-Achinsk and Ekibastuz ones. These basins, where the coal is mined by the most efficient and economic open-quarry method, will be equipped in accordance with one of the programs by powerful walking and wheel excavators, dump trucks, special converyers, railcars, etc. The developoment of new thermal and power equipment has been required for burning this coal in the boilers of the power stations due to the fact that the coal of these basins is of a low grade and with a high content of ash and water. Beside that, the programs envisage work on energy-technological processing of this coal in order to produce high-caloric solid, liquid and gaseous fuel with the simultaneous production of valuable chemicals.

Owing to the exhaustion of the oil fields in the European part of the country and the production of high-viscosity oil, the significance increases of the problem of raising oil recovery by artificial effect on the bed. More than half of the oil remains in the reservoir today. New, efficient thermal, chemical, microbiological and other methods are tested according to the program as well as high-efficient equipment for injecting gas, steam, chemical reagents into the bed. This will make it possible to provide a substantial increase of oil production in the current five-year period and at least 100 million tons of oil will be extracted due to these methods by 1990.

Natural gas production is increased in the USSR at an accelerated rate, which is widely used for generating electric power, heat, as well as in metallurgical, chemical and other major technologies. Considering, that the main production of gas is performed in Western Siberia, the program specially indicates the solution of the problem of most economic transportation of powerful gas flows to the central and western regions of the country. Equipment has been developed and its production started for the construction and operation of gas pipelines of 1420 mm pipes under a pressure of 75 atm. Work is carried out for developing gas pipelines with an operating pressure of 100 atm. and more on the basis of utilizing very strong pipes. Realization of this program, which envisages also the elaboration of gas pumping and other equipment, will raise the pipeline throughout up to 50 billion m3 of gas, which is 2-fold that of the capacity of gas pipelines being constructed today. In accordance with a special program equipment is being elaborated for the recovery of oil and gas from the sea shelf from a depth down to 300 metres.

The Food program of the USSR has been adopted in May 1982 for the period up to 1990. About 40 S and T programs have been elaborated and are being realized to support the fulfillment of targets and measures specified in this program for increasing the production of the main types of foods and developing the material-technical base of the agrarian-industrial complex. A series of these programs is aimed at producing new high-yield varieties of agricultural crops and animal breeds of high productivity. An important role will beglong to biotechnolgoical methods, genic engineering in the solution of these tests. Industrial technologies of agricultural production, based on the utilization of high-efficient machinery, efficient fertilizers, means for the protection of crops and animals against diseases and pests are developed in conformity with the climatic zones of the country. Alongside chemical and microbiological means of crops protection it is envisaged to utilize new physical methods and, in particular, grain treatment by means of electron accelerators.

Vast attention is given in the programs to the elaboration of efficient means for storing agricultural products so as to reduce the losses of worsening of the quality to the minimum. In particular, it is envisaged to employ gas-controlled storage, as well as refrigeration, electronic-ion and other technologies.

A large scope of work is envisaged in the programs for raising the biological value of the foods and expanding their assortment, complex utilization of raw materials and a reduction of losses.

S and T programs have been elaborated and are being realized for improving construction, developing new types of transport and communication, raising the technico-economic level of production and manufactured goods in the major branches of the national economy.

A considerable number of S and T programs deals with social problems. Programs are realized in the sphere of public health with the elaboration of efficient methods and means of prophylaxes, diagnosis and treating malignant tumors, leukosis, diseases of the cardiovascular system, lungs, primary diseases of the mother and infant, new methods of restorative surgery and transplantation. The programs envisage the elaboration of new methods in the sphere of environment protection to prevent pollution of the atmosphere with industrial waste, as well as water reservoirs, effective methods and means of processing solid waste.

Procedures

The drafts of the all-Union programs to be included in the state five-year plan are elaborated by ministries and scientific-research organizations, which are responsible for the respective programs. They analyze the accomplished scientific research and developments, determine the most efficient scientific-technical achievements that can be utilized for the fastest and most wide-scale application of the new technologies, equipment, articles, materials, providing a sharp raise of labour productivity and product quality, an economy of all types of resources.

A program is elaborated for the entire period required for attaining the final aims, with indication of the beginning of mastering the production of the new product and the introduction of advanced technology. The new types of products and technologies by the time of mastering shall correspond to or outstrip by their techno-economic level the most advanced home and foreign achievements. To this end, records of the technical level are elaborated for all the new articles and technologies comprised in the program, with indication of the basic technical and economic indices of the created article (process) in comparison with the existing best home and foreign analogues (projects), the area of planned application of the new articles (processes), their patent purity, eocnomic effect of utilizing the new machinery (technology), limit (maximum limit) price of the article and the required expenditures for mastering the technology. These records are analyzed in the ministries, State Committee for Science and Technology and the USSR State Planning Committee and registered at the All-Union Information Centre for Equipment.

The economic results, i.e. the economy of labour, raw materials, fuel-energy and other resources are calculated for all the new articles and technologies comprised in the scientific-technical program and the annual economic effect of introducing the novelties is determined. These calculations are considered thoroughly, and serve as one of the main criteria for selecting objects of new machinery to be included inthe all-Union programs.

The technical level of the new articles and technologies and their economic effectiveness is supported by the entire complex of required means. Hence, the programs, envisaging the elaboration of new technologies, comprise also targets for developing and manufacturing the required technological equipment, means for mechanization and automation, new materials. The elaboration of new machines is included in the program together with the required materials and completing articles, and the development of new materials - with the technologies and equipment.

The majority of all-Union S and T programs is associated with trying out the novelties under pilot and pilot-industrial conditions, owing to which the programs envisage the construction and putting into effect of respective stands, plants, production. Besides that, the programs comprise targets for setting up leading enterprises or shops, where the novelty will be mastered, and the development of production capacities by means of new construction, expansion, reconstruction or technical re-equipment for increasing the output of new machinery and the application of advanced technologies.

The cooperation of the USSR with the CMEA countries-nmenbers and other countries on the base of intergovernmental and interdepartmental agreements on scientific-technical cooperation is widely represented in the all-Union S and T programs. Problems, associated with purchasing licences instead of our own developments, are considered when elaborating the scientific-technical programs.

Material and financial support of the targets in the S and T programs is effected by the ministires, or by treaties with the direct organizations-customers. The resources are alloted to the executors of the programs in primary sequence by target designation.

The basic targets of the all-Union programs are approved in the State five-year plan of economic and social development of the USSR. The drafts of the all-Union programs e.aborated by the ministries are considered by the State Committee for Science and Technology and the USSR State Planning Committee with the interested organizations so as to coordinate the targets of the programs with the other sections of the plans and resource support. The detailed programs in the full volume are approved by the State Committee for Science and Technology, as a rule, together with the USSR State Planning Committee, and, if necessary, with the USSR Academy of Sciences and the USSR State Committee for Construction.

When the all-Union programs have been approved, they become obligatory for all the executors. The State Committee for Science and Technology, the USSR State Planning Committee, the ministries and departments control the fulfilment of the programs.

Coordinating councils and heads of the programs have been approved by the State Committee for Science and Technology, the USSR State Planning Committee and the USSR Academy of Sciences to support inter-branch interaction of organizational-methodolgoical management of the elaboration of target complex programs, control of technical level and realization of the targets. The heads of programs are the ministers and deputy ministers of the leading ministries responsible for the progams, key scientists.

The head of the program controls the entire complex of work envisaged by the program, participates in determining the executors of the program and the required material, labour and financial resources and capital investments required for its realization, performs operative control of the fulfilment of the targets and measures, supporting the accomplishment of the program, as well as the scientific and technico-economic level of the scientific research, developments and objects of new machinery and technologies. Extensive rights are given to the coordinating councils and the heads of the programs for fulfilling their duties, in particular, in accepting and estimating the results of work on the programs, their resources support, moral and material stimulation for successful accomplishment of the targets in the programs.

The ministries and the USSR State Committee for Science and Technology, as well as the local planning and economic organs, centres of scientific-technical information, scientific-technical public in the union republics carry out close control of the fulfilment of the scientific-technical programs. The Central Committees of the Communist Parties of the Union republics, the provincial and territorial party committees render increasing attention to the programs. The State Committees for Science and Technology reports once in three months to the USSR Council of Ministers on the grounds of the data of this control and quarterly reports of the USSR Central Statistical Department on the fulfillment of the programs. If necessary, the State Committee for Science and Technology proposes corrections and additions to the programs, adds new executors, crates new scientific organizations or reorganizes the existing ones as applicble to changing targets, allots additional means for scientific-research work from the available reserves.

Conclusion

The accumulated experience permits to apply the program-target method more widely for complex solution of scientific-technical problems. Work is carried out continuously for improving the methodology fo elaborating the programs and managing them in the process of realization, bearing in mind intensification of work for determining priority problems, improving analysis and estimation of the technical level of samples of new machinery and technologies. Work is performed on specifying the rights and duties of the heads of the programs, the leading ministries and organizations, improving the support of the programs with the required financial and material resources.

ORGANIZATION AND MANAGEMENT OF FUNDAMENTAL SCIENTIFIC RESEARCH: FORMS AND METHODS OF TRANSLATING RESULTS OF FUNDAMENTAL RESEARCH INTO PRACTICE

INTRODUCTION

Modern scientific and technological revolution has conditioned a number of stable objective trends in the development of science among which the most significant are the scaling up of scientific activities, the growth of expenses necessary to obtain new scientific knowledge, and the increasing influence of science on the economic and social processes. Science has turned into direct productive force of the society producing a revolutionary effect on the technical and technological basis of production. This is acc^mpanied by the growing role of fundamental science the results of which open, as a rule, completely new ways of solving practical problems.

However, the results of fundamental research as such cannot ensure the technological progress. "Materialization" of scientific ideas into new technology presupposes objectively a consecutive realization of several stages, namely applied research, designing and technological developments, creation and testing of pilot prototypes, preparation of industrial production of new articles, all of which constitute an innovative cycle (in principle, however, it is possible to avoid certain stages or ensure their simultaneous realization). Apparently, the duration of this cycle defines dynamics of technical level of production. According to available estimation, reduction of time necessary for mastering scientific and technological innovation by one year can produce a considerable economic effect on the USSR national economy scale.

COMPLEXITIES

Separate stages of the innovative cycle differ considerably by the character and volume of work, the composition of executors and required material and technical means. That is why, it is not practically possible to realize a complete cycle within the framework of one organization, and solution of major scientific and technical problems requires the involvement of a large number

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Presented by V.S. Boytchenko

of organizations (sometimes over 100) belonging to various departments: scientific research institutes of fundamental and applied profile, designing, project-preparation and technological organizations, and industrial enterprises. The coordination of their activities, establishment of efficient links between them in order to maximize fast introduction of scientific results into practice represent the most important aspect of managing S and T progress under modern conditions.

The problem of fast and large-scale translation of scientific results into practice entails considerable difficulties which, viewed as a whole, are conditioned by the discrepancy of a continuous, by its inner logic, process of the transformation of scientific knowledge into material objects of technological progress and the discrete organizational realization of this process. Scientific institutes (academic institutes in the first place) and industrial organizations (designing, technological and production organizations) participating in the innovative cycle have radical structural difference: the former specialized by the branches of science, the latter - by concrete objects. Moreover, the academic and industrial spheres have different systems of planning, financing and management, and their functional aims do not coincide and, in certain cases, enter into contradiction (e.g., mastering of scientific and technological innovations requires a considerable amount of work in preparing design and technological documentation, reorganization of the existing production and so on, which has negative influence on the manufacture of series products). Many results of fundamental sciences have an "interbranch" character and can find the most unexpected application, whereas design and technological solutions laid down in new technology utilize the results from several branches of science. Naturally this creates interdepartmental barriers which make difficult the exchange of intermediate results and, finally, prolong the innovative cycle. The transfer of scientific results from "scientific" to "industrial" stages of the innovative cycle is also hindered by objective complexity, complete novelty and non-traditional character of the solutions suggested by the fundamental science as well as, in certain cases, by the lack of specialist of required qualification in industry. Meanwhile the academic institutes as such cannot translate the obtained results into concrete design and technological developments which could be directly "accepted" by the industry, firstly, becuase they lack necessary experimental and pilot-production basis as well as the designers and engineers of their own, and secondly, because this work does not correspond to the major tasks of the fundamental profile of the institutes.

Thus, the acceleration of innovative cycle demands the creation of such organizational system of integrating science and production in the framework of which it would be possible to ensure a clear-cut orientation of all activities aimed at a common final goal taking into account the specificity of the participating organization and cycle stages, establishment of flexible "direct" and "feed-back" ties between scientific institutes and industrial organizations, and the most efficient utilization of their scientific-technological and production capacities. Concrete forms of such integration are defined by the peculiarities of the existing system of organization, planning and management of the fundamental science in a country. In case of the Soviet Union this peculiarity consists in the fact that a major part of fundamental research is concentrated in the institutes of the USSR Academy of Sciences and academies of sciences of the union republics, and there is also a powerful S and T capacity represented by research, designing and technological industrial organizations.

ORGANIZATIONAL FORMS

For the time-being one may outline four major organizational forms of integration of science and production:

- large long-term strucutural forms of relations (scientific-production associations, "belts of introduction", scientific-technological centres, academic scientific-technological associations);

- short-term forms of relations between the organizations participating in an innovative cycle and belonging to various departments (programmes, coordination plans, economic agreements, agreeements on scientific-technological collaboration);

- task groups created to solve particular scientific-technolgoical problems (technological laboratories, scientific-technological centres);

- planning and informative interaction with flexible organizational subordination (specialized organizations for introduction of new technology, pilot-experimental stations).

The development of the above organizational forms of integrating science and production reflects modern trends in planning and managing S and T progress aimed at maximum efficient utilization of scientific capacities in solving economic and social problems.

Now let us consider some of the organizational forms of integrating science and production which have received wide recognition.

<u>Academic scientific and technological associations (ASTA)</u>

ASTA represents a single scientific research complex which includes all stages of the innovative cycle: fundamental research-applied research-pilot production-introduction. ASTA is oriented towards the elaboration, development and practical mastering of completely new technologies. It comprises large well-equipped research departments and laboratories, experienced design and technolgoical bureau, experimental production and pilot industrial enterprises.

This structure has the following major advantages:

- mobility, ability to change its organizational ties, create complex groups of scientists, engineers and technicians for solving scientific and technological problems and realization of target programmes;

- organizational provisions for a closed innovative cycle (fundamental research-design development-pilot testing) which guarantees a high degree of completion of developments and their fast realization in production; a development is considered to be completed only after its introduction in production;

- development of new technological processes and types of new machines is carried out with direct participation of the authors-researchers whose ideas are implemented in innovative which accelerates considerably the transfer of new technology prototypes to production;

- existence of powerful modern pilot-expermental basis for testing and improvement of scientific-technological innovations and their translation into concrete machines and technological processes;

- elimination of departmental barriers by means of concentrating ample responsibilities in the ASTA "scientific link". This results in the possibility of exercising a direct influence on the topics of scientific research and the volume of manufactured produce, quick introduction of new methods, undelayed provision of equipment and materials required by all ASTA units;

- average two-fold shortening of new technology mastering period by excluding a long and labour-intensive stage of creating semi-industrial installations. A vanguard prototype is manufactured right away followed by transition to its industrial mastering.

At the same time the coordination of activities of the organizations within the framework of ASTA which differ by their structure, rythm of operation and the results obtained, poses serious problems. Successful functioning of such complexes is possible under condition when the organizational unity of all their links is reinforced by meticulously elaborated and strictly

implemented procedures of "through" planning, financing and stimulation accompanied by the provision of "capacity" conjunction of scientific research, designing, technological and production organizations.

2. <u>Interdepartmental target scientific-production complexes (ITSTC)</u>

These complexes which are often formed at a regional level include scientific research institutes, both fundamental and applied, higher educational establishments, designing organizations and industrial enterprises belonging to various departments. Unlike the ASTA where all the activities of the constituent organizations are planned centrally, the interdepartmental target complexes represent a form of cooperation of independent organizations which allocate a part of their resources for joint solution of a concrete scientific-technological problem or execution of a target programme. Interdepartmental laboratories, set up on the basis of academic institutes or industrial enterprises and using common material-technical and human resources, represent a nucleus of ITSTC. Every organization which intends to participate in the activities of such laboratory, renders required specialists, monetary funds and equipment. The academic institutes ensure scientific guidance of these laboratories. Through the Academy the respective departments receive financial resources and labour quotas required by the interdepartmental laboratories.

The main goal of creating the complexes consists in ensuring favourable conditions for the coordination of efforts of organizations belonging to various departments aimed at the manufacture of new produce; for interdepartmental "through" planning; and for translating the research results into practice by means of efficient coordination of work plans of all the participants with due attention to their interests. Thus, the complexes ensure,

- for academic institutes : most active introduction of the results of fundamental and applied research in production;

- for scientists of higher educational establishments : access to modern equipment of academic and branch institutes and enterprises;

- for designing, project and technological organizations : ample possibilities for realizing scientific ideas in concrete developments and their rapid practical application;

- for enterprises : creation of entirely new technology, mastering modern technological processes and the improvement of product quality.

3. Scientific technological complexes (STC)

STC consists of an academic institute a special designing bureau (SDB) and a pilot production attached to it. The academic institute plays a dominating role in STC. It concludes agreements with "outer" customers and, upon finishing the research stage of work, passes the results to SDB. This reinforces actual influence of the institute on the formation of subject areas. The institute is also a "holder" of a mjaor part of instruments and equipment used in the framework of STC. The ratio of work performed by the institute, SDB and the pilot production is 1:0.7:0.2. This creates possibilities for improving material and technical provisions for R and D activities.

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Joint development of all integral parts of STC has appreciably changed the character of its final "produce" increasing the number of finished designs of new technology and adjusted technological processes which can be directly "accepted" by the industry. Correspondingly, among the customers there is a growing number of enterprises which receive innovations ready for industrial application which in turn reduces the share of branch scientific research institutes which traditionally played an intermediate role between the academic science and production (the presence of this intermediate link very often resulted in prolognation of the innovative cycle).

Thus, the creation of STC makes it possible for the academic institute to solve three major tasks, namely:

- to accelerate the development of pilot prototypes of new technology;

- to organize their "direct" introduction in industrial enterprises by-passing branch institutes;

- to reinforce and renew its proper technical basis of research.

4. Problem-oriented scientific research branch laboratories

Problem-oriented scientific research branch laboratories are created on the basis of an academic institute or industrial enterpriese. Scientific and methodological guidance of such laboratories is performed by the institutes, whereas their finanacing and material and technical supplies comes from the branch ministry.

The necessity for creation of such laboratories is conditioned by the fact that in certain areas of S and T progress the branch scientific research organizations lack fundamental and applied research potentials, typical for academic institutes. At the same time the problem-oriented scientific research branch laboratories solve problems which as a rule, surpass the possibilities of academic institutes,which lack adequate experimental and pilot production bases. Thus, the creation of laboratories makes it possible to use directly the newest results of academic science in solving practical problems exploiting the material and technical resources of the interested branches. In this respect an important positive significance is attributed to the feedback: the work of such laboratories allows to widen the scope of fundamental research carried out by the academic institutes in a needed practical direction (very often solution of concrete applied problems gives impetus to a birth of new direction of fundamental research).

It is considered that this form of ties between academic science and production has peculiar prospects in case of mass introduction of high-efficient scientific innovations. It has been practiced on a large scale in the Ukrainian Academy of sciences with the creation of 40 problematic scientific research branch laboratories.

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5. <u>"Belt of Introduction"</u>

"Belt of Introduction" is a complex of designing and technological organizations subordinated to various departments and grouped around one or several large academic institutes in order to translate into practice in respective branches the results obtained by fundamental research. The organizations comprised by the "belt of introduction" are characterized by double subordination: their financing and administrative control lie with the respective ministries whereas scientific guidance is assured by the academic institutes. As a whole these organizations of double subordination are oriented towards the solution of problems set in front of them by the academic institutes.

The organizational structure has the following major advantages:

- owing to the double subordination to the academic institutes and industrial enterprises the departmental dissociation has been reduced and, consequently, the procedure of coordination of scientific results, while passing from one stage of the innovative cycle to another, has been simplified;

- joint financing of plans has resulted in the coordination of interests of the academic institutes as well as the organizations comprised in the "belt of introduction";

- the organizations of the "belt of introduction" work under direct guidance of the authors of scientific innovations thus shortening the time of manufacturing pilot prototypes and improving their technical and economic parameters.

Meanwhile the creation and functioning of the "belt of introduction" pose several serious problems. Such an organizational structure functions efficiently provided there is a conjunction between its scientific and production parts, in other words, when there is a constant "stock" of scientific ideas which can constitute the basis for designing and technological developments. If this stock is exhausted the ministries tend to load the designing bureaus and pilot plants with series production which reduces the innovative potential of the whole complex. Great difficulties are posed by the absence of clear-cut jurisdictinal and organizational regulations governing the interaction of the designing bureaus and pilot production units of the "belt of introduction" and the academic institutes which would take into account the specificity of all integral parts of the complex and minimize departmental barriers.

In order to accelerate the mastering of scientific and technological innovations it is expedient tc include in the "belt of introduction" not series but specialized designing bureaus and pilot production units which would constantly have reserve of production capacities to be used for the "materialization" of new ideas.

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6. Interdepartmental plans for joint activities

Such plans regulate joint activities of academic institutes, higher educational establishments, branch institutes and enterprises in the field of R and D and introduction of S and T achievements in production. Regional science and technology centres for coordination of scientific research have constituted the basis of this system. These centres solve methodological, organizational and operational problems of scientific-technological cooperation of the participating organizations for whom the fulfilment of interdepartmental coordination plans is obligatory. The main feature of these plans consists in the fact that they include only those subject areas which are related to creation of entirely new technical and technological solutions. The coordination plan assignments are taken into account while elaborating current and long-term plans of the respective ministries and departments which guarantees allocation of material-technical, financial and human resources for their excention.

The practice of working out the interdepartmental coordination plans is widely used in the field of chemistry. The realization of these plans has made it possible to ensure a higher level of coordination of the participants' activities, timely provision of necessary resources for all stages of the innovative cycle and, consequently, a considerable shortening of its duration.

A typical feature of the aforesaid forms of integration of science practice consists in strict organizational fixation of the innovative cycle participants. This guarantees a considerable time shortening of industrial mastering of the scientific innovations due to elimination of departmental barriers and certain intermediate stages. At the same time, the creation of such complexes requires, as a rule, a considerable reorganization of activities of the participating agencies, changes of the existing system of departmental planning, financing and management. However, the practice has exposed the need in more flexible forms which would allow, without breaking the existing organizational structures, to combine the participants belonging to various departments in a single organizational mechanism for a period necessary for solving a concrete scientific-technological problem.

7. Scientific-technological programmes

Programmes are considered to be a modern dynamic form of management of S and T progress in the framework of which all stages of the innovative cycle are realized. They allow to concentrate efficiently the efforts of scientists, designers and production workers aimed at the achievement of a definite goal - development of new technologies and their speedy translation into practice. Programme elaboration and realization signify a transition from planning activities to planning results, and from the coordination of activities of scientific and project-designing organizations to the provision of a complete "research-production" cycle.

Let us consider the practice of formulating and executing scientific-technological programmes. Scientific-technological programme is a directive plan document envisaging a complex of measures referring to various spheres of activity (scientific, project-designing, production, construction) accomplishment of which is required for the solution of major scientific-technological problems and wide application of S and T achievements in practice. The programmes envisage the provision of required material and technical resources, definition of major executors and the accomplishment dates for the work forseen. The programmes are aimed at the development and mastering of such technologies which would result in a considerable increase of production efficiency.

The programme approach is applied at all levels of the state planning and management, and the scientific-technological programmes are formulated at four levels proceeding from the scope of problems being solved and the spheres of application: all-union, republican, branch and regional levels. The targets of these programmes are approved and provision of all kinds of resources for their implementation is made in the state plans of respective levels. All-union scientific-technological programmes which are formulated for a five-year period as an integral part of the state five-year plan of economic and social development are being planned, controlled and managed by the central government bodies. 171 such programmes were approved for 1981-85 period.

All-union scientific-technological programmes are subdivided into target scientific-technological programmes (41 programmes) and programmes designed to solve major scientific-technological problems (130 programmes). A distinctive feature of the target programmes lies in the fact that they envisage not only the mastering of new technologies but also their series production on a given scale.

Every assignment envisages a stage-by-stage fulfilment of the whole complex of work during the planned five-year period. In particular, assignments for the development and introduction of new machines, devices and equipment envisage the following stages: scientific research, prepartion of technical documentation, development and testing of pilot prototypes, correction of documentation and preparation of production, production of installment series of a given volume, and organization of series production by volumes specified for each year. For this the central body approves methodological documents regulating the fulfilment of stages and assignments and the procedures of transfer of the intermediate results to a customer or leading organization. For the second level assignments and stages, the direct executors (industrial enterprises, scientific institutes, etc. with indication of departmental subordination) are defined one of which is designated as a leading organization with the respective responsiblities for coordination of the activities of other executors and for the final result. The programme activities of all the organizations-executors are financed from the budget of the respective ministry or department.

The Academy of sciences plays an important role in programme formulation and accomplishment. The scientists have identified the most important scientific and technological achievements ready for practical utilization, have defined the priority areas for S and T development, have evaluated economic prerequisites and consequences of new technology and have outlined the problems requiring programme development.

To ensure interdepartmental activities during the implementation, phase coordinating councils are being organized which are headed by the programme leader. This role is usually performed by leadinq scientists or executive heads of leading ministires.

The programme form of organizing complete innovative cycle (including series productin stage) has the following major common advantages:

- coordination and selection of programme targets having economic and social significance expressed in their planned results;

- strict orientation of the whole problem solving process towards the achievement of final goal;

- accurate estimation of the required resource expenditures and the duration of programme implementation;

- efficient control over the major elements and indices of a programme allowing timely exposure of deviations and introduction of measures for their elimination (including programme discontinuance).

The experiences gained through practical application of the programme method shows that:

- it increases the number of successfully completed developments within the planned time limits;

-it leads to a considerable raise of the expected economic and social effect (sometimes by 1.5 to 2-fold);

- it allows to shorten by 2 - 2.5 times the periods of development and mastering new technology.

However, the programme management is far from using all its potential in practice. It is possible to increase its efficiency, first of all, by:

- more thorough selection of scientific-technological problems to be solved with the programme method taking into account scientific, economic and social significance of the expected results as well as actual possibilities of providing the required resources;

- reinforcement of the role and responsibilities of leading ministries and organizations as well as coordinating councils;

- more efficient conjunction of programme assignments and branch plans for production, capital construction and material-technical supplies;

- shifting to target provision of all programme stages with necessary resources concentrating them in hands of programme coordinating council.

8. Economic agreements (contracts)

Economic agreements between the academic institutes (or higher educational establishments) and the branch organizations for carrying out concrete R and D activities represent one of the most efficient and widely spread forms of ties between science and production. They are being used at all stages of the innovative cycle. In the past 10 years the share of financing the academic science through economic agreements in the total volume of financing increased almost three-fold.

This form of ties has the following important advantages:

- owing to scientific research carried out under economic agreements the scientific organizations become more interested in fast and efficient utilization of the results in practice; this also renders additional possibilities for verification of scientific ideas and theoretical developments directly under industrial conditions followed by their transfer for large-scale practical utilization;

- economic agreements accelerate the process of transfer of scientific resulsts by using material and technical base of an organization-customer (industrial enterprises, designing bureaus, branch institutes);

- obligations stipulated by economic agreements stimulate the researchers to perform their work reliably and in time.

There is quite a number of examples of wide and successful practical use of this form of ties.

Among certain drawbacks of economic agreements and unsolved problems one may indicate the following:

- the industrial enterprises-customers often pose before the scientists trivial, particular tasks trying to find solution of concrete production problems;

- themes of work carried out under economic agreements effect the general subject-area of academic institutes which may result in the reduction of fundamental research activities due to diversion of the researchers for purely applied short-term work;

- in certain cases the juridical regulations of economic agreements do not ensure the protection of authors' rights of the researchers for initial theoretical results which form the basis of further applied research and development;

- often the economic agreements do not envisage the possibility for scientists to participate in final stages of the innovative cycle as the utilization of research results is carried out and financed by the customer;

- as a rule, the economic agreements strictly regulate the use of resources allocated for research. These resources cannot be used either for material stimulation of the institute personnnel, or for hiring additional researchers to carry out the work stipualted by arrangements, or for acquisition of the necessary equipment above the fixed limits.

The economic agreements ensure mutual interests of the participating parties as the academic institute receive the experimental basis for their research and the enterprises-customers-the solution of a concrete production problem. The economic agreements play a significant role under modern conditions of science development when the academic institutes experience the shortage of pilot production units, testing stands and expensive scientific equipment. However, not being a plan document the agreements do not oblige either the customers to guarantee introduction of scientific innovation or the executors to participate in it.

That is why it is necessary to improve this form of ties by reinforcing the role of economic agreement as a plan document obligatory both for the executor and the customer entailing corresponding sanctions for its unfulfilment.

9. Agreements on creative cooperation

Agreements on creative cooperation in carrying out R and D activities are concluded, as a rule, for a long term in order to regulate inter-relations and duties in the process of joint work representing common interest. Agreements of this type neither constitute juridical documents nor contain plan and economic assignments with corresponding financing. The work under such agreements is based on the principles of moral stimulation.

At present the practice of concluding agreements on creative coopration between groups of the interested academic institutes and the whole branches of industry is being widely used.

However, these agreements do not presuppose any provisions enacting a penalty on the executor for violating the assumed obligations. That is why it is deemed expedient to use this form of ties mainly in preliminary stages of fundamental and applied research characterized by a high degree of uncertainty of results and ways of their achievement. Later on one may procede to the conclusion of economic agreements.

10. Complex creative groups

Complex creative groups are composed of scientific workers, designers and production engineers to solve concrete scientific and technological problems encountered in production processes and to execute target programmes. The provision of material-technical and financial resources for functioning of these groups is envisaged in corresponding plans and is done, as a rule, by the branch organizations (institutes, designing bureaus, industrial enterprises). Planning of research and scientific guidance is assured by the academic institutes. The principal index of work performed by a complex creative group is the submission of completed developments to the customer in present time. After termination of its assignment the group is either dissolved or reformed for new assignment.

Major advantages of compelx crative groups consist in the following:

- such groups comprise of specialists of all organizations directly working on a given problem which makes it possible to cut down financial, material-technical, time and labour expenses during industrial mastering of new technology as all requirements of the participating organizations are taken into account;

- the work programme of complex creative groups is approved by the ministry interested in resolving a given problem which eliminates many difficulties when the results are being introduced in production process.

Using this form of ties the academic institutes receive the possibility of approving the scientific research results under industrial conditions, studying the specificity of production and concrete conditions of application of the fundamental research results. In industry it allows to accelerate reorientation towards the solution of concrete tasks in the field of new technology development, to shorten the time of introduction of new ideas in production, to raise scientific-technical level and qualification of personnel. This form of ties acquires a particular importance in solving major problems in modern science-intensive branches of production (radioelectronics, electrical engineering, chemistry, instrument industry, etc.).

The experience of work of several complex groups created at scientific-production associations in the past years shows that owing to certain organizational measures there has been a considerable growth of general economic effect resulting from the introduction of new developments as well as the economic effect per a rouble of expenses from completed and introduced innovations.

However, it is still necessary to find a final solution of the problem of planning and management of complex groups related to material encouragement of all their members on the basis of economic and other results of their work and personal contribution.

11. Temporal S and T laboratories

This form of relations allows to raise personal interest of the leaders of academic institutes and prominent scientists in the realization of their scientific ideas.

Temporal S and T laboratories are organized for a period of three years on the basis of academic institutes to accelerate translation of their research activities results into practice. The laboratories are responsible for carrying out experimental and design work and development of entirely new pilot instruments, materials and technological processes on orders from the ministries and departments.

The provision of labour and material-technical resources for such laboratories is assured by the institute budget as well as the organization-customer. The work is usually performed by scientific personnel, engineers and technicians of the institute who remain in the staff of their structural unit-laboratory, department, etc. They execute the temporal laboratory assignments above the plan of their everyday research activities. For holding of more than one office and the increase of work load resulting form the participation in the activities of temporal laboratories this personnel receives extra bonus amounting to 30% of normal salary (with due account of the volume and quality of work). Temporal laboratories perform their activities using the experimental, production and material-technical infrastructure of the academic institutes or organizations-customers.

The analysis of the activities performed by temporal S and T laboratories of several institutes of the USSR Academy of sciences has allowed to reveal the following advantages:

-simultaneous execution of fundamental research and experimental designing activities makes it possible to shorten the time of translating the scientific results into practice and developing entirely new prototypes on the basis of research results obtained by the academic institute (in certain cases this time has been shortened 3-4 fold and the economic effect from the acceleration of experimental-designing development has increased by 1.5-4 times);

- scientific workers get the possibility of combining their principal work with the above, the plan activities remaining in the staff of the principal structural unit;

- researchers receive the possibility of working over the innovations of their own;

- possibilities of using material-technical infrastructure of the organization-customer.

12. S and T centres for introduction of new technology

As a rule, such centres are created on the basis of large industrial enterprises and include, apart from the engineers and technicians of designing and technological units of the enterprise, collectives of scientists of academic institutes (or higher educational establishments). This form of cooperation ensures rapid complex modernization of machines and technolgoical processes without considerable capital investment. The staff of scientific organizations is used not only during the development stage but also during the creation of experimental prototype, pilot running of new technology and its introduction in mass production.

The activities of S and T centres are characterized by the following features:

- the cooperation of academic institures and industrial enterprises is organized on the basis of plans envisaging the elaboration of five-year complex programmes of cooperation indicating the scope of work, dates and executors;

-elaboration of requirements to be met by the results of scientific research of the academic institutes and qualified assessment of practical prospects of this or that development;

-every service of the centre has its production infrastructure and is responsible for the introduction of scientific-technological innovation;

-the single working body (headquarters) ensures general guidance of joint development of complex programmes; it consists of specialists and leaders of the academic institute and industrial enterprise;

-complex technico-technological teams with the participation of scientific organizations are formed at the stage of the development of experimental prototypes which allows to coordinate the interests of the customer and executor. This also shortens the period of introduction of new technology in production;

-direct contacts of managers and specialists of scientific, designing and technological services of the enterprise with the leading scientists ensure that new and reliable information on valuable scientific ideas reaches the enterprise before it is published, in other words 1.5-2 years earlier than through ordinary channels, which accelerates their use.

These forms of cooperation are mainly oriented towards unitary introduction of new technology and not mass circulation of the newest achievements of science and technology in the national economy.

13. Specialized "introductory" organizations

In certain cases it is expedient to set up specialized organizations that would introduce and circulate in masses new scientific developments on the contract basis (as contractors or sub-contractors).

Initially such "introductory" firms were set up on the basis of self-accounting which invited their personnel on part-time arrangements. These firms rendered their mediation services in preparing technical documentation and experimental prototypes of new technology, identification of enterprises interested in a given scientific development, provision of necessary organizational measures for industrial mastering of the proposed S&T innovations.

With time some "introductory" firms have evolved into powerful new technology introduction associations having at their disposal scientific research laboratories, designing and technological bureaus, production-experimental basis and pilot production units. The structure of such a complex allows to absorb a borrowed scientific idea at any stage of its completion and develop it for its introduction in mass production.

The analysis of modern trends in the development of organizational forms of science and production integration allows to draw the following conclusions:

1. The large-scale scientific activities and the growing role played by S&T progress in the intensification of production for the achievement of major economic and social development goals call for the acceleration of transformation of new scientific knowledge into highly efficient machines and technological process and their wide introduction in practice for solving major planning and management tasks at the level of individual organizations and branches as well as at the state level.

2. Under conditions of the socialist planned economy there have been created most favourable economic and organizational prerequisites for the formulation of single S&T policy, efficient coordination of activities of all the participants of the innovative cycle, centralized provision of necessary resources and mass production of the most prospective prototypes of new technology.

3. A great number of concrete organizational forms of science and production integration reflects the multiplicity of influence of scientific results on production processes; testifies that there are wide possibilities and reserves in this field; and demonstrates an active search for planning and management structures adequate to specificity of development of individual science areas as well as specificity of the industrial branches.

4. The described forms of integration of science and practice have a beneficial features such as: their effoerts towards the most efficient joint use of scientific, technological and production potential of the participants; fostering mutual interests of scientific, and design organizations and industrial enterprises for rapid achievement of final results; eliminating departmental barriers and certain stages of the introduction cycle; and higher flexibility of planning, financing and management mechanism.

5. Given the enlarged scope and complexity of science and technology problems, their interbranch and interdisciplinary character as well as the necessity of ensuring wide participation of various organizations and enterprises one of the major ways of further improvement of science-production integraton forms lies in the development of the programme-target planning of the innovative cycle.

FORECASTING AND SOCIO-ECONOMIC ASSESSMENT IN PLANNING SCIENTIFIC AND TECHNOLOGICAL PROGRESS IN THE USSR

INTRODUCTION

Under modern conditions of the development of S and T progress every viable system of management of this process should inevitably lean on scientifically substantiated forecasting of science and technology and assessment of their socio-economic effects while formulating its policy. Major tasks of forecasting in the system of managing S and T progress at the national economy or branch level consist in: identification and assessment of general trends in development of separate directions of S and T progress as well as their indicators; assessment of probabilities of acheiving this or that level of technology in various fields and directions of S and T development with due account of intertia of the identified trends; identification of future goals of the development of S and T progress on the basis of more general goals of socio-economic development; forecasting and assessment of variants of achieving the formulated goals from the standpoint of time, required resources and probabilities of achievement; substantiation of choice of planning and management decisions in the system of managing S and T progress taking account of possible socio-economic effects; and, finally, continuous forecasting of the process of fulfilling planning and management decisions. Thus, forecasting is present in all stages of management cycle, from elaboration of grads to their realization.

Major problems encountered in the organization of S and T forecasting at various levels of managing S and T progress reflect its specific peculiarities consisting in the form of scientific and management activities, its place and role in general system of management. These peculiarities include the variety of forecasting organizational forms both in different countries and in any given country.

On the other hand, in forecasting it is necessary to take account of an extremely wide spectrum of various factors exerting

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Presented by V.I. Kaspin

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their impact on S and T progress and determining to a considerable degree the character of its development. Apart from forecasting S and T, it is necessary to foresee the development of economy, social and economic factors, policy pursued by the state and its relations with other countries. At the same time coordination of branch and regional aspects represents a complicated problem of forecasting and managing S and T progress.

The problem of socio-economic assessment of new technology and consequences of S and T progress represents an important integral part of scientific and technological policy and planning S and T progress. The importance of its solution corresponds to those difficulties appearing during this process. This is conditioned, on the one hand, by an extreme danger of negative social effects of S and T progress for the desting of countries and humanity as a whole and, on the other hand, by considerable difficulties in modelling and forecasting socio-economic processes and their relations with S and T progress.

METHODOLOGICAL PROBLEMS OF MODERN FORECASTING

Forecasting, being a relatively young scientific discipline, is in a process of accelerated development of its proper theory and methodology which is closely related with the problems of planning S and T progress and social development. In this respect the methodological problems of forecasting should be considered in a complex manner uniting methodological aspects of forecasting with organizational aspects of its utilization in planning and management as well as with the efficiency of forecasting. In our opinion the totality of modern forecasting problems can be represented by the following structural scheme:

Forecasting subject	Contiguous problems	Forecasting object
Aims, concepts, principles of forecasting	Classification & choice of forecasting methods	Analysis and synthesis of forecasting object
Forecasting terminology	Complexing of methods and elaboraion of methodology	Provision of information for forecasting
Methodological apparatus of forecasting	Forecasting verification	Realization of forecasting results
Mathematical apparatus of forecasting	Creation of forecasting systems	Evaluation of forecasting efficiency
Organizational problems of forecasting		

The given scheme subdivides all problems into three groups depending on whether they belong more either to forecasting subject or forecasting object or to contiguous problems.

Forecasting subject denotes any organization or a specialist engaged in forecasting.

Forecasting object signifies those processes, system and events for which forecasting is being made. Continguous problems can be solved only as a result of examining any problems belonging to subject or object groups.

Let us try to characterize in an abridged manner the essence and status of the above-mentioned problems.

<u>Aims, Concepts and Principles of forecasting</u>

The problem of aims, concepts and principles of forecasting is a determinant in the activities carried out during forecasting. The category of aim is qualified as an ideally expected result of undertaken activities. In the process of forecasting the problem of aim acquired a duel meaning for a subject. On the one hand, it consists in the elaboration of aims, i.e. identification of the best result within the framework of a system of controlled activities under consideration (from the point of view of an individual, group or society). In forecasting S and T progress this actually comes to the establishment of future social requirements for its results.

On the other hand, this is a problem of setting goals of forecasting <u>per se</u> in the process of achievement of selected aims. Forecasting can be done to establish inertia dynamics of the development of S and T progress and to clarify a possible level of its development in future. Forecasting can also be aimed at the establishment of possible future jumps (breakthrough) in the development of these or those fields of S and T progress, or vice versa, of moments and reasons (resources included) of restricting the development processes. Forecasting can be directed at the establishment of possible consequences (economic, social, ecological, etc.) resulting from the development of S and T progress. Thus, S and T forecasting in planning and management can be considered as an iterative process of identification of something desired, i.e. development aims or trends and restrictions, and elaboration of the most probable alternatives of their coordination in the process of S and T progress.

Principles of forecasting reflect those factures of elaboration of forecasts which are desirable from the point of view of a subject. Without going into details we shall enumerate those forecasting principles which are practiced nowadays: system principles, principle of compliance of normative and searching forecasting, principle of forecasting variance, principle of continuous forecasting, principle of forecasting verification, principle of forecasting efficiency. The essence of each principle can be easily read from its name. The problem of terminology is a problem of mutual understanding of forecasters from various fields and branches of S and T forecasting, of raising the efficiency of methodological and applied forecasts on the basis of common and uniform use of terminology, unification of notions and facility of methodology exchange and their duplication. The first unified terminology was prepared by the Committee on scientific and technological terminology of the USSR Academy of Sciences and published in 1978. It includes over hundred terms and definitions in the following sections: general notions, forecasting object and forecasting apparatus. It also includes equivalent terms in German, English and French as a reference data.

The forecasting terminology evolves constantly and requires clarification and improvement. That is why starting from 1982 we are engaged in preparation of the second edition of forecasting terminology in the framework of the aforesaid Committee. The work will be finished in 1985.

Methologies of forecasts

Problems of methodological and mathematical apparatus of forecasting are closely interrelated and are often inseparable. The adequacy of method and mathematical apparatus is a determining factor ensuring the reliability of forecasting results.

Among statisitical methods the leading place, as to the scope of utilization, continues to belong to extrapolation methods which are being improved to raise the accuracy of approximation functions, their flexibility and adaptiveness to changing conditions (methods of adaptive levelling, methods of harmonic weights, etc.).

In the regression group of statistical methods certain steps are taken to make the models more complicated, more approximated to real objects, more adaptable, to include the man with modelling process of imitation man-computer procedures. There is a tendency of paying greater interest to the use of identified major components of statistical complexes in the group of factor and dispersion analysis methods aimed at improving monitoring of development processes in future.

After elabortion of collective expert assessment with multiple iterative procedure of collecting opinions about two decades ago there have been no significant changes in the field of expert methods. Major progress has taken place in the field of statistical methods used to process the opinion collection results and qualitative-quantitative transformations of evaluations and classification made by experts.

At present the most perspective direction in solving the problem of methodological and mathematical apparatus of forecasting is represented by the elaboration of mixed methods and procedures which stipulate rational combination of creative possibilities of experts and possibilities of modern computers in processing large volumes of statistical information and making high-speed voluminous calculations. Such man-computer modelling and forecasting systems are being actively elaborated in our country and abroad and evidently will become the most effective instrument of forecasting S and T progress.

Organization of forecasting

The problems of organizations of forecasting at various levels and sub-systems of management of S and T development are considered with all detail further on.

In the group of problems refering to forecasting object the major role belongs to the problem of analysis and synthesis. It reflects the importance of analytical research of the object ensuring elaboration of reliable and adequate forecasting model with due account of branch, regional, functional and other specific features of forecasting object. This problem is very closely related to the all afore-said forecasting problems. At the end of the 70s we suggested fundamental principles of methodology for solving this problem consisting of a totality of principles, methods of analysis of structure and dynamics of the forecasting object, basic requirements for informationa and organization of analytical work.

Basic direction of further solution of this problem lies in the development of concrete research for various objects of scientific and technological forecasting at enterprises and in the national economy branches, generalization of these results and further improvement and development of methodological recommendations for practical application in forecasting S and T progress.

Information for forecasting

The problem of information and its provision plays a particular role in forecasting S and T progress due to a great variety of information sources, the necessity of information covering a considerable retrospective period (especially for long-term forecasting), wide utilization of patent types of information as well as the use of expert information with unknown and difficult to assess indicators of accuracy and reliability. Directions in solving this problem are the following. In case of accumulation and processing of large arrays of retrospective and current technico-economic information it is further development of data banks of various levels and aspects which ensure collective access of various subscribes engaged in forecasting in different fields of S and T progress.

In the field of patent information the All-Union state standard and methodlogical recommendations for patent research was issued in 1984 which includes methods of evaluation of technology level and forecasting trends on the basis of statistical processing of patent and firms' information.

At present an automated system of patent ifnormation has been created in the USSR which by 1985 will be able to ensure for the users the possibility of statistical processing and tracking of trends in a given field of S and T development in the world invention beginning with 1920.

Major problems related to expert sources of information mainly consist in the formation of expert group for forecasting with high average competence of its participants, in the preparation of initial information while carrying out inquests to ensure maximum reliability of evaluation results, in finding and realization of incentives conditioning high interest of experts in formulating qualitative evaluations, in the organization of such procedure of work with the experts which would not take much time, be simple and not tiresome for an expert. Collective or individual inquesting with the use of dialogue mode of operation of computers having the necessary volume of all accessible information for a given forecasting problem seems to be a very promising direction of this work.

Efficiency of Forecasts

The problem of realization of forecasting results is closely related to the problem of forecasting efficiency as the possibility of efficiency evaluation presupposes the knowledge of the realization mode of forecasting results and, on the other hand, the selection of realization mode presupposes the possibility of evaluation of its efficiency compared with other variants.

The problem of forecasting efficiency is the most complicated among all problems of forecasting. It is necessary to point out that for the time being there is no methodology for evaluation of forecasting efficiency while the existing methods of evaluation of new technology or automated management cannot be used in forecasting. Here the major difficulty consists in the fact that forecasting as such cannot ensure the economic effect as it is done through management or planning decision taken or the basis of forecasting. In its turn the efficiency of planning decision is determined by multiple factors of active and subjective character not counting the factor of forecast utilization. In the process of realization of planning decision in science, technology or production the efficiency of final result is subjected to the influence of many factors of this process and it is difficult to determine that part which is affected by forecasting in this complicated two-stage process. The major approach to this problem consists in the evaluation of relative efficiency of decisions taken on the basis of forecasting or without it. In this case the efficiency increment obtained in the forecast variant should be refereed to the forecasting expenditures in order to obatin the forecasting efficiency.

According to the evidence provided by foreign economists the profit received from a unit of forecasting expenditures is, on average, twice as much as the profit on R and D expenditures.

Principal form of realization of forecasts consists in their utilization in elaboration of long-term plans and S and T development programmes at branch, regional and national economy levels. THis will be described later on. The essence of the problem comes to the question as to how to use forecasts in planning. There exist the following possible variants: the forecasts (interval) are used for evaluation of planning decisions reality; the forecasts are used for evaluation of limitations of S and T development; the forecasts suggest a number of possible development variants out of which the most preferable variant is selected to form the plan; the result of mating search (intertia) and normative (target) forecasts is accepted to be a planning variant. All variants enumerated above for realization of forecasts are viable. It is necessary to bear in mind that a forecast *per se* cannot be identified as a plan as its probability character and multivariance are excluded after the adoption of a planning decision which has a single meaning, directive character and addressee.

Contiguous problems

A few words on the contiguous problems, i.e. problems located between forecasting subject and forecasting object problems.

The problem of classification and selection of forecasting method is aimed at bringing order into the system of modern forecasting methods and presenting it in such manner that would make it possible to obtain recommendations on the most appropriate class (or classes) of forecasting methods proceeding from the characteristics of object, availability of information, goals and objectives of forecasting. In spite of a considerable number of various classifications of forecasting methods known from forein sources and elaborated in our country for the time-being there is no classification which would meet the afore-said tasks. We have suggested a way-out which is based on the use of a table reflecting compliance between the indicators of information available for a given object and the possible class of used methods. We have also prepared a variant of the single classification of forecasting methods which is now being discussed and evaluated.

The problem of complexing of methods and elaboration of methodologies reflects the necessity of using several methods in elaborating system forecast of an object. The major approaches to its solution consist in the synthesis of statistical forecasts obtained through various methods as well as the synthesis of statistical and expert forecasts to obtain more reliable results. In this field the soviet forecasters have suggested and implemented several effective approaches and methods.

Speaking about forecasting methodologies it is necessary to point out that mainly they are elaborated either at branch level or for regional development forecasting. In the USSR a considerable number of methodological instructions of both types has been elaborated. However, as a rule, they are of temporal character due to constant changes of forecasting conditions and improvement of methods.

In this respect one may cite the "Methodology of joint forecasting of S and T development by interested CMEA countries" which has been elaborated and approved at the interstate level and widely usedin the CMEA forecasting since 1974.

The problem of verification is the complex of questions connected with the evaluation of reliability and accuracy of forecasts. At present there exist a considerable number of verification methods for both statistical and expert forecasting. To our mind the major direction of solving this problem consists in wide introduction of these methods in practice of S and T forecasting as well as in the possibilities of simplification and reduction of costs of verification procedure as in certain cases these costs amount to the volume of forecasting expenditures which slows down its introduction.

Finally, the problem of creation of forecasting systems and of automated forecasting systems, in particular, embraces practically all problems enumerated before. The forecasting system is defined as the interrelated totality of forecasting methods, information, mathematical and technical apparatus as well as group of people united to carry out continuous (periodic) forecasting for solving the problems of planning and management of a given object. Such systems with automated mode of operation constitute sub-system components in the branch automated management systems. In certain branches of the national economy they are already in operation, in other branches they are being introduced. Major directions of solving this problem consist in raising the level of solving all already mentioned forecasting problems, generalization of accumulated experience of operation of such system, unification of methodological and programming soft-ware and expansion of introduction of the forecasting systems in national economy planning.

A brief survey and analysis of major problems of modern forecasting made in this section shows their considerable number and multiplicity as well as different levels attained in solving these problems. It also shows the major directions of efforts to be undertaken by scientists and specialists in the field of forecasting S and T progress.

FORECASTING AND ELABORATION OF COMPLEX PROGRAMME OF S AND T PROGRESS IN THE USSR

This section is dedicated to consideration of the system of forecasting, planning and management of S and T progress at the national economy level.

As a whole the All-Union state system of management of S&T progress is built on a hierarchical principle.

The highest organ of management of the country - the Supreme Soviet of the USSR - is simultaneously the highest organ of management of scientific and technological development; in the Union republics this function is carried out by republican Supreme Soviets. Current management of the national economy and S and T progress is performed by the USSR Council of ministers and the Councils of Ministers of the Union republics.

Planning of S and T progress is carried out by the USSR State Planning Committee (the USSR Gosplan) and by the gosplans of the Union republics. They carry out long-term, medium-term and current (annual) planning.

The USSR state committtee for science and technology implements the single All-Union state policy in the field of S and T progress and utilization of its achievements in the national economy. Its functions include: determination of strategic directions of S and T development; organization and approval of order of elaboration of S and T forecasts for major problems of the national economy; organization and management of elaboration of important intersectoral complex programmes; further improvement of efficiency of scientific research and utilization of its resulsts in the national economy; maintenance of relations with foreign countries in the field of S and T cooperation; consideration of problems of organization of scientific and technological activities in the country; planning and monitoring together with other state departments and ministries of training and improvement of personnel.

The USSR Academy of Sciences and the Academies of Sciences of the Union republics combine the efforts of outstanding scientists and scientific groups and organizations in solving the major problems determining the development of S and T progress, undertake and develop fundamental research, ensure the development ofapplied research directly connected with production, meet personnel, information and scientific requirements of research activities included in the state plans, ensure high level of R&D activities in the country.

Besides this quite a number of state agencies play a considerable role in the process of managing S and T progress in the country: The USSR State committee for inventions and discoveries, the USSR Central Statistical Board, the USSR State Committee on standardization, etc. These agencies have scientific research institutes which ensure theoretical and methodological work in the field of improvement of planning and management of S and T progress including forecasting.

Forecasting and subsequent assessment are necessary for substantitation of the priority directions of S and T development in order to carry out appropriate allocation of resources required for their development at the national economy level. Every adopted development direction can be represented by a totatility of target S and T programmes ensuring its fulfillment. Proceeding from the targets and allocation of resources by S&T progress directions the Complex programme substantiates the necessity of target scientific and technological programmes. Together with the elaboration of S and T development directions the Complex programme also envisages major directions of development and improvement of the organizational structure of the national economy and economic management mechanism which should ensure practical implementation of the Complex programme. In the process of solving all mentioned problems one undertakes the assessment of possible socio-economic consequences of S and T progress both in production and in the field of social development. Long-term S and T policy contained in the Complex programme serves the basis for the elaboration of the first priority measures for their inclusion into the nearest five-year national economy development plan.

As it has been stated earlier methodological and information background of elaboration of the Complex programme is being renewed and corrected with every new elaboration cycle. That is why its elaboration includes the following typical stages: preparation of methodological background, elaboration of forecasts and correlation of previous forecasts, and elaboration of the Complex programme.

Besides already listed organizations a wide number of branch scientific research institutes and planning agencies as well as territorial planning agencies and their scientific research institutes and organizations are participating in the elaboration of the Complex S and T progress programme.

Basis of Evaluation

The comparison of results obtained in the initial variant with the normative evaluated level by directions and indicators makes it possible to identify the lack of their concordance. This serves the basis for determining necessary shifts in the structure, dynamics, directions of S and T development as well as the ensuing requirements for resources, and for evaluation of possible dates of their implementation.

As it can be seen, forecasting constitute the major part of methodology of elaboration of the Complex programme of S and T progress whereas its reliability and accuracy determine, to a considerable degree, the quality and substantiation of decisions incorporated in the programme.

Concretization and further detailing of general S and T development is done in long-term target programmes (LTP). The aggregated document of the Complex programme specific their number and basic principles (projects).

A long-term target programme is the directive and addressed document which respresents assignments, work and measures tied up by required resources, executors and dates, and directed towards solving major problems of economic, social and scientific-technological develoment.

The list of problems to be included into these programmes is formulated on the basis of their national economic significance which is done by preliminary formulation of a full list of such problems for a perspective period and further selection of the most necessary problems taking acocunt of resource possibilities in the coming period. This implies wide utilization of forecasting methods of evaluating the long-term significance of these problems, their priority, and forecasts of input requirements and possibilities.

After selecting the listof problems to be included into LTP the elaboration of basic principles and projects of these programmes is carried out. At this stage using S and T forecasts in the field of LTP the initial assignment is prepared for elaboration of the programme which defines its structure, sub-programmes, general scheme of its fulfillment as well as evaluation of material and financial inputs.

The totality of LTP projects serves the basis for further elaboration of plans and S and T development programmes at the stage of drafting the Principal Guidelines of eocnomic and social development of the country for 10 years.

After the LTP is detailed from the point of view of fulfillment dates, required resources and executors its first priority objectives are included into the state five-year plan of economic and social development.

The elaboration of all sections of the Complex programme of S and T progress is inevitably based on the analysis and forecasting of major development trends in a given field both in our country and abroad, development priorities of separate directions of S and T progress, forecasting and evaluation of input requirements for various directions, problems and programmes, forecasting of socio-economic effects of this or that S and T policy.

Summing up it is necessary to underline the following moments.

The Complex programme of S and T progress represents a concentrated expression of long-term scientific and technolgoical policy of the state. Its complexness is determined, on the one hand, by consideration of totality of S and T progress aspects (scientific, technological, economic, social, etc.) in their interrelation and interaction and, on the other hand, by concordance and coordination in time, space, inputs (resources), executors of its direction, problems and assignments.

The principal instrument of substantiation of the Complex programme consists in forecasting which is present in all stages of its formulation - from formulation of its targets and evaluation of possibilities to assessment of socio-economic effects of its realization.

TERRITORIAL ASPECTS OF FORECASTING AND MANAGEMENT OF S AND T PROGRESS

Territorial aspect of managing S and T progress is a natural addition to the branch form of management. At present more than a half of the country's scientific potential is concentrated in big towns. It is quite natural that the efficiency of management of S and T progress as a whole depends on how effectively is planned and managed this potential.

The biggest centres of concentration of scientific potential are represented today by Moscow, Leningrad, Kiev and Novosibirsk which account for more than two thires of the country's potential.

It is necessary to note a considerable concentration of scientific potential in scientific centres of the Union republics. They act as interdepartmental coordinating agencies whose major tasks consist in further improvement of the system of management of S and T progress in the republics, concentration of efforts on solving vital S and T regional problems.

Target regional programmes of S and T development are the efficient means of scientific and technological progress at regional level. Taking account of regional peculiarities and regional specialisation of science they ensure the most efficient directions of S and T development with maximum utilization of scientific and technological potential. These programmes are oriented towards solution of those S and T development problems which have not been included into branch or state programmes but must be solved at intersectoral level within regions.

For example, the plan of complex economic and social development of Leningrad and Leningrad province for the 11th five-year period envisages the elaboration of 11 target complex territorial programmes. Their integration into a single complex will ensure the formulation of a regional complex programme of S and T development for a period of 20 years covering such areas as effective siting of the productive forces in the region, major directions of concentration and specialization of science and technology, reconstruction of production and optimal distribution of capital investment.

Complex S and T development programmes for big towns are elaborated in such a manner that they ensure the fulfillment of the All-Union branch programmes in the framework of towns. These programmes should assure the contribution of each town into S&T progress of the country with due account of its regional specialization and resource possibilities. On the other hand, they should also ensure scientific and technological progress in the sphere of production and social infrastructure. S and T development programmes of big towns include forecasting of demographic situation and manpower resources, natural resources and environment protection. On the basis of analysis and forecasting of these indicators one formulates major tasks of S and T progress for a perspective and subtantiated basic directions of S and T development of a town. These tasks and directions receive concrete description in draft target programmes of municipal development. In its turn, after elaboration and approval of target programmes the proposals on their first priority measures are included into the five-year plan of economic and social development.

Regional S and T forecasts and regional complex programmes serve the basis for the elabortion of General schemes of siting the productive forces in the USSR as a whole, the Union republics and big towns.

Regional S and T development problems constitute a special section in the Complex programme of S and T progress of the USSR. This section reflects: basic principles of regional scientific-technological and socio-economic policy for perspective, basic direction of S and T impact on the development and siting of productive forces, substantitation of proposals for further improvement of siting and utilization of S and T potential in regions, major S and T programmes planned for implementation in regions, substantiation of directions of further improvement of territorial organization of the national economy.

The regional section of the Complex programme includes the forecasts of major indicators of scientific-technological and socio-economic development of regions, forecasts of S and T effects on the development of industrial branches and agro-industrial complex, forecasts of develoment of social factors and social problems at regional level resulting from S and T progress.

Interconnection of branch and regional forecasts, programmes and plans ensures balanced matrix structure of planning and management of S and T progress on the country-wide scale.

For big towns special complex programmes of S and T progress covering a 20-year priod are worked out.

Such programmes for Moscow contains a system of interrelated forecasts for all major development aspects of the city: development of science, S and T progress in industry, S and T progress in municipal economy, and in municipal power system.

The programme has a special section dedicated to forecasting of socio-economic effects of S and T progres in Moscow which considers problems related to changes in conditions of work resulting from the introduction of new types of technology, changes in social structure and mode of life of population due to changes of conditions of work under the influence of S and T progress, as well as changes of living conditions, leisure, culture, public health, nutrition, etc.

A particular attention is paid to the problem of environment protection on the basis of the forecasts of development of the city's industry and transport.

The section also contains perspectives of developing the technology of purification works and their evaluation from the point of view of socio-economic efficiency, the analysis of water resources and principal directions of water protection measures in perspective.

All ministries and departments whose enterprises are located in the city as well as institutes of the USSR Academy of Sciences and branch research institutes engaged in S and T progress and socio-economic problems have taken part in the elaboration of the programme thus ensuring real complex character of its perspective forecasts.

PROBLEMS OF SOCIO-ECONOMIC ASSESSEMENT OF S AND T DEVELOPMENT RESULTS

Unbreakable ties between S and T development and socio-economic processes are conditioned by the fact that the level of long-term socio-economic requirements determines the objectives and directions of S and T progress whereas S and T achievements determine socio-economic possibilities of the society. In the system of planning the country's national economy this relationship is being realized during the process of coordination of S and T sections in the Complex programme of S and T development of the USSR with the problems of socio-economic development as well as during elaboration of the Basic directions of economic and social development for 10 years. The plans of S and T development envisage the corresponding system of indices reflecting directions of development of new types of produce with the indication of its technological level and the advantages over the existing types of analagous designation, i.e. one determines the possibilities of new produce to meet the social demand.

In doing so utmost importance is attributed to problems related with raising the level of automation and mechanization on the basis of new technology which is oriented towards the solution of vital social problem of reduction and elimination of hard manual labour. In its turn, this exerts a considerable impact on such social processes as improvement of professional qualification of workers, raising their education and culture levels. At present the country realizes a complex programme of mechanization and automation of labour-intensive production processes embracing all branches of the national economy.

In the same manner the Food programme of the USSR upto 1990 has formulated socio-economic objectives and tasks for better provision of population with food products. The realization of these large-scale tasks has required considerable measures oriented towards further improvement of scientific and material-technical base of the agro-industrial complex. Special sections included into the Food programme have defined the directions of development of the material-technical base and reinforcement of role of science in its realization. These sections formulate principal requirements for raising technical level of all types of agricultural technology which should be used in designing new prototypes and modernizing the existing technology. The corresponding sections contain major tasks directed towards the improvement of social and communal services in the rural areas and principal aspects of environment protection. This complex of tasks serves the basis for assessment of new technology and scientific developments in all branches and fields of knowledge which are connected with the implementation of the Food programme.

The major difficulty in carrying out such complicated assessment of new technology consists in great number of criteria and considerable complications of quantitative expression of separate directions of efficiency. Besides, there are considerable difficulties in dividing separate components of socio-economic effect while assessing S and T achievements as any change in production resulting from the innovation will produce interrelated social and economic results. The social results is usually defined as the achievement of targets set by the society as a consumer of new technology, whereas the economic result consists in the achievement of targets of the society in the capacity of an owner of means of production. From the point of view of measurement, the social assessment of new technology is more inclined to physical indicators characterizing, for example, conditions of work, technology comfort, reduction of environment pollution, etc., while the economic assessment is measured by value indicators.

Given the afore-said peculiarities of assessing socio-economic efficiency, in this field the preference is given to comparative evaluation and not absolute. The task of comparative evaluation consists in determining the advantages of a new prototype as compared to the base item or in selecting the best variant among several prototypes of new technology or scientific developments.

One of the possible approaches to this problem consists in setting preliminary admissible limits of social indicators below which the introduction of new technology is considered not feasible or simply harmful. In comparative evaluation there may be various combinations of social and economic efficiency indicators in the process of selecting a preferable variant of innovation. First of all one discards all the variants which do not meet the admissible limits of social indicators (atmosphere pollution, safety of work, noise effects, etc.) Then the remaining variants are grouped by equal social efficiency indicators and evaluated from the point of view of their economic effect. Out of each group one selects only the most efficient variant. After that the remaining variants are grouped again by their economic efficiency and the selection of the bast variant is made on the basis of social indicators. This consecutive procedure is used in case of great number of different variants under evaluation, for example, while making analysis of a morphological matrix in any S and T sphere, to reduce their initial number. However, this approach does not assure the final choice as it may happen that at this stage we obtain variants having different evaluations of economic and social results. This represents the most complicated case of assessment which implies simultaneous comparison and evaluation of variants by different indicators measured by different units. In such a case one utilizes various approaches and methods of evaluation either by bringing the social result to value measuring unit or by model levelling of compared variants by one of the directions of obtaining the desired effect while selecting the best variant by the other.

While using the first approach it is necessary to have a set of indicators making it possible to present all multiplicity of social results of new technology or scientific achievements as economic results. Besides, it is necessary to elaborate methods and means of transforming physical social indicators into economic indicators. This problem is highly complicated and at present it is solved mainly through expert evaluation, analogy method, social inquest and statistical methods.

In the second approach a certain standard level of social results which can be attained with a given type of technological innovation is set. Then all compared variants of this innovation are hypothetically brought to this level accompanied by calculation of total reduced costs of creating of new technology prototype and bringing it to the desired level in all variants at other conditions being equal. The best variant is selected on the basis of minimum costs.

The notion of "damage" is widely used in many approaches and methods of economic assessment of social effects of new technology. Especially it is widely used in economic assessment of S and T progress effects on ecology. On the one hand, every new type of technology should be assessed from the point of view of its damage to the environment, and, on the other hand, various innovations improving environment protection qualities of new technology or special environment protection technology are assessed from the position of preventing possible damage.

In the work the damage is considered by a wide spectrum of its possible sources in the process of interaction of new technology and nature: loss of natural resources, ineffective utilization of natural resources, impact exerted by unfavourable environment on technology wear-out, decrease of production output and quality. As it is seen from this enlarged list the damage must be assessed in a complicated "technology-damage-nature-damage-technology" cycle with possible extension of this chain. Difficulties of economic assessment of the damage which can result from new type of technology are conditioned by the fact that besides the indicated "internal" chain of interaction there may exist many "external" chains of interaction connecting the assessed technology via nature with other types of technology and various production. Moreover, in some branches of these chains the damage can be quite considerable whereas it is utmostly difficult to track all chains and calculate the total damage. In this respect methodological background of solving this problem presently lags behind the actual requirements of modern stage of S and T progress. At the same time, however, the plans of enterprises annually envisage expenditures on environment protection and rational use of natural resources. These data are also present in annual statistical reports of industrial enterprises.

Assessment of new technology variants in the field of environment protection from the position of socio-economic efficiency is done through the comparison of input variants and social output (result). For example, various projects of purification works for discharge water of industrial enterprises are compared by capital investment and prime costs of purification, i.e. by reduced costs, output and quality of purification, volume of discharge water and presence of detrimental impurities. These indicators exert their impact on a wide spectrum of consequences: operation of enterprises-users of water (water supply mains), pisciculture, flora and fauna of coastal regions, use of water basins for recreation etc.

There also exist methods of assessment of diverted damage and its comparison with reduced costs by variants which makes it possible to carry out their evaluation and selection.

Even such a short survey of problems and approaches to their solution in the field of assessment of socio-economic effects of S and T progress shows how complicated they are and how important it is to find their solution. Among these problems one may also cite the problems of forecasting and assessing the impact produced by S and T development on medicine and public health, human psychology, demography, pedagogy, culture, politics, international relations and many other fields. As a rule these problems are being tackled by the corresponding academic or branch scientific research institutes and organizations.

The major work in the field of forecasting and assessment of socio-economic effects of S and T progress is being carried out by the Sociology research Institute of the USSR Academy of Sciences, the Institute of Economics of the USSR State Committee on Science and Technology and the USSR Academy of Sciences, the Central economic-mathematical Institute of the USSR Academy of Sciences as well as by a number of branch institutes.

One might cite quite a number of institutes engaged in forecasting and socio-economic assessment of S and T development in the most important fields. Among them are the Institute of medico-biological problems and the Institute of plant and animal ecology which are engaged in medico-biological forecasting. The coordination of research programmes in this field is carried out by the Scientific council on biosphere problems of the USSR Academy of Sciences which also coordinates research in the field of ecological forecasting and assessment. The All-Union Academy of agriculture named after V.I. Lenin and the USSR Hydro-meteorological centre and the institutes of the USSR State Committee on hydro-meteorology and environment control are engaged in ecological forecasting.

A considerable amount of work in the field of scientific-technological and socio-economic forecasting is done by the higher education establishments of the USSR Ministry of education and the ministries of education of the Union republics. Among them one can name the Moscow state university, Moscow institute of management, Moscow aviation institute etc.

The country's scientific community takes an active part in the elaboration of methodological instructions and forecasting activities in various fields of science and technology and socio-economic development. This work is coordinated by the Committee on problems of S and T forecasting and elaboration of the Complex programme of S and T progress created in 1976 within the framework of the All-Union council of scientific and technological societies. The Committee consists of several commissions: forecasting methods, branch forecasting, regional forecasting, social forecasting etc. The Committee unifies a wide group of scientific workers in many towns of the country performing great and useful work in the field of forecasting and socio-economic assessment during the preparation of the Complex programme of S and T progress in the USSR. This work is done on social free-of-charge basis.

CO-ORDINATION OF BASIC TARGETS IN SUBSECTIONS OF PLAN FOR DEVELOPMENT OF SCIENCE AND TECHNOLOGY AND WITH OTHER SECTIONS OF STATE PLANS

INTRODUCTION

Intensification of social production currently is a basic direction in the development of the national economy, which raises scientific-technical progress to a qualitatively new level in the system of the national economy. Amplification of the role of intensive factors and their effect on the rates and proportions of development of social production are ensured by wide-scale implementation of the achievements of science and technology, active renewal of the products and raise of their technical level, introduction of advanced technology and high-efficient equipment, improvement of production and labour organization.

Two-thirds of the total increment of labour productivity will be ensured in the eleventh five-year period due to the introduction of measures for raising the scientific-technical level of production.

This, in its turn, stipulates higher requirements to the system of managing scientific-technical progress, its ability to select objectively effective economic measures, plan their accomplishment and estimate the results of their introduction.

Planning the development of science and technology is a major link in the state system of managing scientific-technical progress in the general system of state plans. Acceleration of the development of science and technology and all possible application of the achievements of science and technology in the national economy is the basic factor for raising the effectiveness of social production, improving the quality of the products, expanding their assortment for most complete satisfaction of the needs of the national economy in up-to-date means of production as well as the population in consumer goods.

The plan for the development of scienve and technology is directed toward solving the following major targets:

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- development of scientific research primarily in areas determining the future material-technical base of production;

- substantial raise of the technical level, effectiveness of production and product quality on the grounds of designing principally new implements of labour, materials, and technologies, excelling the best home and foreign achievements by their specifications;

- all-round raise of level of mechanization and reduction of manual labour expenses in all the branches of the national economy and industry, support of high rates in raising labour productivity that will ensure a stable growth of social production;

- mastering and introduction of new high-efficient technologies and types of products, also at newly commissioned enterprises and objects;

- creation and introduction of prospective complexes and systems of machines, acceleration of work on designing, testing and mastering the manufacture of machines and equipment for complex mechanization of agricultural production.

To ensure practical realization of these targets the plan for the development of science and technology is elaborated within a series of sections, the following being the main ones:

- production mastering of new types of industrial products;

- introduction of advanced technology, mechanization and automatization of production processes;

- basic indices of technical level of production and of major types of manufactured products;

- economic effect of scientific-technical measures.

Beside that, the plan for the development of scienve and technology comprises assignments for selling Soviet and purchasing foreign licences and prototypes of new articles; standardization and unification of industrial products; financing scientific-research work; training scientific and scientific-pedagogical personnel, etc.

The basic assignments on the fulfilment of scientific-technical programmes are approved in the State five-year plan of economic and social development of the USSR in order to ensure all-round accounting of the achievements of science and engineering in the plans.

Plan for development of science and technology :

The first section of the plan for the development of science and technology, specifying the targets for mastering the manufacture of major new types of industrial products, is formed with consideration of the basic targets of the scientific-technical programmes, as well as of the proposals of the USSR State Committee for Science and Technology, USSR Academy of Science, USSR State Committee for Inventions and Discoveries, USSR ministries and departments, and Councils of Ministers of the union republics.

The second section of the plan for the development of science and technology comprises targets for the introduction of advanced technologies, mechanization and automatization of production processes.

Coordination of these sections of the plan for the development of science and technology is accomplished due to the fact that the entire scope of manufacturing new industrial products during the period of mastering it in serial production is envisaged simultaneously in the plan of the basic production in the natural form. The same order is true for manufacturing products with the application ofnew technologies and equipment.

The indices of the technical level of production and of the major types of manufactured products, constituting the content of the third section of the plan for the development of science and technology, are elaborated taking into account the following:

- the maximum possible rates of growth of the scope of manufacturing high-grade products;
- satisfying the requirements of the national economy on the grounds of raising the technical level and economic effectiveness of social production;
- increasing the specific weight of products of the highest category of quality to the total scope of production;
- reducing the manufacture of products of the second category of quality on agreement with the respective customers;
- increasing the rate of renewing the manufactured products;
- raising the degree of mechanization and automatization of production processes; and
- reducing labour consumption, material and fund consumption of the production.

Beside the basic ones, specific indices are also elaborated, considering the specifics of individual productions and branches.

2650 The indices pertaining to the specifics of a branch shall characterize:

- qualitative and structural changes in the manufactured products (for example, the mean protein content in nutrient yeast, the mean fat content of milk, the specific weight of cement of grade "500" and higher in the total production of cement, the output of gasoline with an octane ratio of 76 and higher, etc.);

- level of technical base in the branch and utilization of equipment (for example, specific weight of oil extraction at automated oil fields, specific weight of heavy-duty freight cars in the stock of freight cars, average unit power of capacity of equipment for manufacturing the basic types of products, etc.);

- material consumption of production (for example, the coefficient of using ferrous metal rolled stock, the specific consumption of fuel for generating electric power, producing cement, etc., the consumption of steel ingots per 1 ton of ready rolled stock, the consumption of normal oil paraffin per 1 ton of yeast, etc.);

- labour productivity in the natural expression (for example, oil, coal, gas extracton per 1 worker, time consumption for the working cycle from the beginning of well construction till putting it into effect, the annual productivity of one worker at lumbering etc.);

- scope of manufacturing products with the application of major efficient technologies and advanced equipment (for example, open-quarry ore extraction with the application of cyclic-flow technology, production of rolled sheets on complex automated rolling mills, complex processing of wood into sawn timber and technological chips etc.)

The results of raising the technical level of production and of the major types of products, are coordinated by the USSR ministries (departments) and the Councils of Ministers of the union republics, - also with the sections of the state plan for the branch. In particular, the reduction of labour consumption is considered in the plan of labour and personnel, the decrease of the prime cost in the plan of prime cost and profit, the economy of materials on account of mastering new machinery and technologies - in the plan for reducing the norms of material consumption.

Considering the new requirements to planning the development of science and technology, economic calculations and feasibility studies become highly important as integral estimates of the effectiveness of scientific-technical measures, which permits to utilize them as an effective tool for forming an economically grounded policy in the area of scientific-technical progress.

Economic effectiveness:

The general estimate of the effectiveness of scientific-technical measures, comprised in the five-year plans, is made by 2650 the value of the total economic effect of utilizing achievements of science and engineering in the national economy.

The annual economic effect is the total economy at the level of manufacturers and consumers of new machinery of all production resources (labour, materials, capital investments), which the national economy receives as a result of manufacturing and utilizing new machinery, and which, in the end, is expressed as an increase of the national income. This index is specified in the five-year plan as a design one and it is used for estimating the contribution of the branches, associations and enterprises to raising the effectiveness of social production, as well as selecting the most efficient directions for the development of science and engineering.

The increment of profit (reduction of prime cost) from the manufacture and utilization of new machinery in the planned period is the approved index of economic effectiveness.

In accordance with the "Methodology (basic principles) for determining the economic effectiveness of utilizing new machinery, inventions and rationalization proposals in the national economy", approved by the USSR State Committee for Science and Technology, USSR State Planning Committee, USSR Academy of Science and State Committee for Inventions and Discoveries on 14 February 1977, the planned increment of profit from the manufacturing of new machinery is determined by the following formula:

$$P2 = (W2 - C2)\,A2 - (W1 - C1)\,A2$$

where:

P2 - is the planned increment of profit;

W2 and C2 - wholesale price (less turnover tax) and prime cost of manufacturing a unit of new product in the planned year;

W1 and C1 - wholesale price (less turnover tax) and prime cost of manufacturing a unit of replaced product in the year preceding the introduction of new machinery;

A2 - volume of production of new product in the planned year.

The planned reduction of the prime cost from the utilization of new machinery in the production processes indicated the absolute reduction of expenditures per unit of product or for the planned scope of work as a result of utilizing more efficient means of labour, advanced implements and production methods.

The direct effect is considered in the calculations of the plan of prime cost, which is revealed in the reduction of technological labour consumption, material consumption and other variable expenditures for production.

The economic effect of the measures for raising the techno-economic level of production, which is expressed in reducing the expenditures for production, is determined by calculating the economy gained from each measure. The total effect is determined by summing up the economy from all the measures.

The economy from all the measures (irrespective of financing sources), contained in the state plans for the development of science and engineering and in the plans for the technical development of the enterprises, is considered in the calculations of the prime cost.

The elaboration of measures for raising the technical level of production, comprising of the introduction of new and improvement of the active machinery and technology, precedes direct elaboration of the plan. In the case of unpreparedness or incompleteness of the measures at the moment of elaborating the draft plan the economy may be determined, proceeding from the planned expenditures for introducing new machinery and normative dates of its pay-back (coefficients of effectiveness).

The calculation will not deal with :

- relative economy formed as a result of increasing the scope of production at the enterprise proper; and

- economy formed by utilizing new machinery at newly commissioned enterprises and objects.

The economy is determined for all the types of expenditures for raw materials, other materials, fuel, energy, wages with extras, and other production expenditures associated with the implemented measures. Depreciation of the new and replaced implements of labour is also included in the calculations. If one or the other measure affects the absolute value of expenditures, which are conditional-constant (for example), the introduction of automatic systems of management and a resulting decrease of expenditures for management), these expenditures are considered as direct ones in respect to the given measure and their change is included in the calculation of economy.

In order to coordinate the economic results of introducing new machinery with the planned changes in the prime cost, it is necessary to determine simultaneously with the annual design economy also its value gained from the moment of introducing the measure up to the end of the year, proceeding either from the scope of work in this period, or from the part of annual economy, pertaining to the calendar time period from the beginning of introduction to the end of the year.

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Impact of specific measures:

Simultaneously, the calculations consider the transient economy from the measures accomplished during the preceding year. The value of this economy is determined as a difference between the annual design economy and its part considered in the planned calculations of the preceding year. The sum of economy may be increased or decreased with consideration of the changes in the scope and dates of introducing individual measures.

For measures, which are planned for a number of years from the beginning of utilization and up to reaching the design power of the leading industrial unit, installation, line, etc., the economy is determined in the annual plan, proceeding from the increment of the scope of work dome by means of the new machinery in the planned year without accounting the scope of introduction before the beginning of the stated year.

Calculations of different types of scientific-technical measures:

Calculations by the factor "Introduction of new advanced technology, mechanization and automatization of production processes" indicate the reduction of expenditures as a result of utilizing major new types of technologies, technological equipment, means of mechanization and automatization for the first time, major new types of economic materials utilized for the first time, as well as expansion of the application of advanced technological processes, technological equipment, means of mechanization and automatization.

The effect of measures, based on the utilization of up-to-date computer engineering, on the prime cost is calculated by the same factor.

The calculations by this factor consider also the economy, forming as a result of creating automatic systems for managing the branches, associations and enterprises, computer centres and subdivisions, as well as putting individual computers and other computing means into effect.

Calculations by the factor "Expansion of scope and improvement of employed machinery and production technology" indicated the economy from all the other measures, except those stated earlier. These calculations, in particular, consider the reduction of expenditures as a result of:

- wider utilization of earlier introduced technical means, including the replacement of equipment, machines and other means of labour at active enterprises by new ones (the manufacture and operation of which has been mastered and, therefore, not included in the plan for the development of science and engineering);

- modernization of equipment, structures and transport means including that done in the course of overhaul:

- utilization of means of "small mechanization": various accessories, attachments, more perfect tools, starting and adjusting devices, etc.;

- partial improvement of the employed technology and production methods, including the introduction of rationalization proposals and foremost experience at individual stages of the production process and operations.

Calculations by the factor "improvement of utilization and application of new types of raw materials and materials" consider the economy forming as a result of accomplishing measures for more rational utilization of raw materials and material resources, which is not indivated in the calculation by the factors stated earlier, including:

- improvement of utilizing natural raw materials, in particular, by reducing its losses at extraction, enrichment and primary processing, as well as most complete extraction of useful components when utilizing complex raw materials;

- improvement of utilizing raw materials in the production process (improvement of cutting out, decrease of allowances for processing, introduction of new recipes);

- utilization of substitutes, more economic profiles of rolled metal, more efficient grades of cement, etc.

- more complete utilization of raw material and material waste in production, recovery of used materials, utilization of secondary heat, etc.

Data on the reduction of norms of consumption of material resources and the plan of measures for their economy are the initial ones for calculations by this factor (as by other factors associated with the utilization of raw materials and materials).

The effectiveness of measures for improving the products and directed toward reducing their material and labour consumption, for example, the utilization of advanced construction materials, reduction of the mass of the machines and equipment owing to rational selection of an optimum design safety margin, improvement of the configuration of the construction with a decrease of their overall dimensions etc., is indicated by the factor "Change of construction and specifications of articles".

The summary economic calculation effect of manufacturing and utilizing new machinery is determined by the formula :

$$E_c = P_2 - E_n I_2$$

where:

E_c - is summary calculation effect of scientific-technical measures in the planned year;

P_2 - increment of profit (reduction of prime cost) from all the measures in the plan of new machinery in the planned year;

E_n - normative coefficient of effectiveness of the new machinery (E_n = 0.15)

I_2 - capital investments (expenditures) for all the measures in the plan of new machinery

When determining the summary economic effect in the composition of the capital investments (expenditures) of the manufacturer and consumers of machinery, the direct capital investments are considered as well as other expenditures for creating and utilizing machinery irrespective of the sources for financing them. These expenditures include:

- expenditures for scientific-research and experimental design work, including testing and field changes in the experimental prototypes (only for new machinery). If the results of scientific-research and experimental-design and projecting work, associated with the creation of new machinery at the level of inventions and discoveries, make it possible in the future to expand considerably the scope of their application, then only a part of the respective expenditures, determined by examination, is referred to the stated measure concerning new machinery;

- expenditures for purchasing, delivering, assembling, dismantling, technical preparation, adjusting new machinery and mastering of production;

- expenditures for replenishing turnover funds associated with the creation and utilization of new machinery;

- the cost of production areas, other elements of the basic funds associated directly with the production and utilization of new and base machinery;

- expenditures for technical measures and plants, preventing negative consequences of the effect of utilizing the machinery on the environment (prevention of environment pollution), as well as on the labour conditions (reduction of production noise, maintenance of normal conditions in the production premises, prevention of traumatism, etc.).

The plans for the development of science and technology are coordinated with other sections of the state plan by means of calculations determining the effect of introducing new machinery on the basic indices, characterizing the development and raise of production effectiveness. The effect is determined with consideration of the planned scope of scientific-technical measures for each year of the five-year period.

The effectiveness of the scientific-technical measures is indicated in the following sections and indices of the plan:

(i) For production

The increase of the scope of production due to the introduction of new machinery:

(a) major types of products in units of measurement adopted in the plan;

(b) output of commercial, pure products (normative);

(c) output of products of the highest category of quality;

(d) increase of the specific weight of products of the highest category of quality in the total scope of commercial, pure products (normative);

(ii) For labour:

(a) raise of labour productivity due to the introduction of new machinery;

(b) relative liberation of industrial-production personnel;

(c) relative economy of wages fund.

The results of introducing measures by the plan for the development of science and technology are considered also when elaborating norms, normatives of utilizing material-technical and labour resources specified for the planned period. The economy of raw materials, other materials, fuel and energy per unit of manufactured products is indicated in the change of the norms of consumption of these types of resources; the economy of labour resources is indicated in the change of labour normatives and norms of labour consumption; the economy of capital investments is indicated in the change of the normatives of fund consumption and specific capital investments.

Alongside the determination of the stated indices of the effectiveness of utilizing machinery, calculations are made of the reduction of expenditures per unit of consumer's effect, i.e. per unit of capacity, power, and other similar indices.

The calculations should be carried out by the elements of expenditures in cost values as well as in natural units of measurement in order to intensify the effect of new machinery on raising the technical-economic indicaes of the articles (reduction of norms of material consumption, energy consumption per unit of power, capacity etc.).

PLANNING OF MASTERING AND INTRODUCING NEW MACHINERY AND TECHNOLOGIES

INTRODUCTION

The planning of science and technology development is a major link both in the state system of managing scientific and technical progress and the general system of state plans. Acceleration of the development of science and technology, and all-round utilization of the achievements of scientific-technological progress in the national economy are important factors for raising the efficiency of social production, improving the quality of product, expanding its variety for the most complete satisfaction of the requirements of the national economy in modern means of production, and the needs of population in consumer goods.

The structure of the state plan of economic and social development of the USSR includes a section "Development of Science and Technology", the indices of which are approved by the USSR Council of Ministers.

S&T development plan is aimed at acceleration of the realization of S&T discoveries and innovations designed to raise the productivity of social labour and the quality of produce, and envisages the elaboration of various indices, beginning with the planning of targets of science and technology programmes down to removing obsolete products from production and replacing obsolete technological processes. The principal form of S&T development planning by the State consists in a five-year plan, which is elaborated proceeding from the targets of national economic development and the Basic long-term directions of S&T development.

Measures planned for S&T development comprise in effect all complex of work related to scientific research, designing and introduction of results into national economy. These masures are specified in five-year and annual plans and are subject to approval at various management levels - in the state plan, in plans of ministeries, departments, union republics, research and designing organizations, in production and financial plans of productive associations and enterprises.

Presented by Y.V. Bryzgalov

MASTERING AND INTRODUCING NEW MACHINERY AND TECHNOLOGY

Mastering and introducing new highly efficient technological processes and types of products, complexes and systems of machines for the mechanization of production processes, and reduction of manual labour costs in the branches of industry constitute an integral part of the S&T development section of the state plan.

The plan for mastering the production of new types of industrial product may comprise:

- targets for mastering the production of new types of machines, equipment, apparatus, devices, constructions, articles and materials, created in correspondence with the Target complex economic and scientific-technological programmes, as well as those to be produced at newly commissioned enterprises;

- targets for introducing into production the results of completed research projects of major national economic significance in compliance with the proposals of the USSR State Committee for Science and Technology, the USSR Academy of Sciences, the USSR State Committee for Inventions and Discoveries;

- targets for mastering the production of new types of machines, equipment and other kinds of new articles created in accordance with the decision of the directive bodies;

- individual targets for mastering the production of machines having general economic application and major types of new articles required for raising the technical level of production in various branches of the national economy, which have been created in compliance with the plans of the USSR ministries and union republics;

- targets for mastering the production of major types of products planned to be sold at licence market abroad, as well as those to be produced according to the purchased foreign licences and prototypes;

- targets for mastering the production of new machines, devices, articles, equipment and materials in conformity with proposals for introducing the results of S&T cooperation of the USSR with foreign countries;

- targets for mastering assembly articles designed for assembling new types of products and supplied in the form of cooperation to enterprises of other ministries with the indication for what type of new produce they have been manufactured;

- targets mastering the production of new types of industrial produce or articles under modernization, as well as assembly articles whose mastering has been started but not finished in the years preceding the planned period;

- targets for experimental-industrial testing of principally new types of articles of major national economic significance, as well as targets for the production of pilot machines and equipment of machine-building industry which full under priority list including manufacturing assembly articles and materials for them.

Criteria for selection of targets

Selection of targets for the introduction of advanced technologies, mechanization and automation of production processes for their inclusion in the draft plan is done on the basis of their economic significance taking into account the following criteria for drawing up the draft plan for mastering new types of industrial products:

- results of elaborating target based complex economic and S&T programmes;

- recommendations of the USSR State Committee for Science and Technology, the USSR Academy of Sciences concerning the utilization of S&T achievements of major significance in the national economy;

- proposals of the USSR State Committee for Inventions and Discoveries for the introduction of major inventions into production process;

- decisions and orders of the directive bodies;

- proposals of the USSR State Committee for Science and Technology and other ministries and departments for solving scientific and technological problems which are being elaborated by the Soviet Union in cooperation with foreign countries;

- proposals of the USSR ministries and the Councils of Ministers of the union republics for including those items in the state plan that, though being elaborated in branch and republican plans, have national significance, as well as recommendations for wide-scale introduction and utilization of S and T achievements of other branches of industry.

The plan envisages also targets for mastering major technological processes for which the selling of licences abroad is planned, and targets for mastering technologies and equipment based on purchased foreign licences and prototypes.

Aiming at ensuring accelerated application of the results of research and technical developments in the national economy, the plan comprises targets for commissioning pilot plants for testing major technological processes.

Means and methods

The tasks of acceleration of S&T progress urge that during the elaboration of draft plans for mastering new types of industrial products and introduction of advanced technologies, means of mechanization and automation of production, special attention should be paid to the creation and introduction of:

- principally new, highly productive, energy-,material- and labour-saving machines, equipment and technological processes whose technico-economic parameters would not yield to the highest world standards;

- automated complexes and systems of machines with complete technological cycles, multioperational equipment and flexible technological complexes based on this equipment and utilizing industrial computerized manipulators;

- new technologies transforming modern production (lazer, radiation and plazma technologies).

This means that while planning new types of industrial products the priority in their mastering and organization of serial production should be attributed to such types of new technology and materials utilization of which would ensure considerable saving of fuel, energy, metal, reduction of labour costs and improvement of quality of products. For example, the introduction of high-capacity power blocks (1-1.2 million Kw per unit) allows to reduce capital construction costs by 10%, specific number of servicing staff by 40-50% and to save up to 3% of fuel.

The calculations and experience show that utilization of one programme-operated industrial manipulator replaces from 2 to 4 workers and increases labour productivity by 2-4 times. Use of tungsten-free hard alloys and powder speed-cutting steels for cutting tools raises the productivity of machine-operators by 15-18% and saves alloy additions (tungsten, moloybdenum). Introduction of high-capacity units and plants, built on the basis of advanced technology, in chemical and other industries raises considerably labour productivity and reduces consumption of metal per unit of product by 7-10% and the cost of a unit of the equipment capacity by 5-15%.

Experiences

The experience of creation and introduction of new technology shows that it is necessary to switch from planning individual types of machines and equipment over to the creation of systems and complex of machines and equipment to achieve full mechanization and automation of major production processes in the branches of the national economy.

In agriculture this is manifested in creation and introduction of complexes of machines to mechanize all processes of cultivation, harvesting and processing of agricultural crops. In machine-building this means creation and introduction of mechanized and automated complexes for metal rolling, coal mining with miners being absent from the forefield; complexes of continuous-operation machines for capping and open air excavation of coal; automated complexes and lines equippped with automatic programme-operated manipulators for machining, punching, painting, assembling, etc; creation of automated enterprises and flexible automated production units capable of timely and comparatively costless readjustement for production of new products.

Attention should be paid to the development and utilization of technologies which ensure full and all-round use of basic raw materials eliminating the environment pollution and use of human labour for low-qualified and hard work.

At present all branches of industries use articles and semi-finished products made by the method of powder metallurgy. In machine-building this comes to construction, friction, ball-bearing and other articles in metal-processing and mining - hard and super hard materials, powder metal tools. The calculation show that 1 ton of metal powder substitutes 1.5-2 tons of ferrous or non-ferrous rolled stock (onaccount of the waste reduction and the increase of durability), saves the labour of 190 machine-operators and eliminate the work of 80 metal-cutting machines.

Metal powders help to solve the problem of protecting metals from corrosion. A new method of plazma pulverization of a thin coating of metal powder increases the corrosion resistance of metal constructions, machines, equipment and parts and hardens the surface of machining.

Application of new technologies is used to increase crude oil recovery form oil-bearing strata by steam and hot water displacement, filling oil wells with water with added chemical agents, etc. The calculations indicate that the recovery of oil increases by 10-13%.

The new types of industrial produce and technology which are included in the draft state plan, as a rule, ought to be elaborated on the grounds of discoveries and inventions, initiate qualitatively new generations or series of products, ensure the solution of principally new technical targets in all industrial branches. In all cases, new produce and new technological processes, when applied, must ensure a significant raise of production efficiency.

While selecting problems to be included in the draft state plan a thorough attention is paid to the technico-economic level of new technology being created so that it does not fall behind the best world standards.

The basic specifications, characterizing the qualitative parameters of machines, equipment, apparatuses, devices, instruments, articles, materials and products, are indicated for every new type of industrial produce which is included in the state plan. The basic technico-economic parameters, characterizing its national economic significance, are indicated for every measure on introduction of the advanced technology which is included in the state plan.

A record of technical level, compiled in compliance with the established form and consisting of information on a complete technical-economic specification and comparison with the best home-made and foreign analogues, as well as indices of economic efficiency and costs, accompanies each article or measure comprised in the state plans.

The record of technical level is utilised for evaluating the technical level and quality of a product, the technical level of a technological process, as well as for analysing the financial, labour and material costs for their invention, manufacture and full mastering.

The information stated in the record of technical level is used for technico-economic backgrounding of the adopted decisions when planning the mastering of new types of industrial products or advanced technologies, as well as solving certain other problems.

The practice shows that selection of new scientific and technological development, formulation of scientific and technical policy of a certain branch of the industry, determination of rates and proportions of STT development should be carried out proceeding from the national economic efficiency. The targets for mastering new types of industrial products and advanced technology, stipulated by the State plan, should be considered as a social order of the national economy, determining the role and place of science and technology in raising the efficiency of social production.

<u>Quality and utility</u>

The nomenclature of technico-economic parameters in the record of technical level, shall contain parameters that are common for all the types of products and technological processes, and specific parameters for groups of similar products and technological processes. The nomenclature of these parameters shall be the minimum necessary and sufficient for adopting decisions at the state and branch levels of management. The nomenclature of technico-economic parameters in the record of technical level, is determined by the leading organization and is obligatory for all the enterprises and organizations compiling records of technical level for products or technological processes comprised in the given group. The established nomenclature of technico-economic parameters shall ensure a comparison of domestic and foreign analogues and characterize the stability of manufacturing quality

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and competitiveness of the evaluated products on the foreign market.

The indices of quality shall comprise:

- basic parameters of designation, determining the utility of a product or technological process (not more than 2-3 parameters). For example, the parameters for machine-building products include productivity, capacity, load-carrying capacity, speed, etc.;

- basic physical parameters (mass, overall dimensions);

- basic parameters of economical consumption of raw materials, materials, fuel and energy, consumption of material resources per unit of produce (ferrous, non-ferrous, metals, raw and other materials), consumption of energy resources per unit of produce (electric power, fuel and other types of energy);

- basic parameters of unification , the coefficient of applicability, the coefficient of mutual unification.

The economic indices shall comprise:

- annual volume of production;

- elaboration costs;

- capital investments for mastering;

- prime cost of manufacturing;

- limit and wholesale price;

- annual economic effect per unit of produce or per unit of scope of application of technological process under conditions of its complete mastering as compared with the existing process;

- costs of mastering the technological process (required for its complete mastering under production conditions, adopted for calculation of the economic effect).

When selecting home-made or foreign analogues for comparing with the planned new product, the domestic prototype is represented by the product whose parameters are calculated for the second year of planned serial production of the product under evaluation, or by the best industrially mastered product abroad, and in case of new technological processes - domestic technological processes mastered by the beginning of the planned period, or foreign analogues. If no analogues are available, the base values of the parameters are determined by the leading organizations for the given type of product or technological process.

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All industrial products which are being newly mastered and contained in the state plans, as a rule, shall be certified only by the highest category of quality with indication of the certification date. This means that plans contain the products, whose parameters of technical level and quality excel the best homdemade or foreign achievements or equal them, determine technical progress in the national economy, ensure a substantial raise of labour productivity, economy of materials, fuel and energy, meet the population demands, and are competitive on the foreign market. These products shall be characterized by stability of the parameters of technical level and quaitly on the grounds of strict observance of technological discipline and high culture of production. The manufacturer shall provide the products of the highest category of quality, as a rule, with prolonged guarantees of reliability, long life and other quality indices. It is necessary to note that the state plans may comprise industrial products that are not certified in accordance with the established order. These products are food products of medical designation, also unique machines and equipment, manufactures in single quantities, large installations of major national economic significance which are included in the state plans for experimental-industrial testing. Certification of newly mastered products shall be performed not later than one year, and of highly sophisticated products - not later than two years after the beginning of serial production.

The industrial products whose quality (super or first class category) has not been certified are to be removed from production. Upon the request of corresponding ministries and departments approved by the USSR State Commitee for Science and Technology, the USSR State Planning Committee may allow, by way of an exception, the manufacturing of uncertified produce during a period not exceeding two years.

The annual state plan contain only such new types of industrial products, whose prototypes have been run through the required tests and approved in the established order for serial production, as well as articles, whose testing and mastering is envisaged in the programmes for solving major scientific and technical problems. The plan comprises also large and unique machines and equipment manufactures in single units (hydroturbines and steam turbines, rolling mills, boilers and reactors, installations for oil-refining and chemical industries, ships, etc.) whose testing and commissiong is performed in the process of their industrial operation.

Other measures

The five-year plan envisages the production of new types of industrial products, beginning with the manufacture of the first industrial series subsequently during the years of the five-year period up to their complete mastering. The produce is considered completely mastered if the technology and organization of production ensures the manufacture of products of the planned (proper) quality under conditions of serial or mass production

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and which have gone through state certification (this will not concern products manufactured in single units or small batches). The annual plans envisage the production of each type of these products during the period from the manufacture of the first batch and up to the complete mastering.

The dates of planning the mastering of the manufacture of products by years are determined by the volume and duration of the measures related to the preparation for industrial production of the articles (elaboration of design and technological documentation, manufacture of devices and tools, organization of serial production), as well as by the quantity of articles, whose required volume of production can be ensured only under conditions of serial production.

Henceforth the targets for elaboration, mastering and preparation of the production of new and modernization of the existing machines, equipment and instruments comprised in the five-year and annual plans of economic and social development of the USSR, as well as in the plans approved by the USSR ministries and the Councils of Ministers of the union republics, will be determined proceeding from the differentiated normatives set for the renewal (modernization) of production.

If the date of manufacturing the first industrial series (the principal industrial prototype) falls beyond the planned period, this assignment is included in the state plan with the note "To be continued in the year..." . In this case the ministries and departments shall envisage in their branch plans the concrete volume of production under this assignment for the planned period as well as the measures for preparing the production that will ensure the manufacture of products in accordance with the date determined by the state plan.

The entire volume of manufacturing new types of industrial produce, included in the state plan, during the period of mastering its serial production, is envisaged simultaneously in kind in the production plan.

The measures, evisaged in the state plan for introducing advanced technologies, are planned for the period from the beginning of mastering and up to reaching the full capacity of the leading industrial unit, installation or production line, etc. (in accordance with the specified time of commissioning technical projects adopted in the branch). The entire volume of production based on the application of new technological processes and equipment, envisaged in this section of the plan, is included simultaneously in the plan for the manufacture of given products.

The draft state plans comprise assignments for mastering the production of new types of industrial produce and measures for introducing advanced technology which are preconcerted by the ministries and union republics with the respective consumers and co-executors.

The elaboration of state plans for new types of industrial produce and the introduction of advanced technology is based on the principle of branch planning. This permits to systematize various types of production and technological processes irrespective of branch subordination, ensures the possibility to perform calculations required at different stages and levels of national economic and branch planning.

New types of industrial products in the state plan, are grouped by branches according to the "All-Union classifier of industrial and agricultural products" which is an integral part of the Single system of classifying and coding technical and economic information. The classifier establishes economic specifications for the produce of every branch of the industry and the agriculture which are most essential for the given classification. At each classification stage the produce is specified by a concrete feature.

When elaborating state plans of new types of industrial produce and advanced technology, the application of all-union classifiers for the branches of the national economy allows to use computerized planning processes.

It is not enough to design and introduce new types of technology for raising technical level of production. It is necessary to ensure serial and mass production of new machines on such a scale that would enable efficient re-equipment of the national economy branch, make it possible to carry out the complex mechanization and automation of production processes, and ensure a large scale manufacturing of products through the application of advanced technology.

Consistent application of a system of indices of technical level of production and manufactured articles in planning S and T development constitutes one of important preconditions for the achievement of the highest final results due to the utilization of S and T innovations. The introduction of the system ensures strengthening of planned influence of the State on the improvement of work of the industrial branches and science and technology policy control; the increase of the volume of progressive types of produce; the improvement of technical base of the branches or production; better use of equipment; the expansion in the utilization of principally new and advanced technological processes; higher level of mechanization and automation; lowering of labour-, material- and energy-intensity of production; as well as higher reliability of manufactured goods.

The introduction of the system of indices of technical level of production and manufactured articles permits to switch from the stage of designing, mastering and introducing new types of technology and turn to the stage of reequipment of production on the basis of advanced technology, means of mechanization and automation, as well as introduction of modern technology in the production of major types of products.

However, the system of indices can operate at its full capacity only if it reflects major trends of technical progress in all branches of the national economy; when each and every index provides full information necessary for the determination of general economic effect, expressed in monetary value in kind or in saving of labour; and when it ensures active interrelation of the S and T development plan with other sections of the national economy plan, namely production, capital investment, labour, social development, prime cost and profit.

Highly productive technology, especially in machine complexes or systems, requires a profound organizational restructing in the process of its use, as well as the organization of planning to ensure its maximum efficiency.

The use of numerical programme control machines ensures high productivity of labour and a good quality of products. However, the maximum efficiency of numerical programme control equipment can be achieved only when it is used in groups at production lines or workshops. In other words the problem of automation of management requires higher level of the production organization.

The present number of planned indices of S and T development does not meet the requirements of the national economy in new technology necessary for technical reequipment, reconstruction, mechanization and automation of the existing production, and for the manufacturing of products of proper quality. It is necessary to introduce considerable changes in the contents and aims of the S and T development plans so that they become an instrument for optimum management of proportions, structure, technical level and efficiency of production as well as of products quality. This means that together with the planning new types of products and advanced technology it becomes imperative to control the development of production in order to convert the process of designing and introduction of new technology into a continuous conveyer system.

ALLOCATION OF RESOURCES FOR SCIENTIFIC AND TECHNNOLOGICAL DEVELOPMENT IN THE USSR

INTRODUCTION

Soviet science has played and continues to play a major role in investigating the problems of economic, social and cultural development of the country, and turned into a direct productive force.

S and T Organization

The USSR State Planning Committee and the USSR Central Statistical Department have determined a branch "Science and scientific maintenance" in order to evaluate and plan the development of the scientific potential. In accordance with the existinbg classification of branches in the national economy, the latter branch includes:

1. Organizations carrying out scienti*ic-research work:

   a) academies (except educational ones), scientific-research institutes, observatories, independent scientific-research laboratories;

   b) designing organizations carrying out scientific-research work;

   c) scientific and experimental stations;

   d) experimental fields, supporting and experimental bases carrying out scientific work;

   e) state archieves carrying out scientific work;

   f) scientific organizations for environmental control (reserves, botanical gardens, zoos, and other similar organizations carrying out scientific work);

   g) museums, libraries, book chambers carrying out scientific work. 2650

Presented by A.A. Gorin

2. Designing and projecting organizations (independent ones.

3. Experimental plants that do not manufacture industrial products for sale.

4. Hydrometeorological service.

5. Organizations for geological exploration.

6. Organizations for servicing scientific institutions:

a) prospective exploration of reserves of fish, whales, marine animals and products;

b) experimental fields, supporting and experimental bases (not carrying out scientific work);

c) other organizations servicing scientific institutions (including experimental-technical laboratories, normative-research and scientific-testing stations, central bureaux of technical information, computer centers of scientific organizations, etc.).

A wide network of scientific organizations, scientific-production associations, experimental laboratories and subdivisions, designing bureaux are functioning in the branch "Science and scientific maintenance". Scientific-research institutes and a large number of problem and branch laboratories are functioning at many universities and higher educational institutions.

It is necessary to note that the total number of those working in the branch is increasing continuously. The average rate of increment of the number of those working in the branch exceeded that of workers and employees in the national economy by 1.6 times in 1966-1980. About 4.5 million people have been employed in the branch by the end of 1983.

RESOURCES

An increase of expenditures for the development of science can be illustrated by the following figures: the expenditures for science from the state budget and other sources have increased in 1983 as compared with 1960 from 3.9 billion roubles to 25.6 billion roubles, i.e. increased 6.6 times. The material-technical base, one of the components of the scientific potential, is also developing at a high rate. An analysis, made by some economists at scientific-research and designing organizations of individual branches of the extractive and manufacturing industries, had indicated that the average increment of the capital funds in 1971-1980 was approximately 9-10%, and the average annual increment of their active part was 12.2%. The part of computer facilities in the capital funds increased 3 times.

The result of scientific research and developments depends greatly on the level of scientific-technical information (STI). The acquisition, processing and presentation of the required scientific-technical data under modern conditions to the interested organizations with sufficient operability has demanded the creation of a powerful information base of science.

About 20,000 organs of scientific-technical information are fucntioning today in our country, including 10 all-union, 15 republican, 87 central branch and 111 interbranch territorial organs of scientific-technical information.

The development of the scientific potential requires considerable financial resources, which is associated with the expenditures for renumeration of the workers in the branch "Science and scientific maintenance", and for maintaining the existing scientific-research institutios and organizations, experimental bases and units, as well as for supplying them with up-to-date scientific equipment, experimental bases, and for creating large technically equipped plants.

Thus, the financial resources of science include means from different sources, which are spent for the basic and other activities of the branch, as well as means for capital construction.

The major items for spending the financial resources are the current expenditures and the financing of capital investments.

The current expenditures include those for the wages fund, for purchasing equipment and implements, operting and other expenditures for scientific-research work.

The capital investments, including those for construction and assembly, are envisaged for the construction of new, expansion and reconstruction of operating scientific-research institutes, special designing organizations, that are on an independent balance and carry out scientific-research work, experimental bases and other subdivisions subordinted to the scientific-research organizations.

The scope and form of financing science is regulated by the financial policy of the state, which is closely associated with the system of managing scientific research and developments. In accordance with the two levels of managing science in the country, i.e. the *general state and branch (departmental) systems* of management, there exist two levels of realizing the financial policy in this branch. The following directions of financiald policy are characteristic of the general state level:

- determination of the total scope of expenditures for science in coordination with the State plan for the development of science and technology, including means from the state budget and other sources;

- distribution of the total amount of financing by the ministries and departments;

- determination of the normative of deductions from the basic activities of the enterprises and organizations to the centralised funds of the ministries and departments, which are spent for scientific-research and experimental-designing developments;

- control of utilizing the financial resources.

PROPOSALS FOR RESOURCES

Proposals are elaborated at the branch level of the ministries and departments, which are the major managers of the budget and centralized means, for the organs of the top level in accordance with the listed directions. Beside that, they distribute the established scope of financing to the departmental scientific-research organizations, determine normatives of deductions to the funds for economic stimulation of scientific-research organizations, and control the use of the financial resources.

Current expenditures for research and developments are planned in the USSR in a centralized order in the five-year and annual plans.

Expenditures for scientific-research and experimental-designing work, carried out by independent scientific-research and project-designind organizations of the USSR ministries and departments and the Councils of Ministers of the union republics, are specified in the State plan for economic and social development of the USSR in the section "Development of science and technology" (appendix: "Financing of scientific-research work").

The expenditures for scientific-research and experimental-designing work, performed by laboratories, designing organizations, experimental plants, shops and experimental units of industrial enterprises, are envisaged in the plans for the development of branches, production, scientific-production associations and industrial enterprises.

The expenditures for scientific-research work, carried out at the faculties of higher educational institutions, are envisaged in the plans of the ministries of higher education, the ministries of education of the USSR and union republics, as well as other ministries and departments, comprising higher educational institutions within their system. Expenditures, associated with mastering and introducing new technologies in the national economy, as well as capital investments for the construction of objects of science, are envisaged in the respective sections of the plans of the corresponding branches of the national economy in the industry.

Planning of expenditures for research and development is effected in the USSR by the USSR State Committee for Science and Technology. The plan for financing scientific-research work envisages the total scope of expenditures for scientific-research work with a wages fund for the workers of scientific-research organizations, and determines the sources for financing this work. The USSR State Committee for Science and Technology coordinates with the USSR State Planning Committee and USSR Ministry of Finance the total scope of expenditures, the wages fund and the allocations from the budget for science in the USSR for the planned period.

The draft plan for financing scientific-research work is elaborated by the USSR ministries and departments, Councils, of Ministries of the union republics for the group of organizations planned in the established order by the USSR State Committee for Science and Technology.

Draft plans for financing scientific-research work in the union republics are elaborated for the republic and for each ministry and department separately, including union-republics ministries of the union republics. The USSR union-republican ministries elaborate draft plans for the whole branch, for the USSR union-republican ministry and for each ministry of similar profile in the union republic.

The USSR Ministries and departments and the Councils of Ministers of the union republics supplement the draft plan for financing scientific research work with a summary estimate of expenditures for production at scientific-research organizations, that have been transferred to the self-supporting basis, and summary estimate of expenditures for scientific-research organizations that are financed from the state budget.

The USSR State Committee for Science and Technology elaborates a draft plan for financing scientific-research work in the USSR within the limits of the basic indices of the plan coordinated with the USSR State Planning Committee and the USSR Ministry of finance on the basis of the respective draft plans of the USSR ministries and departments and Councils of Ministers of the union republics. The draft plan is submitted in the established order for consideration to the USSR Council of Ministers.

The plan for financing scientific-research work, elaborated by the USSR State Committee for Science and Technology, is, therefore, a component part of the State Plan for economic and social development of the USSR and of the State budget of the USSR.

INDICES OF RESOURCES AND EXPENDITURES

The following indices are specified for the USSR ministries and departments and the Councils of Ministers of the union republics in the State plan for economic and social development of the USSR: the total scope of expenditures for scientific-research work, including scientific-technical programs and problems in the area of natural and social sciences, the average annual manning table and the wages fund for those working at scientific-research organizations, also expenditures accounted for in the prime cost of the industrial products, construction-assembly work, in the plans of operating expenditures, and in the plans for the distribution costs of the USSR ministries and departments and those of the union republics, while the State budget of the USSR envisages the allocations from the state budget for scientific-research work.

The USSR ministries and departments and those in the union republics, in their turn, determine the total scope of expenditures, including the average annual manning table, the wages fund for the workers, and the sources of financing these expenditures for the subordinated scientific-research and project-designing organizations. The leaders of the scientific-research organizations determine the salaries for the workers within the limits of the established indices and in correspondence with their rights (in conformity with the standard scheme of salaries established for the given organization), the structure and manning table, the expenditures for individual items in the estimate of expenditures of the organizations, and certain other problems associated with financing scientific-research work.

The scope of expenditures for science is determined in the USSR proceeding from the increase of the national income rate and the targets of science in the planned period, the state of the scientific base (availability of scientific organizations, number of workers therein, experimental base). The increment rate of expenditures for science, as a rule, is adopted at a higher level than the increment rate of the national income in order to ensure the development of scientific-technical progress in the USSR at the required level.

The total scope of expenditures for scientific-research work at a USSR ministry and department, or in a union republic is determined on the basis of estimate-financial calculations by enlarged items: wages, purchase of equipment and implements, capital repair of buildings and structures, other expenses.

The expenditures for scientific-research and experimental-designing work by the types of scientific research (fundamental and applied research and developments) are not planned in the USSR, because these notions are conditional, and the establishment of plans of expenditures by the types of research might limit the existing possibilities of maneuverability with the financial resources and their rational utilization.

When determining the scope of expenditures for scientific-research work, it is considered that the USSR ministries and departments and those in the union republics finance primarily scientific research associated with the fulfilment of governmental assignments, scientific-technical programs, and the solution of problems in natural and social sciences, as well as works of major significance for development of the branch.

Scientific-technical programs and problems in natural and social sciences are financed by the ministries and departments that are stated in the programs as financing organizations.

Expenditures for scientific-research work, envisaged by the scientific-technical programs and the problems in natural and social sciences, are stated in a separate line in the finance plan.

Organizations, comprising baside projecting, designing and technological departments, also a scientific-research department, referred to in the established order as a scientific organizations, have in their plan of financing scientific-research work also a scope of expenditures that relate only to the scientific-research work carried out by the stated department.

The sources for financing scientific-research and experimental-designing work in the organizations are as follows:

- allocations of union, republican and local budgets. Only works of theoretical character and those of general-union significance are financed by allocations from the state budget;

- means from the single fund for the development of science and technology (fund for scientific research) formed in the established order;

- means considered in the prime cost of industrial products, construction-assembly work, in the plans of operating expenditures, and in the distribution costs of the USSR ministries and departments and those of the union republics;

- receipts to the accounts of organizations for scientific-research work performed by economic contracts (interministerial orders), concluded on the basis of the Standard Instruction for concluding economic contracts and issuing interministerial orders for scientific-research, experimental-designing and technological work. Works, performed by organizations in accordance with contracts or orders, are remunerated by the customer on account of means specified for these purposes in their balances of income and expenditure (finance plans), or estimates of expenditures;

- profits remaining at the disposal of the ministry (department) and used for scientific research in accordance with the decision of the USSR Government, etc.

SOURCE OF FUNDS

The sources for financing scientific-research work are determined, proceedings from the following considerations:

- scientific-research work, associated with the fulfilment of assignments of directive organs, scientific-technical programs and the solution of problems in natural and social sciences, also scientific-research work of fundamental (theoretical and exploration) character are financed by the single fund for the development of science and technology, formed at the ministries in the established order, as well as by allocations from the state budget;

- scientific-research work of general state and branch character are financed by the single fund for the development of science and technology, by means envisaged for scientific-research work in the plans of prime costs of industrial products, construction-assembly work, deliveries, in the plans of operating costs, and in the plans of distribution costs of commercial, provision, trading and purchasing organizations, as well as in the estimates for construction (when scientific-research work isd envisaged at the construction of the given object);

- scientific-research work of general state and branch character in the areas of construction and industrial materials is financed by allocations from the state budget, that are specifically assigned for these purposes in the established order, in the area of agriculture on account of allocations from the state buget and deductions from realizing products cultivated at the experimental farms and produced at the enterprises of scientific-research organizations;

- scientific-research work carried out by scientific-research organizations of the USSR Ministry of Geology, ministries and departments of geology in the union republics is financed by allocations from the state budget for operating expenditures for exploration and topographical work.

Scientific-research, experimental-designing and technological works and measures, associated with the development and mastering of new technologies, are financed by the single fund for the development of science and technology at ministries (departments), wherein scientific-research, designing, project-designing and technological organizations, enterprises, production and scientific production associations have been transferred to the new system of planning, financing and economic stimulation of work on new technologies.

The major sources of financing expenditures for scientific-research work are the allocations from the state budget and the means proper of the USSR ministries and departments: the single fund for the development of science and technology. The allocations from the state budget have reduced almost two times during the last two decades as compared with the total expenditures for scientific-research work.

The reduction of the part of the state budget in the total expenditures for science is explained by the expansion of direct self-supporting ties of the scientific organizations with the industry and the transfer of industrial ministires to the new system of planning, financing and economic stimulation of new technologies.

All branch scientific-research organizations (except the scientific-research organizations of the USSR Academy of Sciences and Academies of Sciences of the union republics, the scientific organizations fo the agricultural organs, in the area of health care, and some others) and designing organizations have been transferred in 1961 to the self-supporting system. The economic basis of these organizations are the fixed and current capital, the system of cost evaluation of work carried out, the system of advance payments by the customer for the expenditures of the executors of contractual works, material sanctions for unsatisfactory experimental-designing work.

Scientific-research organizations of the USSR Academy of Sciences, Academies of Sciences of the union republics, organs of the agriculture and health care, which are financed by the state budget, also carry out certain scientific-research work on conditions of contracts with the enterprises and organizations of the customers. When the USSR Committee for Science and Technology plans the scope of economic contractual works for the USSR Academy of Sciences, the Academies of Sciences of the union republics and the branch academies, it proceeds from the necessity of maintaining the optimum level of fundamental research.

When planning and financing of scientific-research, experimental-designing and technological works, great attention is rendered to economic contractual works, because the latter assist in accelerating the development and introduction of new technologies, and the fulfilment of works by contracts contributes to introducing the self-supporting system.

PROCEDURES FOR FINANCING

The USSR State Committee for Science and Technology together with the USSR State Planning Committee, USSR State Committee for Construction, USSR Academy of Sciences, USSR Ministry of Finance and with participation of USSR ministries and departments has elaborated and affirmed a Standard instruction for concluding economic contracts and issuing interministerial orders for scientific-research, experimental-designing and technological work, which should be followed when concluding economic contracts.

This instruction envisages the conditions of the contracts and interministerial orders, cost and order of payments, order of changing and cancelling contracts (orders), responsibilities of the executor and customer.

The decision No. 695 " On planning and intensifying the effect of the economic mechanism on increasing the effectiveness of production and quality of work", adopted in 1979, has given further impetus to the development of the principles of the self-supporting system in scientific-research work. In particular, this decision determines to complete the transfer of scientific and designing organizations and enterprises of industrial ministries to the new system of planning, financing and economic stimulation of work on new technologies. All the industrial ministries are functioning currently under these new conditions.

The essence of the new system is that the means, alloted earlier to the ministries for scientific-research work (from the budget and deductions from the prime cost of industrial products), as well as the means of mastering and introducing new products and technologies are combined into a single fund for the development of science and technology. This fund is designed for financing scientific-research, experimental-designing and technological work and reimbursement of expenditures associated with the development adn mastering of new types of products and technologies, introduction of scientific organization of labour, as well as for financing additional expenditures for improving the quality of products and elevated expenditures during the first years of manufacturing new products.

This fund is formed by deductions from the planned profit of scientific-production associations (enterprises) and organizations in conformity with the normative established for the ministry (department) in percent to the pure (normative) or commodity product. Beside that, a part of the additional profit (sums of allowances to the wholesale price) from realizing new highly efficient products and products with a state Quality Mark is also added to this fund.

The mechanism of forming the single fund for the development of science and technology is specified in the "Methodological Instruction on the formation and utilization of the single fund for the development of science and technoloigy", affirmed by the USSR State Committee for Science and Technology, USSR State Planning Committee, USSR Ministry of Finance and USSR State Committee for Prices.

The State plan for economic and social development of the USSR in 1981-1985 has affirmed for the first time the normatives for forming the single fund for the development of science and technology and the scope of expenditures for scientific-research, experimental-designing and technological work with subdivision by the years. However, these normatives are not strictly permanent. They are reviewed by the USSR Committee for Science and Technology together with the USSR State Planning Committee and the USSR Ministry of Finance in connection with the arising necessity of additional financing of scientific-research work at one or the other ministry. The decision of the CC CPSU and the USSR Council of Ministers "On improving planning and intensifying the effect of the economic mechanism on increasing the effectiveness of production and quality of work" envisages the possibility of utilizing the means of the State budget for financing major scientific-research work, requiring considerable expenditures, alongside the means of the single fund for the development of science and technology.

The ministries envisage up to 20% of the means in the single fund for the development of science and technology for carrying out scientific work of fundamental and theoretical character, exploration and initiative research in order to ensure scientific and technical work done in anticipation in the branches transferred to the new system of planning, financing and economic stimulation of work on new technologies.

Scientific-research, designing and technological works (except works of fundamental, theoretical and exploration character), as a rule, are carried out by scientific-research and project-designing organizations of the ministries proper by zakaznarjads of the Chief Departments and Associations of the ministries, or by economic contracts with the enterprises and organizations of the customers.

Thus, purposeful planning and financing of all the works, beginning with research and developments and ending with the mastering and introduction of new technologies in the national economy, is performed by the single fund for the development of science and technology at the ministries transferred to the new system of planning and financing work on new technologies.

USSR ministries and departments, that have not been transferred to the new system of planning and financing scientific-research and experimental-designing work, and the Councils of Ministers of the union republics submit, alongside the plan for financing scientific-research work, also proposals on the scope of expenditures for scientific-research and experimental-designing work, that are considered in the prime costs of industrial products, deliveries, construction-assembly work, in the plans of operating costs, in the plans of distribution costs of commercial, provision, trading and purchasing organizations, and in the estimates for construction.

MANAGEMENT OF RESOURCES

In order to intensify the interaction of the component parts of the scientific potential, when carrying out the entrie complex of work in the cycle "research-development-introduction", and considering the matured necessity and significance of planning the branch "Science and scientific maintenance" proper, the Government has decided that beginning with the plan for 1984 the USSR State Planning Committee and the USSR State Committee for Science and Technology shall develop and affirm the average annual manning table and the wages fund of those working at the institutions and organizations of the branch "Science and scientific maintenace" proper. Beside the plan for financing scientific-research work, financing of the organizations of scientific and maintenance is performed mainly by the means of the ministries and departments proper. This plan specifies the manning table and wages fund of those working at the institutions and organizations of the USSR ministries and departments, Councils of Ministers of the union republics (without the Academy of Scineces), USSR Academy of Sciences, Siberian Branch of the USSR Academy of Sciences and the Academies of Sciences of the union republics.

Capital investments for the construction of scientific-research organizations, their experimental bases, as well as for the construction of experimental plants, shops, experimental and experimental-industrial installations at industrial enterprises are envisaged, in accordance with the order existing in the USSR, by the USSR ministries and departments and Councils of Ministers of the union republics in the total scope of capital investments for the development of the respective branches of the national economy and industry.

The same system of planning capital investments has been established for the construction of objects of science, envisaged in the programs for the solution of major scientific-technical problems. It has been determined that the provision of works, envisaged in the scientific-technical programs, with the fiancial and material-technical resources is performed in primary order by the USSR ministries and departments.

The USSR State Committee for Science and Technology has been given the right to consider the lists of objects to be constructed for the scientific-research organizations and their experimental-industrial bases, participate in considering the proposals of the USSR Academy of Sciences, USSR ministries and departments and Councils of Ministers of the union republics on the total scope of capital investments for the development of science together with the USSR State Planning Committee. As a result, the USSR ministries and departments, Councils of Ministers of the union republics submit together with the plan for financing scientific-research work also calculated indices of the scope of capital investments and construction-assembly work for the construction of scientific-research organizations and their experimental bases, that are envsiaged for them in the total scope of capital investments for the development of the respective branches of the national economy and industry.

The total scope of capital investments and construction-assembly work for the construction of scientific-research organizations and their experimental bases comprises capital investments for the construction of new, expansion and reconstruction of functioning scientific-research institutes, central and special designing organizations, that are on independent balance and carry out scientific-research work, experimental enterprises, shops, installations for checking the results of scientific research and actual development, that are subordinated to scientific-research organizations or directly to the ministries and departments.

The indices of the scope of capital investments and construction-assembly work are supplemented with a list of continuing and newly started construction of objects of scientific-research organizations and their experimental bases, envisaged by the plan of capital investments for the respective branches of the national economy and industry, with indication of the dates of beginning and finishing the construction, the estimate cost, the planned scope of capital investments and construction-assembly work, and the indices of introducing the production capacities into operation.

The USSR State Committee for Science and Technology is given the right to have at its disposal reserves of allocations from the state budget for scientific-research work, a manning table and wages fund for the workers of scientific-research organizations that amounts to 1.5% of the total scope of expenditures for scientific-research work. This reserve is used by decisions of the Committee for carrying out major scientific-research work, the necessity in which arises during the year, in order to accelerate the introduction of the results of these works in the national economy, including works associated with obligations of the Soviet Side in scientific-technical cooperation with foreign countries.

In addition to the reserve at allocations for scientific-research work, the decision No. 814 adopted in 1983 "On measures for accelerating scientific-technical progress in the national economy" specified a reserve of means that has been created since 1984 for works on general-union scientific-technical progrmas. This reserve is also at the disposal of the USSR State Committee for Science and Technology. It is formed by annual deductions from the single funds for the development of science and technology at the USSR ministries and departments at an amount of 1.5% of the part of these funds spent for mastering and introducing new technologies.

This reserve is used for the following works in the general-union programs: works associated with the preparation and mastering of new and modernized types of products, testing the latter at the customer's, introducting advanced technologies; carried out by designing, project-designing and technological organizations, production and scientific-production associations, enterprises, temporary collectives, created for carrying out work on solving prospective scientific-technical problems of inter-branch character, as well as for reimbursing elevated expenditures during the first (and in some cases the second) year of serial manufacture of a new product.

An analysis of the current expenditures and their structure for scientific research and developments during the last decade indicates an annual increase of the scope of expenditures of scientific research work, including an increase of the part of expenditures for state scientific-technical programs and problems in the area of natural and social sciences.

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EFFECTIVENESS

One of the major conditions for raising the effectivensss of research and development is the provision of scientific-research organizations with up-to-date scientific equipment, devices, machiens, as well as the required materials and technical accessories. It is known that exploration and experiments have become considerably more complicated during the recent years and their accomplishment is virtually impossible without sophisticated and precise devices and installations. As a result, the structure of expenditures for science envisages a gradual reduction of the specific part of the wages fund and increase of the specific part of material provision of science in the total scope of expenditures.

Owing to the fact that the society is unable to increase the resources of science infinitely, the major direction of increasing its effectiveness in the future will be intensification of the research process on the basis of improving the equipment of science with automatic devices and other up-to-date means of research, implementing measures for reducing the number of workers at scientific organizations and institutions ad at those of scientific maintenance.

Considerable reserves for rising the effectiveness of scientific-research and experimental-designing developments in the country are associated with the expansion of international cooperation in science, primarily with the CMEA member-countries. Labour division in science, specialization of the countries for the solution of individual scientific-technical problems makes it possible to accelerate greatly the development of advanced technologies, articles and materials, and to reduce the expenditures of each country for financing large-scale projects.

The entire complex of measures for the further development of the scientific potential of the country will make it possible to accelerate the rate of socio-economic development of the USSR.

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FINANCING SCIENTIFIC RESEARCH WORK

INTRODUCTION

The scientific and technological revolution has increased the dependence of economnic and social development of the society and our knowledge of the nature of the society. Developoment of this knowledge and its utilization to achieve national economic effect is determined by the value of available resources. Scientific activities and introducing their results in all the spheres of social life also require considerable amount of resources.

Financing of scientific and technological progress is based on a system of forms and methods of the utilization of financial resources to achieve accelerated S and T development and introduction of its results in the production. The principles governing the determination of volume of financial resources and their allocation, selection of mode of financing - play a major role in the acceleration of scientific and technological progress. Financial relations create an active system for controlling the efficient use of allocated resources. Thus, the improvement of financing scientific and technological progress is of major significance for its management.

INDICES OF S AND T FINANCING

Financial indices occupy an important place in S and T development plans. The allocation of financial resources should be based on optimum correlations among resources channelled to R&D activities, mastering and introduction of new technology, improvement of production assets, etc. This determines the strucutre of expenses for the development of science and technology and introduction of their achievements in the production. Optimum development of various directions of scientific and technological progress through preplanned proportions of resource allocation represents one of the major taks facing the financial system.

Presented by K.A. Efimov 2650

SOURCES OF FUNDS

The development of scientific and technological progress depends to a great extent on the volume of resources allocated for financing "science-technology-production" syustem. While determining the amount of financial expenses for S and T progress for the national economy as a whole the following data are taken into account:

- national income and industrial production growth rates;

- targets set for scientific development for the next five-year period

- volume and scale of scientific novelties to be introduced in production.

Depending on the sources of financing and target designation of these S and T development measures, the funds are subdivided into:

- state funds

- proper funds (centralized branch funds and reserves, as well as funds of production associations, enterprises and organizations)

- credit funds (credits of the USSR State Bank and the USSR Construction Bank).

The proportions of these funds are determined by the significance and scale of S and T development measures as well as by the financial status of production associations, enterprises and scientific research organizations.

The state funds are mainly used for financing fundamental research programmes and for highly important and costly R and D activities aimed at creation and introduction of principally new technologies whose resulsts may be used in a number of branches of the national economy and produce corresponding effect mainly in the long run. Such allocations are also used to finance all scientific research organizations of the USSR Academy of Sciences, the academies of sciences of the union republics and a number of other institutions.

The financing of S and T activities of all union significance directly from the state budget ensures the concentration of these resources on the most important programmes. It widens the possibilities of their stable financing and offers financial control by the state bodies in determing the volume and justification of expenditure as well as increases economic responsibility of branch management bodies for the fulfilment of the relevant programmes.

The proper funds, as a rule, are related to the economic and self-accounting performance of enterprises and organizations, as well as ministries (committees). These funds depend on the achievements of significant quality of resulsts of highe quality and on the efficiency of social production. These funds are subdivided into branch centralized funds and reserves and funds of production associations, enterprises and organizations.

The branch centralized funds and reserves are formed in the ministries (committees) and are designated for financing S and T develoopment measures carried out by the subordinate associations, enterprises and organizations in accordance with the planned assignments approved by the higher bodies.

The funds of production associations, enterprises and organizations are used for compensating towards expenses resulting from the planned creation of new technology and improvement of the product quality.

All financial resources are apportioned on the basis of priorities in the development of branches and economic regions, and the achievement of the highest economic efficiency.

FINANCING R AND D ACTIVITIES

A continuous growth of expenditures to finance science represents a typical feature of the economic development under modern conditions. During the Tenth Five-year plan period about 98 billion roubles were allocated for R and D activities. The share of expenditures for science in the national income increased 1.3 times from 3.6% in 1966 to 4.6% in 1980.

However as a share of the total budgetary financing, volume of expenditures for science decreased from 61% in 1965 down to 50% in 1979. This trend became more evident in 1969 after the introduction of a new order of financing scientific research work which envisaged the creation of the single fund for S and T development in a number of Ministries. Such a fund is formed by deductions from planned profits received due to technological progress in the branch or economic performance of production associations, enterprises and organizations of aforementioned ministries.

The decrease of the centralized budgetary allocations for applied R and D activities resulting from the increase of the proper funds of branch ministries is useful only to a certain limit. Hence the share of budgetary financing of R and D activities should be determined taking into account the status and prospects of developing concrete directions of science and technology.

The proper funds of ministries, committees, enterprises and organizations channelled to finance R and D activities tend to grow. They accounted for 39% of total R and D budget in 1965 and 50% in 1979 and currently remain at this level. These funds are 2650 formed mainly by the deductions from the profits of enterprises and the increases in prime cost of products.

The increases in prime cost of industrial product, construction-assembly work, transportation, as well as operational costs and circulation expenses of trading, procuring, selling and supplying organizations are centralized by the ministries and committees and reallocated among scientific and designing organizations. The value of these deductions does not usually surpass 0.15-0.2% of the prime cost of product of a given branch. At present the expenses, included in the prime cost of industrial product, constitute about 5% of funds allocated for R and D activities carried out by scientific research organizations of the ministries and committees (not taking into accounts capital investments).

Applied R and D activities of the industrial ministires which fall under a new system of planning and economic stimulation are financed from the profits of industrial enterprises and organizations. At present almost all industrial ministries and committees work according to this system.

Deductions from profits are centralized in each ministry, forming the single fund for S and T development, and then reallocated among scientific and designing organizations in accordance with the plans approved for R and D activities.

A certain part of R and D activities is carried out by scientific research and designing organizations according to the orders placed by industrial enterprises. At ministries and committees these activities are now being financed from the single fund of S and T development.

R and D activities are financed from the capital investments only in cases when this work is foreseen in the project documentation and budgets or when it relates to the creation of unique macrodimensiaonal equipment.

Methods of financing R and D

The system of financing R and D activities undergoes permanent evolution. Various methods of attaining this goal have been laid down. One of them consists of most wide-scale application of advanced technico-economic norms and normatives of resource consumption in planning. As far as planning of the development of science and technology is concerned, the plan for 1981 comprises of the volume of expenditures for scientific-research, experimental-designing and technological work at the majority of industrial ministries, determined on a normative basis as a percent of the volume of product. The wage fund of the workers of scientific and designing organizations is also calculated by the normative, adopted in the branch, as percent of expenditures for R and D activities.

The esseence of the normative method of planning the volume of expenditures for R and D activities is that the manufacture of products with improved technico-economic characteristics is impossible under current production conditions without certain scientific preparation. Hence it is necessary to invest an objectively stipulated means in scientific-research and experimental-design to maintain the established rate of improving the technical level of the manufactured products and their production levels in the current planned period. The normative for determining the planned volume of expenditures for R and D activities reflects the scientific capacity of a unit and the cost of the products in the branch under the established conditions of their production.

In order to establish a scientifically substantiated normative of expenditures for R and D activities and the normative of the voluem of the Single fund for the development of science and technology it is ncessary to determine the closest relation between the volume of expenditures for scientific-research and experimental-designing work and the volumetric index, expressing the final result of production, which is influenced by these expenditures. It is important to determine the effect of investments in R and D activities on the change of the quantitative and qualitative parameters of the products, determine the manifestation of the results of expenditures for scientific preparation for production in the branch.

Instead of a number of sources for financing, namely, allocations from the budget, deductions from the prime cost of commerical products for scientific-research work aimed at mastering new machinery, receipts for the fulfilment of scientific-research and experimental-designing work in compliance with contracts, etc., a single fund for the development of science and technology has been established for the ministries. It is formed mainly by deduction from the planned profit of the enterprises by the normative for ministries in percent to the commodity produce and in certain branches, to the normative net produce.

The normative for determing the planned volume of expenditure for R and D activities and the normative for the formation of the single fund for the development of science and technology are closely linked with one another. The stated fund is a source for financing the entire cycle "science-production": scientific-research, experimental-designing and technological work, developments and mastering of new types of products and technologies, as well as additional expenditures for the introduction of scientific organization of labour, improvement of the product quality, and heavy expenses during the first years of manufacturing the product.

The Single Fund

The size of the single fund for the development of science and technology regulates the volume of financial resources alloted for production mastering of the results of R and D activities for compensating heavy expenses during the first years of manufacturing the new product. A part of the fund, except the means for financing R and D activities, stands as a planned volume of expenditures for the introduction and production mastering of new machinery, and improving the product quality. The establishment of an economically substantiated normative for the single fund for the development of science and technology is highly significant as well as allocation of the fund for financing R and D activities and measures for introducing and production mastering of advanced machinery and technology.

The single fund can be carried over and its resources are not be to withdrawn and used for other purposes. The industrial ministries (committees) may transfer a part of the single fund to all-union (republican) industrial associations and large production and scientific-production associations for financing measures for the development of science and technology specified in the plan.

The single fund has been created for the first time in the Ministry of Electrotechnical Industry, when the branch was shifted in 1969 to the new system of planning, financing and economic incentive of work in the area of new machinery.

The single fund replaces three basic sources of financing R and D activities and measures for mastering new machinery: budget allocations for financing, as a rule, activities of state significance; resources included in the prime cost of product (fund of scientific-research work in the ministry) for financing research and develoopment of branch significance; resources of the fund for mastering new machinery, also created due to the deductions from the prime cost of the product. The majority of industrial ministries has been shifted currently to the new system. The single fund is formed of the deductions from the planned profit of the scientific-production associations, (enterprises) and organizations in accordance with the normative established for the ministry (department) in the state five-year plan of economic and social development of the USSR (with distribution by the years) in percent to the net produce (normative), and in certain branches, to the commodity produce.

A part of the additional profit (sum of increment to the wholesale price) from the realization of new high-efficient products and products with the state Quality mark is also transferred to the single fund.

The planned sums of deductions are increases (decreased) when overfulfilling (underfulfilling) the plan respectively. The increase may be only due and within the limits of actually gained aboveplan profit. Besides that, a part of the additional profit (the sum of increment to the wholesale price) is transferred to the fund from the realization of new high-efficient products and products with the state Quality mark. The amount of this part is half of the rest after deductions to the funds of economic incentive of the associations (enterprises), scientific-research, project-designing and technological organizations. The receipts to the single fund are not envisaged from the sume of incentive increment in the financial plans and are gained in part from the actually obtained sums of increment.

It is possible now to finance extraordinary expenditures from this fund for raising the quality, life term and reliability of the manufactured products as compared with the indices available in the effective state standards and technical conditions.

This change, as compared with the order existing earlier, is called upon to intensify the economic stimuli for exapnding the manufacture of high-quality articles and ensuring systematic renewal of the assortment of products alongside the earlier directions of spending from the single fund, i.e., financing R and D activities; financing expenses for mastering an introducing new machinery and technologies; compensating for increased expenditures during the first two years; and serial production. The ministries (committees) may finance from the single fund such activities as project-exploration and pre-project activities of R and D institutes that were not included in the plan. The single fund may also be used for extraordinary bonuses for the development, mastering and serial production of high-efficient machines and equipment that are significant for the national economy and for the creation and mastering of principally new technologies.

Examples of S and T Financing

The measures for enhancing the scientific preparation of reproduction have stipulated the accelerated creation and intensification of the production of high-quality new machinery in the electrotechnical industry and instrument engineering. The expenditures for R and D activities has increased in 1971-1975 at the Ministry of Instrument Engineering by more than by 154% and at the Ministry of the Electrotechnical Industry by 150% increasing the activities. Their efforts were directed towards the eletrotechnical industry in the creation of new products, enhancing greatly their efficiency and quaitly and regulating the standards of manufactured articles. Considering the total scope of new machinery in the branch, there is a large number of articles, whose technico-economic level excelled that of domestic and foreign achievements.

Similar results were achieved in the field of instrument engineering in the Ninth five-year plan period when average annual increement of R and D expenditures reached 9.1%.

The experience of other ministries such as Ministry of Electro-technical Industry, Ministry of Heavy and Transport Engineering Industry, Ministry of Chemical Industry, Ministry of Instrument Engineering and Automatic Means, demonstrate the positive effects of the new system of planning, financing and economic incentive for the creation, mastering and introduction of new machinery.

<u>Other sources of R and D Financing</u>

Creation of the single fund for S and T development does not preclude utilization of other sources of financing R and D activities. When necessary, major R and D activities, requiring considerable amounts of expenditures, are financed not only through the single fund but also through the state budget. The requirement for such allocations is stipulated mainly by the realization of complex S and T programmes whose significance is becoming more and more important.

During the formulation of the state financial plan a reserve of 1% of total allocations is put aside at the disposal of the USSR State Committee for Science and Technology which is used to finance additional activities which arise in the course of fulfilment of scientific research assignments of the plan.

Moreover, in accordance with recent decisions on the acceleration of S and T progress, the ministries and committees transfer annually 1.5% of the Single S and T development fund assigned for the mastering and introduction of new technology to the USSR State Committee of Science and Technology for supplementary financing of activities carried out in compliance with the all-union S and T programmes. These two reserves ensure stability of financing contingency activities of the plan.

<u>Financing measures for introduction of S and T achievements in the national economy</u>

A considerable part of material and financial resources is being spent for the introduction of technological innovations and the development of industrial production.

	1970	1975	1980
Actual expenditures on introduction of new technology (including expenditures of previous years), million roubles	5,011	7,518	9,700

The expenditures on introduction of new technology in industry include the cost of equipment comprising transporation, assembly and setting up expenses, the cost of modernization of equipment, the cost of construction and reconstruction of buildings and other work necessary for introduction of new technology.

The distribution of expenditures on differest aspects of introduction of new technology are as follows:

	Actual expenditures on introduction of new technology (including previous expenditures) in 1979, in per cent
Introduction of advanced technology	39.7
Mechanization of production	22.5
Automation production	11.3
Introduction of computers	4.0
Modernization of existing equipment	2.9
Other measures	19.6

The capital investments occupy the highest share in the total expenditures on introduction of new technology. In 1979 it reached 37%. The capital investements are used for the organization of production of new more advanced products and construction of new or reconstruction of existing capacities.

The next highest share is for production development fund in the introduction of new technology. It is formed directly at the enterprise level and is utilised for replacement equipments and improvmenets of existing capacities. The share of this fund reached 20% in 1979.

The fund for mastering new technology is the third significant source of financing. In 1979 its share increased to 20% with simultaneous decrease in state budgetary allocations, in accordance with the principles of self-financing. In 1979 77% of all expenditures on the mastering new technology in industry was covered by this fund. With the transition to new system of planning, financing and stimulating work in the field of new technology the fund for mastering new technology is included in the Single fund for S and T development.

With the creation of the Single fund for S and T development, the branches of the national economy hold considerably larger resources of their own for R and D activities aimed at the introduction of new technology in production. The plans envisage only the volume of R and D activities whereas the expenditures on mastering new technology are determined by the ministry itself. Apparently, a further perfection in planning expenditures is required, especially in terms of elaborating scientifically justified branch normatives for R and D expenditures and for mastering technology.

Sources of Credit for accelerating of S and T progress

Credit is one of the sources of financing S and T progress. The need for credit appears when there is a lack of state or own resources necessary for carrying out R and D work.

Distinct from the state budget financing, credit requires the repayment of the funds with interest. The date of repayment, as a rule, is determined on the basis of projected indices of efficiency of those measures for which credit has been received which corresponds to the principles of self-financing. A long-term credit for the introduction of new technology is usually granted for a period up to six years when the repayment is made within the time limit annual interest rate at 2%. Credit is granted by the offices of the USSR State Bank and the USSR Bank for Construction.

A short-term credit is granted, as a rule, for a period of one year and is used mainly to service the turn-over in the process of production and circulation. In recent years the granting of short-term credits has been on upward trend. These credits are granted for the improvment of production, renewal of assortment and raise of quality of products.

At present the role of credit in the national economy has grown, resulting in the expansion of projects and the increase in the share of long-term financial sources of investments in capital goods.

There have been important changes in the terms of granting and repayment of loans for technical improvement of production.

The expansion of projects, prolongation of new production and mastering of new products are important measures in the sphere of credit financing aimed at further intensification of production. These loans are granted to cover expenses of new enterprises and workshops being put into operation and for preparation and mastering new types of products and new technological processes. Expenses for design technologies for proudction of new articles and experimental prototypes are being met by credits. Loans are also granted for setting up various types of equipments, automated and remote control devices, etc. Such credit is granted now for a period up to three years.

PLANNING OF HUMAN RESOURCES

IN SCIENCE AND TECHNOLOGY

INTRODUCTION

The growth of number and complexity of the problems put in the forefront by the needs of the national economy develoment of the USSR and the requirements of modern stage of the scientific and technological revolution, the increasing role of S and T, the development and introduction of new technological processes and flexible automated systems demand a corresponding training of scientific, technical and scientific-pedagogical cadres.

The number and strucutre of scientific and scientific-pedagogical workers in the area of science and technolgy, the quality of their training and the effectiveness of their utilization render a decisive effect on the direction and rate of scientific-pedagogical personnel, as a productive force of the society, occupies an important place in the State plan of economic and social development of the USSR.

Before the Great October Socialist Revolution, Russia was according to V.I. Lenin, "an incredibly, inconceivably backward country, poverty-ridden and half-wide, equipped with modern implements of production four times worse than England, five times worse than Germany, ten times worse than America". Three quarters of the population then was entirely illiterate and only 0.2% had a special higher or secondary education. The number of scientific workers in 1913 in Russia was only 11,600 including 6.658 professors and teachers of higher educational institutions.

In order to provide rapid mobilization of scientific personnel, develop science and raise the national economy, it was necessary to plan for them. Hence the USSR Academy of Science started to work actively in 1918 on collecting information and publishing handbooks, illustrating the composition of the scientific personnel of the country and its scientific centres.

Presented by G.I. Sadovsky

MODELS FOR DEVELOPMENT OF S AND T HUMAN RESOURCES

The major target for study of the professional structure of the scientific and scientific-pedagogical personnel is the proportions of their subject and functional distribution in the system of scientific activities; exploration for efficient distribution in the system of scientific activities; exploration for efficient methods of maintaining these proportions, and investigation of the possibilities of optimum combination of different subject and functional elements in the activities of scientists and scientific collectives.

In the USSR there are three groups of "controlled" models, permitting the prognostication of the number of scientific personnel: model of requirements, model of supply and balance model.

The requirement establishes the relations between the number of scientific workers and the level of development of the national economy estimated as the ratio of the increment of social labour productivity to the national income, and prognosticates the requirement in scientific personnel to ensure the expected raise in this level.

The supply model constitutes a system of scientific personnel as a sum of different levels of professional-qualification levels and the relations between them. An enlarged model of this type takes into account the graduation of students from higher educational institutions and post-graduate courses, the share of graduates immediately starting scientific work specialists having experience of other work and natural losses, etc.

The aim of the balance model is to coordinate the requirement and supply of scientific personnel.

DISTRIBUTION

The number of scientific and scientific-pedagogical workers and their attributes are shown in table 1.

Statistical accounting of scientific workers by the branches of science is performed in the USSR annually, and by the scientific professions from the beginning of the 60s.

A substantial increase in the number of scientific workers was observed in each branch of science during 1950-1974 as shown in table 2.

The correlation of the numbers of the most and the least mass branches increased from 95 in 1950 to 400 in 1974. The three most mass branches today (technical, physico-mathematical and economic science) increased considerably faster than the scientific personnel proper. The physico-mathematical sciences went from the 6th place by the number of scientific workers to the 2nd, and the economic science - from the 10th to the 3rd. The priority of these branches in personnel reinforcement of science revealed to a great extent the process of its transformation into a direct productivity force, maintaining acceleration of scientific-technical progress on the basis of elaborating and introducing new machinery and technologies, and raising the economic substantiation of production in all its areas.

NATURE OF SHIFTS

As indicated by statistical data, furnished by the USSR Central Statistical Department, the quantitative changes in the professional structure occur quite intensively. Local qualitative shifts are not so dynamic but their accounting is of no less significance for controlling the training and utilization of the scientific and scientific-pedagogical personnel.

Changes of this type occur in three directions associated with:

1) the appearance of new areas of research, which become the base for the formation of new scientific professions;

2) differentiation of scientific professions, specified by the continuous expansion of the subject areas and the increase of personnel with the development of research;

3) integration of professions, establishment of new subject and methodological ties between them.

Consequently, as the sciences and requirements of the higher educational institutions and the national economy develop, the nomenclature of professions is subjected to periodic review. In recent years professions associated with the study of the plasma, radiochemistry, the creation of robots and manipulators, oceanic geology, allergiology and immunology, etc. have been introduced in the nomenclature of professions.

MOBILITY AMONG DISCIPLINES

Examples, illustraint the differentiation of professions of scientific and scientific-pedagogical personnel, are clearly expressed in the nomenclature of technical scineces: in instrument engineering, wherein the professions differentiated by the types of instruments; in management, automatics and computer engineering, and some others. Optics and solid-state physics, organic chemistry and biophysics, computer engineering and ethnography, and many other professions stated in the nomenclature represent today whole complexes of scientific directions with hundreds of scientific and scientific-pedagogical workers specializing in each. Radicalorecombination luminescence, which is a direction of physics, has about 600 scientific workers in the USSR and, to our mind, will form in the near future into a separate profession.

Table 1

Number of Scientific Workers

(In thousands)

	1950	1965	1970	1975	1980	1981	1982
Total number of scientific workers (including scientific-pedagogical personnel at higher educational institutions)	162.5	664.6	927.7	1223.4	1373.3	1411.2	1431
including those with scientific degrees of:							
Doctor of sciences	8.3	14.8	23.6	32.3	37.7	38.7	39.7
Candidate of sciences	45.5	134.4	224.5	326.8	396.2	409.7	423
Of the total number of scientific workers a scientific degree of:							
Academician, corresponding mrmber, professor*	8.9	12.5	18.1	22.9	27.4	28.1	28.7
Assistant professor	21.8	48.6	68.6	87.9	110.7	115.7	121.3
Senior scientific worker	11.4	28.7	39.0	53.3	66.0	68.6	70.9
Junior scientific worker and assistant	19.6	48.9	48.8	45.0	41.1	40.2	40.6

* Including 2.6 thousand academicians, members of the USSR Academy of Sciences and corresponding members.

Table 2

Distribution of Branches of Science by Number of Scientific Personnel and Rates of Its Growth in 1950-1974

Branch of Science	Rank by Number 1950	Rank by Number 1974	Change of Rank by Number	Rank by Rate of Growth
Technical	1	1	0	2
Medical	2	4	-2	17
Physiological	3	6	-3	10
Chemical	4	5	-1	9
Agricultural	5	8	-3	16
Physico-Mathematical	6	2	+4	3
Pedagogical	7	9	-2	12
Biological	8	7	+1	7
Historical	9	10	-1	13
Economical	10	3	+7	1
Art Criticism	11	13	-2	11
Geological-Mineralogical	12	11	+1	4
Philosophical	13	12	+1	6
Geographical	14	14	0	14
Veterinary	15	16	-1	18
Law	16	15	+1	5
Architecture	17	17	0	8
Pharmaceutics	18	18	0	15

2650

Professional mobility in science has turned into a mass phenomenon under conditions of scientific-technical progress. In accordance with the data of mass surveys of scientific and scientific-pedagogical personnel at academic and branch institutes and higher educational institutions, a certain number of the personnel works not in conformity with the specialization gained at the higher educational institution. They even changed not only their specialization but even their profession stated in the diploma on graduation (see Table No.3).

Table No.3

Distribution of Scientific Workers by Degree of Correspondence of Basic Education to Subject Work at Different Types of Scientific Organizations %

	Correspond completely to specialization at higher educational institution	Do not correspond to narrow specialization at higher educational institution but correspond to general profession stated in diploma	Refer to science with general profession stated in diploma	Do not correspond, & do not refer to adjacent area of science
1	2	3	4	5
Scientific workers of USSR Academy of Sciences (chemical& physics)	17.8	47.3	29.5	5.4
Scientific workers of branch scientific research institutes (chemico-technological profile)	34.6	39.8	22.4	3.6
Professor teaching personnel (chairs of chemical and chemico-technological profile)	30.5	56.3	9.5	3.7

This is also explained by the fact that there have appeared the so-called "mixed sciences" (physical chemistry, radio physics, geophysics, etc.). Even in medicine one may find specialists trained as engineers or in cybernetics, which is quite normal. The number of scientists, who changed their profession in the area of physico-technical problems of material science, in the area of biochemistry, biophysics and physiology, increases to 29% while in the area of mathematics, mechanics and cybernetics it reaches 34%.

PLANNING POST-GRADUATE COURSES

Planning the post-graduate training of scientific, technical and scientific-pedagogical personnel is carried out in order tomeet the demand of the national economy, academies and their institutes, research institutes, higher educational establishments, qualification improvement institutes, branch research institutes and designing institutes in the highly qualified personnel.

The quality of training scientific, technical and scientific-pedagogical personnel at the scientific organizations of the USSR Academy of Sciences and at higher educational institutions depends at large on the availability of scientific schools, directions, prsonnel of scientific-research institutes of the academies, and professor-teaching personnel at higher educational institutions. It is for them to solve the task of transferring their scientific and professional knowledge, accumulated in the course of decades, to the future scientific and scientific-pedagogical workers, to arm them with modern scientific methods of research and skills of creative exploration of new and progressive ideas in the subsequent acceleration of the scientific-technical revolution.

Post-graduate courses were organized in our country for the first time in 1925 under the Presidium of the State Scientific Council. The number of students reached only 30. In 1929 the number of post-graduate students reached 5,000. Consequently, a strong foundation was laid down for training scientific and professor-teaching personnel during the first years of the Soviet power.

As a result of the planned measures for training and drawing in new teachers at higher educational institutions the number of the professor-teaching personnel increased by 1939 to 58,200 i.e. three-fold as compared with the 1925/1926 academic year.

The decision of the Soviet government to introduce in 1937 staff rates of salaries permitted to reinforce the professor-teaching personnel, raise scientific-research work at the higher educational institutions to a higher level, and create a stable staff at the higher educational institutions.

A teacher of a Soviet higher school is a pedagogue and a scientist. The social duty of each teacher is to improve continuously his pedagogical mastership, renew his store of knowledge, and, basically, contribute to the further advance of Soviet science and technology.

The decision of the Central Executive Committee of the USSR in September 1932 on the introduction of scientific degrees and ranks contributed to the scientific advance of the scientific-pedagogical personnel.

As a result of organizing the Committee for Higher Schools in 1936 it became possible to centralize the entire work on conferring scientific degrees and ranks at the Higher Certification Commission.

In planning the training of scientific, technical and scientific-pedagogical personnel speical attention is given to expanding the training of personnel in the major branches of science, and in professions, whose requirements in the national economy are not satisfied yet completely, and reducing admittance in professions, whose requirements in specialists is low.

The plans of training scientific and scientific-pedagogical personnel are elaborated by the USSR State Committee for Science and Technology by the branches of science on the basis of draft plans of the USSR ministries (departments) and the Councils of Ministers of the union republics.

The USSR ministries and departments submit draft plans elaborated by the branches of science and professions for the ministry (department) proper; the Councils of Ministers of the union republics - for the republic proper and separately for the ministries and departments of republican and union-republican subordination.

These draft plans comprise of figures of admittance and graduation from post-graduate courses with division into forms of training.

Beside that, calculation indices are submitted for preparing and defending dissertations by competitors and post-graduate students of earlier years and for additional requirements in candidates of science.

The figures for admittance to post-graduate courses, submitted by the USSR ministries and departments and the Councils of Ministers of the union republics, as well as the scope of claims for training personnel at inter-departmental and inter-republican post-graduate courses are determined on the grounds of calculating the additional requirements of the subordinated higher educational instituions, scientific organizations, enterprises and other organizations in candidates of science.

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Determination of additional requirements

The additional requirement is determined for the year of graduation of the planned admittance to the post-graduate courses with consideration of the following factor:

1) number of vacant posts occupied not by candidates of science but by persons without scientific degrees at the time of drawing up the plan (determined by the staff list);

2) scope of natural losses of candidates of science (calculated of the grounds of actual data for the last 5-8 years);

3) scope of increment of posts to be occupied by candidates of science, proceeding from the planned scope of scientific-research work (at higher educational institutions - from the planned number of students).

When calculating the additional requirement, the derived value should be reduced by the calculated value of replenishing the number of candidates of science owing to graduation from post-graduate courses with defense of dissertations by persons whose time of post-graduate training neds not later than the year preceding the year of graduation of the planned admittance to the post-graduate courses, as well as by the expected scope of replenishing the number of candidates of science by competitors and persons trained earlier at post-graduate courses but who had not defended dissertations in the prescribed date (considered for all the years from the moment of elaborating the draft plan up to the year of graduation of the planned admittance to post-graduate courses inclusively).

The additional requirements in candidates of science is calculated by all the ministries and departments, having subordinated scientific-research organizations, higher educational institutions, scientific-production associations, organizations and enterprises carrying out scientific and scientific-research work.

USSR ministries and departments lacking post-graduate courses, submit data on additional requirements in candidates of science together with claims for training scientific and scientific-pedagogical personnel at inter-departmental and inter-republican target post-graduate courses.

The number of disertations to be defended by competitors and post-graduate students, who graduated earlier, is determined by ministries and departments by the expected number of dissertations to be defended by the workers of subordinated scientific organizations and higher educational institutions.

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Admittance

The figures for admittance to target post-graduate courses are calculated to satisfy the requirements of scientific-research organizations, higher educational institutions, scientific-production associations, organizations and enterprises in candidates of science but having no means to train them on the spot.

The figures are approved as follows:

1) admittance to inter-departmental and inter-republican target post-graduate courses - by the USSR State Committee for Science and Technology on the basis of claims submitted by USSR ministries and departments, and Councils of Ministers of the union republics;

2) admittance to inter-departmental target post-graduate courses - by USSR ministries and departments and those of the union republics;

3) admittance to inter-republican target post-graduate courses - by councils of ministers of the union republics.

Admittance to target post-graduate courses is effected on account of the general plan of admittance at the place of training the post-graduate students.

Graduation from post-graduate courses is determined by the number of post-graduate students, whose time of training ends during the planned years with account of students who discontinued studies. The figure of dismissal from post-graduate courses is determined on the grounds of dismissal figures for each type of training in a number of preceding years with consideration of measures to reduce this figure.

The USSR ministries and departments and the councils of ministers of the union republics, having subordinated higher educational institutions, indicate figures in the plans for training scientific and scientific-pedagogical personnel at higher educational institutions by the branches of science.

A series of decisions have been adopted in the last two decades with the aim of improving the training of scientific and scientific-prdagogical personnel. In 1974 the Higher Certification Commission was transferred from the USSR Ministry of Higher Education to the system of the USSR Council of Ministers. Final certification of dissertations is performed by the USSR Higher Certification Commission. The passing of entrance examinations to the post-graduate courses, candidate examinations while studying at the courses, preliminary examinations of the dissertation work at the meeting of the chairs, departments of scientific-research institutes, as well as at the enterprises where the work has been done, are all intermediate instances for certifying the future scientist. Prior to defending the dissertation it is required to publish the main ideas of the dissertation in the form of a scientific article or monograph, introduce the results of research in thenational economy while circles of readers, i.e. scientists and practical workers can familiarize themselves with the dissertations.

Privileges and Advantages :

An efficient system of training scientific and scientific-pedagogical personnel has been formed in the Soviet Union. The state grants the post-graduate students and competitors of scientific degrees a series of privileges and advantages, and the work of scientists in our soceity is a highly esteemed area of human activities.

The creative cooperation of the USSR Academy of Science with the higher school in training scientific and scientific-pedagogical personnel is manifested in various aspects. The Academy coordinates and plans fundamental and theoretical research at higher educational institutions, participates in scientific research at the latter institutions and in elaborating problems associated with the further improvement of the educational process. The Institutes of the Academy of Science are the scientific basis for the post-graduate students and teachers of higher educational institutions to work on probation. These steps raise the level of training scientific and scientific-pedagogical personnel, and permit selection of the most capable and trained specialists for independent scientific activities.

The most important item in the entire problem of scientific and scientific-pedagogical personnel in our country is the one of the preparation and defence of doctor dissertations. The system was adopted in 1962, according to which teachers, having a scientific degree of candidate of science and working at doctor dissertations of actual and national-economic significance, may occupy during 2 years vacant posts of senior scientific workers for successful completion of their dissertation work and its subsequent defense. Practice has revealed the efficiency of this measure.

Besides, the Soviet State grants a right for paid 3-6 month creative holidays for teaching personnel of the higher educational institutions and scientific workers of research organizations for successful completion of their dissertations. The higher educational establishments also give paid creative holidays (up to 6 months) for work over teaching manuals and important scientific monographs.

Number of Post-graduates :

During the fifty years of its existence the USSR Higher Certification Commission certified 56,000 doctors of science and about 600,000 candidates of science. It is necessary to stress the significant part of the USSR Higher Certification Commission in forming the scientific potential of our state, in the training of scientific and scientifif-pedagogigal personnel of highest qualification, as well as in efficient utilization of the results of dissertation work in the national economy of the USSR after final certification by the Commission.

A network of specialized training-scientific organizations and institutes have been set up with the aim of raising the skill of leaders, workers and specialists of planning organs, and scientific and scientific-pedagogical personnel. These include Academy of Social Science , Academy of National Economy, Higher Economic Courses, and other institutes and faculties for improvement of skills. Work on probation is practised for teachers, assistant professors and professors, lecturing on special subjects,, at advanced industrial enterprises, leading higher educational institutions and academic scientific-research institutes.

Consequently, all these support the training and graduation of hundreds of thousands of high-skilled Soviet specialists for all the branches of the national economy in the country, as well as training of scientific and scientific-pedagogical personnel for the further successful advance of Soviet economy, science and engineering (see Table No.4).

The development of higher schools and the training of scientific and scientific-pedagogical personnel in the union republics, is shown in table 5. where there was not a single higher educational institution before the Great October Scoialist Revolution.

Table No. 4

Number of Scientific Workers Trained at Post–Graduate Courses

	1940	1965	1970	1975	1980	1981	1982
Total number of postgraduate students (at end of year)							
studying:	16863	90294	99427	95675	96820	97860	98320
discontinuing work	14425	51109	55024	41857	39666	42011	44228
without discontinuing work	2438	39185	44403	53818	57154	55849	54092
At scientific organizations (less higher educational institutions)							
studying:	3694	36882	42518	39969	38767	39197	39271
discontinuing work	2919	17765	18725	13052	11376	12043	12525
without discontinuing work	775	19117	23793	26917	27391	27154	26746
At higher educational institutions:	13169	53412	56909	55706	58053	58663	59049
discontinuing work	11506	33344	36299	28805	28290	29968	31703
without discontinuing work	1663	20068	20610	26901	23751	23568	27341
Total graduated per year	1978	19240	25870	26021	23751	23568	24203
Scientific organizations (without higher educational institutions)							
studying:	506	7395	10757	10374	9213	8944	9377
discontinuing work	454	4701	5842	4880	3325	3142	3427
without discontinuing work	52	2694	4915	5494	5888	5802	5950
Higher educational institutions							
studying:	1472	11845	15113	15647	14538	14624	14828
discontinuing work	1411	8764	10620	10707	8474	8413	8637
without discontinuing work	61	3081	4493	4940	6064	6211	6141

Table No.5

Number of Post-Graduate Students in Union Republics by end of 1982

	Total number of post-graduate students	Studying	
		at scientific organizations (less higher educational institutions)	at higher educational institutions
USSR	98320	39271	59049
RSFSR	67977	26831	41146
Ukrainian SSR	13202	4576	8626
Byelorussian SSR	3123	1224	1899
Uzbek SSR	3295	1565	1730
Kazakh SSR	2377	1011	1366
Georgian SSR	1459	620	839
Azerbaijan SSR	1601	961	640
Lithuaninal SSR	871	362	509
Moldavian SSR	619	353	266
Latvian SSR	725	235	490
Kirghiz SSR	639	409	230
Tadjik SSR	580	263	317
Armenian SSR	918	424	494
Turkmen SSR	459	252	207
Estonian SSR	475	185	290

METHODS OF DETERMINATION OF ECONOMIC EFFICIENCY

OF CAPITAL INVESTMENT AND NEW TECHNOLOGY

INTRODUCTION

Recent Soviet decisions stress that one of the important tasks in the field of further improvement of management of the national economy consists of the substantiation of the most efficient directions of economic development ensuring fast progress of the economy along intensive ways of development. In this respect a particular importance is attributed to raising the level of scientific substantiation of methods used in determining economic efficiency of planning and project preparation decisions and their wide introduction into practice of economic activities.

METHODOLOGY FOR DETERMINING EFFICIENCY

We have accumulated a considerable experience in elaboration of methodological problems of determining efficiency of new technology with certain practical outcome. Our planning and project preparation practice in selecting the best variant of capital investment and new technology has always used as criterion the minimum annual reduced costs or calculated the indicator of returns of additional capital investment comparing it with the normative. Recently in planning and stimulating new technology the indicator of the national-economic effect is widely used. While calculating this indicator one has started to take account of social factors as well as factors related with rational use of natural resources, environment protection and external economic activities. In substantiating large capital construction projects, production development and siting, formation of large intersectoral scientific and technological programmes together with the existing prices the so-called completing costs of minig and agricultural produce are widely used. In determining the economic efficiency of new products of high quality the calculation is based not on a selling price but on the price upper limit reflecting the economy of expenditureof user of new technology and so on. The afore said methods which are widely used in modern planning and project preparation activities are based on a theoretical concept of comparative efficiency of capital investment. A considerable contribution to its development has been made by such outstanding Soviet economists

Presented by D.S. Lvov

as V.V. Novozhilov, A.L. Lourie, L.A. Vaag, T.S. Kharaturov and others. Later the methodology of comparative efficiency has merged with a general theory of optimal planning and management of the socialist economy whose elaboration and develoment resulted from the work done by L.V. Kantorovich, A.G. Aganbegyan, N.P. Fedorenko, V.F. Pugachev, S.S. Shatalin, N.Ya. Petrakov, etc.

It might be very useful to generalize our country's experience in the field of technical-economic substantiation and to use it in the system of economic measurement of scientific and technological progress, in selection of the best large S and T development projects from the national economy point of view. In this connection the subsequent part of the present paper is dedicated to princcipal problems of methodology of determining economic efficiency of new technology.

1. Methodology of general and comparative efficiency

Modern practice of economic substantiation of planning and project preparation decisions is characterized by a wide use of two fundamental principles, namely general and comparative efficiency of capital investment.

General efficiency is determined as a ratio of the national income to the production funds or a ratio of the national income increment (net produce or profit) to the capital investment which triggered this increment. In this case the efficiency is defined as the total volume of the national income or its increment (or profit).

Comparative efficiency is determined by the difference of the so-called reduced costs. In this case the efficiency is defined not by all value of the national income increment (net produce) or profit but only by that part which is formed after reducing the net produce or profit by its normative part (the product of efficiency normatives of production resources by their utilized volume).

General efficiency indicators include output/capital ratio. One may note a certain decrease of this ratio during recent years, but this does not imply that this has resulted in a decrease of efficiency of social production as a whole. Academician T.S. Kharaturov indicates that"the efficiency of social production may even rise due to decrease of current costs or prime cost of produce. In its essence, the calculation of efficiency of capital investment comes, to a considerable degree, to a comparison of single costs and prime costs. That is why under certain conditions it is more feasible to incur additional costs if they are returned within a normative period from savings in current expenditure". Thus, it is admitted that output/capital ratio cannot be used for determining efficiency of capital investment or other economic measures. And it is correct. One may speak about capital investment efficiency not taking account of the level of cost of other production resources only in conventional terms, bearing in mind that this is only a quotient factorial efficiency.

It must be also added that orientation towards the increase of output/capital ratio in every economic entity does not always bring growth of the sum total of output/capital ratios of all totality of these entities.

For example, let two enterprises be engaged in production of the same produce. Let the volume of their net produce be 2 and 8 million roubles and the production fund capital investment 6 and 16 million roubles respectively. Under these conditions the output/capital ratio of the first enterprise will be 33 kopecks per one rouble of fixed assets and 50 kopecks for the second enterprise. The sum total output/capital ration in this case will be equal 45 kopecks.

Now let us see what happens to the total output/capital ratio if each enterprise is oriented towards the increase of output/capital ratio.

Let us assume that there is a possibility to redistribute the output and capital investment in a different way bringing the capital investment of the first enterprise up to 18 million roubles and the output of produce to 7 million roubles. This will bring a reduction of produce increment of the first enterprise to 3 million roubles and of capital investment volume to 5 million roubles. The total output of produce of the two enterprises will remain unchaged whereas the volume of capital investment will increase by 1 million roubles. Then the output/capital ratio of the first enterprise will climb from 33 kopecks to 39 kopecks and from 50 kopecks the second enterprise. However, the total output/capital ratio of these enterprises will drop by 2 kopecks (instead of 45 kopecks it will be 43 kopecks).

This "paradox" results from the fact that the indicator of output/capital ratio does not meet the requirement of subconjugation of local (self-accounting) aims to general (national economy) interest of production development as a whole.

Among general efficiency indicators there is also an indicator of profitability which is widely used in economic practice. There is a question whether this indicator makes it possible to reflect to a fuller degree changes of production efficiency.

Before answering this question let us consider the following example. There are two variants of production development:

Production Development Variants

Indicators	Variants I	Variants II
Annual output of produce, million roubles (P)	5	5
Prime cost of annual output of produce (C), million roubles	4.2	3.6
Capital investment in production funds (I), million roubles	2	4
General effieicney 100(P - C)/I minus investment profitability, per cent	40	35

As we can see for the equal volume of produce (5 million roubles) the second variant of production development requires twice as much of capital investment accompanied by a reduction of profitableness from 40 to 35 kopecks. On the basis of general efficiency indicator the preference should be given to the first variant. However, this less capital-intensive variant is characterized by higher production running costs. Annually the cost over run comes to 600 thousand roubles (4.2-3.6). Let us suppose that this cost over-run results from overconsumption of fuel in transport operation. To compensate this overconsumption it is necessary to install additional petroleum refining capacities. What is the volume of capital investment needed to compensate the indicated overconsumption of fuel? This question can be answered easily. If we accept the normative coefficient of capital investment efficiency to be 0.12 (as it is recommended by Standard methodology of determining economic efficiency of capital investment), then to compensate annual loss of 600 thousand roubles it is necessary to invest additionally 5 million roubles into the petroleum refining industry (600/0.12). Thus, the realization of the first variant will require not 2 million roubles of capital investment but 7 million roubles (2+5) which exceeds the volume of capital investment of the second variant by 75%. Morever, the afore said 5 million roubles have been neglected by the profitableness indicator. Only additional calculations make it possible to identify the more capital-intensive vriant which originally seems to be less capital-intensive. One may eliminate these calculations if during economic substantiation of the variant we would use direct comparison of estimated payoff periods with the normative payoff period. In our example the additional capital investment equals 2 million roubles and the prime cost reduction for the same output of produce- 0.6 million roubles. This shows that estimated payoff period will be 3.33 (2/0.6) or twice as less as the payoff normative period which equals 8.33 years (1/0.12). This confirms efficiency of the second variant.

Thus, by using the indicator of "payoff period" it becomes possible to identify the most efficient variant of a project preparation decision. However this indicator does not represent general efficiency of capital investment but rather comparative efficiency related directly to the indicator of annual reduced costs. This can be easily seen from making a simple transformation of the initial formula used for selection of the best variant of capital investment by minimum estimated payoff period. It is possible to express our example in the following manner.

$$Te = (I2 - I1)/(C1 - C2)$$

$$Tn = 1 / En$$

where Te and Tn denote the corresponding estimated and normative payoff period of additional capital invesment;

En denotes a normative coefficient of capital investment efficiency;

I1 and I2 denote the corresponding capital investment volumes for the first and the second variants;

C1 and C2 denote prime cost of equal output of produce for the first and the second variants.

This produces the inequality $(C2 + En.I2) < (C1 + En.I1)$. The left and the right parts of the inequality represent nothing else but annual reduced costs of the variants compared. As the left part of the inequality is less than the right part the second variant of capital investment is more economical than the first one, and vice versa. Thus, the most economical <u>always will be a variant</u> which is characterized by the smallest value of annual reduced costs. This is true for any number of compared variants. It is not difficult to calculate the effect of using the most economical variant. It equals

$$(C1 + En.I1) - (C2 + En.I2)$$

which, when transformed, give C - En.I. Thus, the effect represents above normative saving or, as we have already noted, general saving (profit) reduced by its normative value which equals En.I.

In our example the reduced costs for the first variant will be 4.44 million roubles (4.2 + 0.12 x2) and 4.08 million roubles (3.6 + 0.12 x 4) for the second variant. The economic effect of the second more economical variant will be equal 0.36 million roubles (4.44 - 4.08).

It is necessary to point out that in project preparation practice the choice of the best variant of capital investment and new technology, especially when their number exceeded two, has been on the basis of minimum annual reduced costs and not minimum estimated payoff period. This is explained by simpler calculation procedure. Morever, very often the calculation of payoff periods is erroneous. The comparison of all variants is carried out with a single base whereas it is required to carry out consecutive comparison of all variants in pairs. The calculation procedure in this case consists in maximum possible approximation of estimated efficiency of capital investment to the normative efficiency. Moreover, one has to take account of conventional meaning of "payoff period" notion. It is not by accident that this notion is written in inverted commas. Usually it signifies a period of time during which real accumulated saving of running costs becomes equal to initial volume of additional capital investment. But every economist knows that saving received during the first year is considerably higher by its real value than the same saving received one or more years later. From the standpoint of the national economy this growth of value is determined by the possibility of multiple use of saved resources in the reproduction process. In view of this there will be no integral saving "counter-balancing" additional capital investment. That is why the words "payoff period" do not bear the implicit meaning. These reasons lead to usual substitution of "payoff period" indicator with its more "reliable" equivalent - annual reduced costs. It is necessary to underline once again that the essence of these two indicators is the same as they reflect comparative efficiency of one variant of capital investment with the other. It is only with these indicators (and not general efficiency indicators) possible to select the best variant of capital investment and new technology. And this is not by accident as the comparative efficiency indicators are oriented towards the national economy level of capital investment efficiency which is reflected in a normative efficiency coefficient established in a centralized manner. Does it mean that general efficiency indicators should not be taken into account while determining the efficiency of capital investment and new technology?. Definitely not. It is feasible to use them in technical - economic analysis of initial variants, to assess real possibilities of realizing the best variant selected on the basis of comparative efficiency criteria. But the general efficiency indicators cannot be used for direct comparison and selection of the best variant of technical decision. This is a prerogative of the comparative efficiency indicators. This difference between general and comparative efficiency indicators constitutes a corner-stone of a draft of Complex methodology.

II. Generalizing indicator of capital investment and new technology efficiency

Amy process of productive activities of people involves three factors of production: alive labour, running material

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expenditure (raw materials, materials, fuel, electric power, etc) and production funds, i.e. three different types of labour expenditure varying by their circulation period which cannot be summed up in a different manner. Production results in output of commodities or implementation of work of a given volume, quality and assortment done within specified period of time.

Division of output by number of workers produces a labour productivity indicator. Inalogically, division of output by value of productive funds produces the output/capital ratio whereas division of material cost by output gives an indicator of material intensity of a good, etc.

The growth of social production efficiency is related to positive dynamics of each of the afore-said indicators. However, in real life there may occur opposite-direction dynamics when an increase of efficiency triggered by one factor is accompanied by a decrease of efficiency resulting from another factor.

That is why these proportional indicators of efficiency cannot be used either to determine changes of aggregated efficiency of production or to select the most preferable variant.

Correct determination of economic efficiency of social production can be done only on the basis of taking account of combined impact exerted by all economic growth factors. This brings a problem of commensurability in a generalizing indicator of diverse trends characterizing separate although closely inter-related aspects of economic dynamics.

The interests of raising efficiency of all social production require the use of more elaborated method of measurement of production cost making it possible to compare the output not with separate types of cost but with their sum value.

And there exists such method of brining separate criteria to a single generalizing indicator. For example, for this purpose one may use a national economy production function which relates the volume of national income (Y) to the volume of labour resources (L) and productive funds (F).

$$Y_t = Y(L_t, F_t, t) \qquad (1)$$

On the basis of differentiation and local linear homogeneity it follows from (1) that there is a relationship between the national income increment (ΔY) during a short period of time (Δt) and the increments of productive funds (ΔF) and number of workers (L) for the same period:

$$\Delta Y = (\partial Y/\partial F)\Delta F + (\partial Y/\partial L)\Delta L + (\partial Y/\partial t)\Delta t \qquad (2)$$

In optimal planning theory values $\partial Y/\partial F$ and $\partial Y/\partial L$ are determined efficiency normatives of utilization of the productive funds (EN) 2650 and labour resources (F_L). Consequently,

$$\Delta Y = E_N \Delta F + E_L \Delta L + \partial Y/\partial t \qquad (3)$$

Each of the afore-said normative shows by how mnay units will grow the national income resulting from a unit increment of the corresponding resource while the volume of the other resources will remain unchanged.

The first two summands (3) can be interpreted as the national income growth resulting from the expansion of volume of the production resources being used whereas the third summand reflects changes in the national income due to better use of the production resources in a given period of time compared to what has been originally planned on the bais of the normative set for this interval of time. It is not difficult to show that it is just so.

It is known that the national income growth takes place under the influence of two factors - an increase in number of workers engaged in material production and an increase of labour productivity. In its turn the growth of labour productivity results from provision of labour with better tools, utilization of advanced technologies saving not only alive but also past labour, better organization and management of production.

Let us assume that in one year the national income has grown by ΔY, where $\Delta Y = Y_t - Y_{t-1}$. If the labour productivity in year t remained at the level of a previous year, i.e. t-1, the national income growth resulting from the increase of number of workers engaged in the material production would have been

$$\Delta Y_L^{0} = (Y_{t-1}) / L_{t-1} \cdot \Delta L_t$$

where Y_{t-1}/L_{t-1} stands for labour productivity in the previous year and ΔL_t denotes the increment of workers engaged in the material production during year t in relation to year t-1.

However, the basis of labour productivity and ensuing growth of the national income have been determined by keeping capital/labour ratio unchanged. This requires additional investment in amount of $\Delta F^{0} = F_{t-1}/L_{t-1} \cdot \Delta L$ In this case ΔF^{0} value is a sort of compensator of the unchanged labour productivity. In view of this it is rightful to state that a part of the national income increment results from the productive funds. There is strict evidence that this part is proportional to the elasticity coefficient of replacing the labour with the funds and to the normative coefficient of capital investment efficiency E_n. Then the national income increment resulting from the increase of workers engaged in the material production will be somewhat lower than the labour productivity indicator, i.e. it will equal not

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$Y_{t-1} / \Delta L_{t-1}$ but $\Delta Y'_{t-1} / \Delta L'_{t-1}$,

where $\Delta Y'_{t-1} / \Delta L'_{t-1}$ is not an average

but a top value of labour productivity. The latter shows what would be the increment of labour productivity if the capital/labour ratio at additional working places were lower than at already existing working places. The top value of labour productivity can be expressed as $EL = (\Delta YL - E_n F)/\Delta L$.

In reality the labour productivity does not remain stable, it goes up. Simultaneously this is accompanied by drawing additional capital investment into economic circulation which increase the capital/labour ratio and organizational-technical level of production. This explains the fact that the total growth of income actually exceeds that part which is directly determined by additional expenditure of production resources utilized with unchanged basis efficiency. This part can be rightfully considered as an increment value of normative net produce (ΔY_n)

which is defined as $\Delta Y_n = E_L \Delta L + E_N (\Delta F^{\circ} + \Delta f) = E_L \Delta L + E_N \Delta F$,

where $\Delta F^{\circ} + \Delta f = \Delta F$ stands for the total increment of productive funds in year t as compared to year t-1.

The increment of normative net produce could be interpreted as the increment of income at the expense of extensive factors of economic growth. Then the increment of income on the basis on intensive factors (ΔYt) will equal :

$$\Delta Y_I = \Delta Y - \Delta Y_N \qquad (4)$$

This equation shows that the income increemnt resulting from the intensive factors does not depend on the resources but on the efficiency of their utilization during a given period of time, i.e. it represents income/time function ($\Delta Y / \Delta t$). It also follows that this income increment is nothing else but an over normative income. The latter is called a national economic effect.

By substituting ΔYI with R and through developing components of (4) we obtain :

$$R = \Delta Y - (E_L \Delta L + E_N \Delta F) \qquad (5)$$

With E_N and E_L normatives set for a given period of time and with actual or planned values of ΔY, ΔF and ΔL it becomes possible to determine a value of national economic effect both for the national economy as a whole and for separate branches and economic entities. In doing so, it is important to use single value units for measuring physical volume of the national income and the resources used for its generation. Their role is played by stable prices, normatives of efficiency of production resources and wages. In view of this the economic effect will be determined by the following modified formula :

$$R = \Delta Y - (1 + E_w)\bar{W} \cdot \Delta L + E_N \Delta F \qquad (6)$$

where $\bar{W}$ stands for average wage of one worker engaged in the material production which is accepted to be constant for a given period of time;

E_w denotes efficiency normative of work in relation to wage fund.

This formula makes it possible to use current prices, normatives and real dynamics of average wage. Burt then we shall determine not the intensification effect but the effect of current functioning of production.

The necessity of ensuring stable prices and evaluation in calculations in calculating the national economic effect is conditioned by the following thinking.

Current changes of wages are reflected in real functioning. It is known that in our country the wages are constantly rtising which corresponds to the Party's course aimed at continuous growth of the people's welfare. Socio-economic policy of the state is also reflected in the level of dynamics of prices: low prices for articles of the first necessity, housing and communal services, higher prices for luxurious articles and products which are harmful for health. In the process of current economic activities the existing system of prices and normatives makes it possible to solve problems related to creation of necessary conditions for self-accountingactivities of enterprises and amalgamations etc. In this respect prices, normatives and wages servicing current economic circulation and thus realizing socio-economic objectives of the plan are of little value for measuring the economic effect. As known, the economic effect reflects changes in full national economic expenditure and production. Current prices and evaluations reflect the process of redistribution of the society's net income. Whereas while determining the economic efficiency we are more interested in finding out what increment of net income we receive by spending our resources, i.e. we are trying to solve the problem of economic measurement of our input and output. We receive the possibility of subsequent redistribution of our income in the national economy to the extent of the excess of output over input. After the redistribution is done in our plant, after it has reflected prices, evaluations and wages the economic effect cannot be determined as it is dissolved in current prices and normatives. And here we come across another task - evaluation of self-accounting efficiency of production, determination of income or profit ensured by current productive functioning. Solution of this task is comportant and necessary. However, at present we are interested in real growth of income ensured by the existing volume of prouction resources. That is why it is necessary to assure stable prices and evaluations while determining the national economic effect. Apparently a five-year period represents normal limits within which one may carry out such evaluations.

An important pecularity of calculations of the national economic effect done on the basis of Formula (6) consists in the fact that they are considered to be an integral part of a more general task- formation of the best variant of national economy plan. This is conditioned by the fact that the calculation of the national economic effect is based on a system of economic normatives reflecting target objectives of the plan. In this sense, the plan and normatives constitute a single unity: during the process of interated procedure of elaboration of the best variant of planned decision the corresponding normatives are being established. With the framework of a new five-year plan the system of economic normatives represents an initial basis for calculation of the national economic effect. They help to identify the most efficient variants of production of development from the national economy point of view.

The interrelation of methods of calculating the effect with the plan makes it possile to use it as a generalized indicator of efficiency for all levels of economic management. From the point of view of its economic content the indicator of national economic effect represents <u>an increment of net economit profit</u>. While analysing operation of separate economic projects the indicator of net profit growth for each project can be integrated to produce a single generalized indicator for the national economy as a whole.

In calculations one may use an indicator of full national economic effect. It differs from the net effect by the inclusion of material expenditures. In this case the effect is determined as a difference between the gross output growth (X) and the reduced costs (Z):

$$R = \Delta X - \Delta Z \qquad (7)$$

In its turn $\Delta Z = \Delta S + \Delta M$, where $\Delta \underline{S}$ stands for the increment of net normative costs: $(1 + E_w) \times W \Delta L + EN \Delta F$ and ΔM denotes the increment of running material costs and depreciation. Formula (7) corresponds to formula (6) as:

$$\Delta X - \Delta Z = (\Delta Y + \Delta M) - (\Delta S + \Delta M) = \Delta Y - \Delta S$$

This indicates to wide possibilities of using the formula of 2650
annual reduced costs in production management.

On the basis of the national economic effect indicator one can also calculate other interconnected indicator: the effect of relative saving of resources and the effect of enlargement of production scale.

The value of the national econopmic effect (or intensification effect as it has been called earlier) is determined for different economic results of two years under comparison. . The calculation of generalized indicator of efficiency reduced to a similar economic result makes it possible to determine the effect of relative saving of et normative expenditures which results, in principle, from scientific and technological progress and consequently can be called the effect of S and T progress (RSTP). Its value is determined by the following formula:

$$R_{STP} = S'_{t} (Y_{t+1} / Y_{t-1}) - S_{t-1} \qquad (8)$$

It is possible to express S and T progress effect by relative saving of separate types of resources: wage fund resulting from disengagement of workers

$(R_{W} = W_{0} (Y_{t-1} / Y_{t}) - W_{t}$ and productive funds $R_{F} = F_{t-1} (Y_{t-1} / Y_{t}) - F_{t}$

Similarly to RW and RF indicators it is possible to calculate relative saving of corresponding material resources.

It must besaid that neither RSTP indicator nor indicators of relative saving of separate resources (RWand RF) are not additive, i.e. they cannot be added by direct count by separate products or economic entities (brahcnes, enterprises) if there is no coincidence of output growth rates of these entities with the natioanl income growth rates. In such cases there appear additional factor conditioned by structural heterogeneity of the national economy as well as by unequal growth rates of separate economic entities. It is necessary to take account of this factor by introducing the effect of structural changes in the national economy in a general scheme. To determine its value it becomes necessary to analyse intersectoral ties and proportions of economic growth of separate branches, enterprises (amalgamations). Under these conditions it is possible to single out a certain part from the macroeconomic RSTP value which results from the structural changes in the economy.

Relative saving of resources (STP effect) constitutes a part of the total national economic effect. Its another part is represented by the effect achieved through enlargement of economic measures effective from the position of basis time moment. It is called the scale effect (R_S):

$$R_S = R_{STP} - R = (Y_{t-1} - S_{t-1})[Y_t / Y_{t-1}) - 1] \quad (9)$$

Given the fact that RSharacterizes the enlargement of output leading to the increase of the total economic effect it is rightful to qualify it as intensive and not extensive factors.

When making a choice of the best planning or project prepparation variant of production development, creation and introduction of new technology, reconstruction of the existing and construction of new enterprises indicators of annual and integral economic effect of new technology are used.

The annual effect is calculated by dividing the difference of reduced cost by annual output of new technology. Another variety of this effect is calculated for the whole period of utilization of new technology but always on the basis of annual output.

The integral effect is determined as a sum of annual economic effects for the whole planned period of new technology production and utilization. In doing so one takes account of economic dissimilarity of inputs and outputs carried out and obtained at different moments of time. For this piurpose one uses a corresponding method of reducing costs and output by time factor just in the same manner as it is done according to a standard methodology and new technology methodology. The only difference consists in the fact that complex methodology envisages the use of the same normative utilized in the calculation of reduced annual costs and not a diminished one recommended by the aforesaid methodologies. To our mind such approach to taking account of time factor opens its economic essence and content more fully and precisely.

The integral economic effect represents the most important dynamic characteristic of new technology. It reflects changes in costs and output at different stages of life span of new technology beginning with the project development activities and ending by the use of this produce by customers. The integral effect, in its essence is a cumulative effect relaized during the last year of production of new technology.

However, there is another group of tasks (f.i. evaluation of aggregate effect for the national economy as a whole, ministry, amalgamation and so on obtained due to the introduction of new technology) where it becomes necessary to determine the effect directly for one separatley taken year. In this case it is not feasible to calculate the integral effect as various types of newtechnology have different utilization periods, beginning and duration of production, etc. That is why in planning new technologyit is necessary to take account of both the annual and integral effects. The annual effect value serves the basis for calculation of the integral effect. But it alsohas the meaning o its own. It serves the basis for determination of financial, material and other types of production resources allocated for scientific research and designing organizations, amalgamations and enterprises for a concrete year of elaboration, mastering and series production of new technology. It is also used in determining the volume of that portion of profits received by amalgamations and enterprises from introducing new technology whcih goes to the state budget. The selection of the best variant of new technology should be done on the basis of the integral effect. It also plays an important role while substantiating prices for new products of industrial-technical designation.

In this respect it is also necessary to mention the incentive-bonus system used in creation and introduction of new technology. It is known that today the volume of such bonus

depends on the volume of annual economic effect. However, it seems expedient in determining the volume of bonus to tak account of not only annual saving due to new technology but also the time during which one will receive this saving, i.e. to take account of life span of new technology, volume and period of its production. This will make it possible to reinforce the orientation of designers towards the creation of such tehcnology which produces maximum integral economic effect.

ECONOMIC METHODS OF STIMULATING

SCIENTIFIC AND TECHNOLOGICAL PROGRESS

INTRODUCTION

The perception of scientific-technical progress as improvement of the economic indices in the activities of enterprises on the basis of introducing the achievements of science and technology into production is evidently the same the world over. Introduction implies organization of the production of new materials and articles, machines, equipment, devices, means for servicing them, etc. New technologies, based on the achievements of fundamental and applied sciences and put into practice at manufacturing enterprises, are also considered as "introduced" and indicate scientific-technical progress in one or the other branch of material production. New methods of production and scientific labour organization are highly important for improving its effectiveness and represent one of the methods for realizing the achievements of economic science in production. In other words, scientific-technical progress means improvement of the effectiveness of production on the basis of achievements in sciene and technology.

DETERMINANTS OF S&T PROGRESS

Intensification of production is the major component of scientific-technical progress, and this requires up-to-date technologies, equipment, machines and devices. Computer engineering is also used for this purpose. More and more technological lines and machine tools are equipped with programme controlled microprocessors and other means of automation on the basis of computer engineering. Robotics is applied on an expanding scale in production using flexible readjustable lines. Another significant part of scientific-technical progress lies in the improvement of the technical level of production, the technical level and quality of the materials, and the articles manufactured by the enterprises.

The rates of scientific-technical progress are determined primarily by the creation and widescale application of new techniques and methods, based on new implements, new materials with predetermined properties, enabling to raise sharply labour productivity, reduce the weight of the machines and mechanisms, make them more reliable and extend their lifetime.

Presented by N.Y. Safronov

Improvement of production technologies is the determinative direction of scientific-technical progress today. Replacement of the technologies used at the current stage by more advanced resource-saving and wasteless technologies, ensuring more complete utilization of the raw material and economy of labour, material-technical and fuel-energy resources, is the most efficient direction of scientific-technical progress.

Thus, new technologies, introduced in the extractive branches of the industry, change radically the ideas on the mehtods of drawing deposits, considered earlier as non-prospective. Advanced methods of extracting useful minerals ensure an increase in production from the entrails of the earth. Our planned transition to qualitatively new methods and means of increasing the oil recovery of the formation, the extraction of coal, non-ferrous metal ore and other useful mineal's makes it possible to increase the output of these valuable raw materials by 15-20%.

New technologies render great help in the utilization of energy and material-technical resources, and reduction of labour expenditures. For example, enlargement of the unit capacities of the basic technological equipment in the power industry, i.e. replacement of power-generating units of 300 MW units with 800 MW has made it possible to reduce the specific capital investments in the construction of electric power stations by 8-10%, the specific labour expenditures in construction by 15-20%, the specific consumption of conditional fuel by 3-4%, the specific number of servicing personnel by 40-50%, and the specific metal capacity of the equipment by 15-20%.

Various economic levers, which are of interest to the designers and manufacturers of new machinery, in accelerating their developments and introduction into practice, in reducing the cycle "investigation-production", are applied in the national economy of our country in order to accelerate the rates of scientific-technical progress to the maximum.

ECONOMIC STIMULANTS

The economic levers, or stimulants, as they are called too, may render effect on different sides of scientific-technical progress: on the process of developing innovations, the process of their introduction into industrial production, and the process of their utilization. It is possible practically in every case to provide effective stimulants to the designers, maufacturers and users of the new machinery, either stimulating them economically for one or the other achievements, or by raising the economic profitability.

SINGLE FUND

The economic stimulants, increasing the profitability of the new machinery for the designers and manufacturers, for example, for the scientific-research organizations and the industrial enterprises, are made up by the single fund for the development of science and technology (SFDST), which is formed in industrial ministries. As an experiment, this fund was formed in the Ministry of the Electrotechnical Industry as far bask as 1969. It has been formed currently in all the ministries.

The single fund for the development of science and technology is formed by the deductions from the planned profit of the enterprises, subordinated to the given ministry, as a certain percent, and from other sources. Before the formation of SFDST all the scientific-research and experimental-design work had been financed from different sources, that was, on the whole, inconvenient for the research organizations and enterprises. Leaving aside all details, it is necessary to note that this fund enables to prepare and bring the manufacture of new machinery to a commercial level, carry out experimental work at industrial enterprises of the respective branch, compensate increased expenditures associated usually with the production of new machinery during the first year and, sometimes, the second year too. It is clear that increased expenditures are undesirable in the production of new machinery and, in this case, only the opportunity to gain considerable profit in the future may stimulate the enterprises to start the manufacture of new machinery. The possibility of compensating this by utilizing SFDST increases sharply the interest of the enterprises in introducing and, consequently, accelerating scientific-technical progress. The feasibility is considered currently for intensifying its stimulating role and articles are published frequently in the press with proposals of the heads of scientific-research organizations and enterprises to this end.

PRICE FORMATION

Price formation for new products according to the methodology adopted in our country, which is not associated with the market conjuncture, is a major sitmulant, increasing the profitability of the new machinery. Leaving aside the order and rules of price formation, it is necessary to note that it is based on calculating the expenditures for social labour (prime cost), a certain norm of profit for the manufacturer of the new machinery, and its eocnomic effectiveness per unit of useful effect. It should be noted also that the effectiveness of new machinery determines the so-called allowance to the wholesale price, whereas 70% of it is used for stimulating the development engineers and manufacturers of the new machinery, while the remaining 30% is divided equally between the state budget and the single fund for the development of science and technology in the branch.

The allowance to the price, the major part of which is used for economic stimulation of the development engineers and manufacturers of new machinery, is a powerful stimulant, making it possible to increase sharply their interest in introducing not only new machinery, but the most effective types that contribute to increasing the rate of scientific-technical progress to the amxlmum.

The allowance to the price is effective for one year, but if the economic effect of introducing the innovation is not evident after that year, then the State Quality Mark will be given to it, thereby prolonging automatically the term of its action for three years more. When observing certain conditions, the term of the allowance to the price may extend to seven years, and even 9-10 years in the case of very complex articles.

The decision "On measures for accelerating scientific-technical progress in the national economy", adopted on August 18, 1983, establishes the magnitude of this allowance up to 30% of the wholesale price of new machinery, which is most significant for the national economy. The allowance may include up to 70% of the economic effect of the production and utilization of the respective articles. A certain calculation mechanism has been developed in order to determine the magnitude of the allowance to the price in case the economic effect will not reach some maximum values.

One can imagine the significance of this stimulant, considering the tremendous scope of production of some highly effective objects of new machinery. The sums, assigned in some research organizations for awarding the workers, who have developed the new machinery, may make up and do constitute today up to 40% and more of the total value of these means.

Thus, SFDST and the prices are effective factors, stimulating the acceleration of developing and introducing new machinery and technologies, improving their qualitative and quantitative characteristics on the whole, accelerating scientific-technical progress.

SELF-SUPPORTIVE BASIS

However, the self-supporting basis is the major stimulant today. It is directed toward stimulating accelerated development, mastering and introduction of the achievements of science and technology into the practice of industrial production.

In the general sense, many Soviet scientists understand the self-supporting basis as a socialist system of economic relations, combining centralized management with relative economic independence of the economic links, based on stimulating the growth of production effectiveness in the interests of the society and individual collectives. In a narrower sense the self-supporting basis means that the enterprise or organization itself (within certain limits) can choose the most attainable final result and the dates of attaining it, and when the final result has been gained, then the possibility (again within certain limits) to utilize the resulting material advantages. The major principle of the self-supporting basis is that the material advantages may be gained only when the final result will be realized actually in the industry and, basically, in a material form. Unfortunately, as it will be shown below, this principle is not always observed owing to some reasons.

The self-supporting basis had been itnroduced in the industry in the present form in the second half of the 1960's. The self-supporting basis in science or the self-supporting system of organizing work for the development, mastering and introduction of new machinery had been realized gradually in some ministries in 1969-1979. The Ministry of the Eloectrotechnical Industry had been transferred in 1969 to this system of organizing work, then some more ministries, and in 1980 all the industrial ministries of the country had been transferred to this system in accordance with the decision of June 12, 1979, "On Improving planning and intensifying the effect of the economic mechanism on increasing the effectiveness of production and quality of work". Since that time the system has proved its effectiveness during these years and it has been decided, to transfer six more branches of the national economy to it by 1987: construction, transport, communications, agriculture, geological exploration, and logistics.

FUNDS FOR ECONOMIC STIMULATION

It is necessary to stress two major aspects of this system: the creation of SFDST for financing measures on scientific-technical progress, mentioned earlier, and the creation of special funds at scientific-research organizations that also stimulate the development of work on scientific-technical progress in the national economy, comprising of the fund of material incentive (FMI), the fund of socio-cultural measures and residential construction, and the fund for the development of production. These three are called funds of economic stimulation (FES).

The major source for the formation of FES are the deductions from the profit of the enterprises in the branch of the industry, produced by reducing the prime cost of the product as a result of introducing scientific-technical achievements. This source is most significant because the actual result, gained by the developmeent engineers, stands as concrete profit, which is reflected in the balance of income and expenditures of the enterprise. The fund-forming index for determining the magnitude of deductions from the profit is the actual economic effect from introducing the development. Up to 16.5% of the economic effect in some branches is deducted from the profit to the funds, while in others it is less. The percent of deductions is established on the basis of calculations made by the central organs. The ministries have the right to establish differential values of the deductions for their enterprises and organizations within the limits of the total values of planned deductions, depending on the levl and significance of the development. The ministries exercise this right on a wide scale, establishing differential scales, considering, for example, the fulfilme t of assignments of scientific-technical programs, the availability or lack of Author's Certificates or patents, etc. The means, produced from this source, depending on the ministry, constitute from 20 to 40% in the total amount of means in the funds of economic stimulation.

The next source is the allowances to the price of new highly effective products, that have been mentioned earlier. Alongside the reduction of the prime cost, this source is the case when the entire effect or a part of it in one or the other form remains in the branch of industry proper. In many cases, however, the achievement, developed and realized in one branch of the industry, produces an efect in quite another branch, and it is not always possible to transfer a part of the effect to the manufacturer of the new machinery by an allowance to the price.

The self-supporting basis envisages in this case that the respective means may be included in the estimate of expenditures for scientific-research work. A special scale is used in this case for determining the magnitude of deductions to the funds of economic stimulation, depending on the economic effectiveness of the developed and introduced new machinery. Table 1 illustrates that the scale is regressive, i.e. the magnitude of deductions decreases at an increase of the economic effect. This scale has been elaborated before introducing the self-supporting system of organizing work on developing, mastering and introducing new machinery, and it is far from satisfying everyone today, because it stimulates insufficiently the fulfilment of most effective development.

IMPACT OF ECONOMIC STIMULANTS

Certain types of developments exist, wherein it is impossible to determine the economic effectiveness in principle, while their social significance is at an extremely high level. For example, developments in ecology (environmental control), safety precautions, fire safety, etc. The self-supporting system envisages material stimulation of these developments. The estimate of expenditures for them may include in a separate line means for rewarding development engineers with premiums up to 20% of the wages fund during the entire term of development work. These means make up 20% or less in the total scope of FES respectively.

In many cases with most valuable technical solutions the term of their development and introduction is quite long. The date of receiving the material stimulation for the well-done work may be postponed in this case for so long that the effect of this factor, as a stimulant for accelerating scientific-technical progress, may decrease drastically. In order to eliminate such situation the self-supporting system envisages that, if the term of development and introduction of new machinery is longer than two years, then the development engineers may be given an advance payment, constituting up to 30% of the deductions to the fund of stimulation, calculated from the guaranteed economic effect. (The guaranteed economic effect is the anticipated economic effect that has been agreed upon by the development engineer and the customer of the results of the development, calculated on the basis of the specific effectiveness of the new mach'nery, guaranteed by the development engineer, and the guaranteed scope of its introduction, guaranteed by the customer).

If the guaranteed effect is attained after introduction, then the final sum of deductions to the funds of stimulation is reduced by the amount of the earlier advance payment, but if it is not attained and the final sum of deductions is less than the advance payment, then respective means ought to be returned to the SFDST of the customer of the development, as it is given in Fig.1. This threat is evidently the reason why advance payments even for development with a long cycle are accepted with reluctance and their part in the total sum of the funds is negligible.

Up to 20% (usaually 15%) of the means obtained from the stated sources are directed to the centralized premium fund of the ministry, and the rest is divided between the fund of material incentive and the fund of socio-cultural measures and residential construction in the relationship 60:40.

The means gained for winning in competitive research, means for additional stimulation of development engineers gained from the centralized premium fund (in accordance with the order of spending it), means gained for handing over their achievements (i.e. developments made for their branch of industry proper or for the natioanl economy) to other branches, as well as means gained from other sources of fund formation are directed only to the fund of material incentive.

Other sources are used for the formation of the fund of production development in scientific-research organizations (see Fig.3). The major source of these means is the profit of scientific-research and experimental-design work, which is included in the estimate of expenditure for their fulfilment. This profit constitutes 1.5% of the annual guaranteed economic effect, which, naturally, is corrected, depending on the effct gained factually after completing and introducing the development. Two limitations are applied to the profit: the profit may be maximum 6% of the estimated cost of the work and charged only for developments, whose guaranteed effect exceeds the estimate cost two times and more.

Another source of the development fund is made up by 75% of the sum of income topping the expenditures for works fulfilled in accordance with development contracts. Means gained from realizing extra equipment and from selling licences, as well as from some other sources are also directed to the fund of production development.

The fund of production development is a quite strong stimulant for research organizations, because it is a source of its own means for purchasing equipment, devices, materials, that are necessary for the development of the organization and for 2650 preforming work on their own initiative. It creates certain guarantees for the banks when granting loans.

Naturally, the stimulating role of the incentive funds is revealed not only and not so much at the time of their formation, as in the process of spending them. The scheme of spending the fund of material incentive is presented in Fig.4, illustrating the material interest of the development engineers of new machinery in creating these funds and, consequently, introducing their achievements into the practice of industrial production, in accelerating scientific-technical progress in the national economy. The basic direction of spending FMI is current rewarding fo the development engineers with a premium at the receipt of the respective means. At least 60% of these are paid directly to participants of the given concrete development, depending on their personal contribution to this concrete ahcievement. It is clear that the greater the economic effect of this development, the more the respective development engineer received.

Material encouragement for fulfilment of the quarterly thematic plans by the organization proper is envisaged by the self-supporting system to raise the material interest of the respective functional departments in the general result. Up to 10% of the fund of material incentive is spent for these purposes, as well as for rewarding the administration and management.

Situations may arise when it is necessary to do some thing operatively in order to accelerate sharply some research, development, mastering, introduction etc. The system envisages the spending of a part of this fund for rewarding the fulfilment of major assignments. Usually, from 5 to 10% of the FMI is spent to this end.

Premiums for the results of the year are of major signficance for the retention of cadres in production, which is a problem that arises only under conditions of complete absence of unemployment and at a shortage of cadres. Certain sums are reserved to this end during the year as well as the remains of the FMI, that have accumulated for some reasons by the end of the year. The unofficial name of this type of material incentive is the "thirteenth salary". At the beginning fo the next year the remaining and specially accumulated means are distributed between all the workers of the organization, depending on the time one is working at the given scientific organization. Naturally, the longer the time of one's work therein, the bigger the material incentive. The "thirteenth salary" is not paid if the time of work is less than two years. Each worker is interested, thereby, to prolong the time of one's work and in stable work of the scientific organization proper.

The means of the fund of material incentive are spent also for rendering material assistance, for compensating holidays in the part associated with premiums from the fund of material incentive, as well as for premiums by the results of socialist emulation, for premiums and remuneration for other achievements in work.

The fund of socio-cultural measures and residential construction is highly significant as a factor stimulating the creation, mastering and introduction of new machinery and accelerating scientific-technical progress.

DIRECTIONS FOR UTILIZATION OF FUNDS

The following major directionsof spending the fund of socio-cultural measures and residential construction are recommended in the estimate of expenditures with consideration of solving the primary social targets of the labour collectives:

a) for construction (fractional participation in construction) of apartment houses, children's institutions, preventoriums, clubs, sports structures, and other objects of cultural purpose;

b) for repair of apartment houses and cultural objects, for purchasing various equipment and appliances as well as specialized means of transportation for the stated objects, etc.;

c) for sanitary measures, including the purchase of medicines, passes to homes of recreation and medical treatment, which are granted on conditions of giving such passes on account of the means of state social insurance and means of the trade union budget;

d) for cultural-educational and physical culture measures;

e) for lowering the prices in the dining-rooms and buffets of the organizations and intensifying the nutrition of the children in the kindergareens, pioneer and health-improving camps, as well as of the workers, who are treated in the preventoriums;

f) for other purposes envisaged by the measures for social development of the labour collectives.

The concrete directions of utilizing the fund of socio-cultural measures and residential construction are determined by the administration of the organization together with the trade union committee.

As a rule, 8-9% of the fund of socio-cultural measures and residential construction of the given organization may be spent for partial reimbursement of the expenses for maintenance of the objects of cultural purpose and the pioneer camps.

Premiums for outstanding achievements in science,
technology, production organization occupy a special rank among 2650
the methods of stimulating scientific-technical progress.

The highest rewards in our country, that are awarded for these achievements, are the Lenin and State Prizes, which are awarded by the Committee for Lenin and State Prizes. This Committee is composed of outstanding scientists, authoritative managers of production. The prizes are awarded once annually: to the birthday of the founder of our state V.I. Lenin and to the anniversary of the Great October Socialist Revolution. The winners of these prizes are awarded the title of Laureate of the respective prize, they are awarded with honourable badges. Prizes of the USSR Council of Ministers are awarded now for several years for outstanding achievements in science, technology, production management. The prizes of ministries, departments and Councils of Ministers of the union republics, range in amount from 3,000 to 40,000 roubles.

Some other prizes have been established for profound achievements in the development of science and technology, including prizes, which are granted by the USSR Academy of SCiences, and prizes of the USSR Exhibition of Achievements of the National Economy.

All these prestigious prizes are granted to collectives of authors, who contributed greatly to accelerating scientific-technical progress, gained profound results in raising the effectiveness of the developed new machinery and technology, provided priority of Soviet science and technology on different areas of knowledge. The outstanding achievements of the collectives of scientists and production workers induce other collectives to attain just as valuable results, thereby ensuring an active stimulating effect of these prizes on accelerating the rate of scientific-technical progress in the natioanl economy.

Attention should be given to one more stimulating factor. A system of remunerating the labour of scientists by the method of the Physico-Chemical Institute named after L.Y. Karpov is being checked now experimentally for some years in several dozens of research organizations. The essence of it is that, by certifying the workers with consideration of their contribution to science, they are granted a higher or, on the contrary, a lower salary for a certian time and within certian limits, which are wider than the existing salary "fork". Data, published in the press, indicate that a reduction or increase of the salaries renders a strong effect on the efficiency of the scientists' labour, induces the most capable ones to put forward all their efforts, while the incapable ones leave the area of scientific activities. The rates of raising the economic effectiveness of the institutes, that have shifted to this system of labour remuneration, are much higher, and the rates of raise in the salaries are essentially lower than in the case of institutes that have not shfited to this system.

It is impossible to deal with the vast number of factors in a brief report that render a stimulating effect on accelerating scientific-technical progress in the national eocnomy, for example, granting bank credit on favourable terms, reserving

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capacities of industrial enterprises, preferential supply of material-technical resources for work on new technologies, creation of temporary collectives and subdivisions, etc. However, it is necessary to deal more with the further development of the self-suporting system, which is one of the basic stimulants.

The decision of July 12, 1979, "On improving planning and intensifying the effect of the economic mechanism on increasing the effectiveness of prdouction and quality of work" envisages to shift research, designing-technological and other organizations of the industrial ministries by 1985 to a system of payments for fully completed work accepted by the customer. Unlike the existing system, wherein the expenditures, including those of the intermediate stages, are reimbursed, but not the final result, the new system implies payment only for completed work. And the work should be not simply completed, but checked and accepted by the customer for introduction. The developments will be realized on account of the USSR State Bank credit for a "normative" percent (0.5% annual bank rate), and if the work is not fulfilled in due time and needs additional crediting, then the bank rate increases to 3%.

The completed and accepted developments remain till final introduction on the extra balance register of the executor and accepted to the balance of the customer. It is written off the balance after introduction. All the developments in this case will be strictly accounted for, and it will be possible to judge of the labour effectiveness of one or the other organization and adopt operative measures to improve, if necessary, its work by analysing the increase or decrease of the scope of incomplete production.

The self-supporting system, described earlier for organizing work on developing, mastering and introducing new machinery, does not satisfy today fully the industry, which has accumulated considerable experience of operating under these conditions. Certain normative documents require improvement, for example, the "Instruction on the formation and utilization of funds of economic stimulation at scientific-research, designing, project-designing and technological organizations, production associations and enterprises transferred to the self-supporting system of organizing work on developing, mastering and introducing new machinery on the basis of contracts, as well as the "Standard Instruction for rewarding works of scientific-research, designing, project-designing and technological organizations, production associations and enterprises transferred to the new system of planning, financing and economic stimulation of work on new machinery".

Table 1

Scale for determining size of premium, depending on value of annual economic effect

Annual economic effect	Size of premium in percent of annual economic effectiveness
Up to 10,000 roubles	From 6 to 25%, but maximum 2,000 roubles
From 10,000 to 20,000 roubles	From 5 to 20%, but maximum 3,400 roubles
From 20,000 to 50,000 roubles	From 4 to 17%, but maximum 6,000 roubles
From 50,000 to 100,000 roubles	From 3 to 12%, but maximum 10,000 roubles
From 100,000 to 500,000 roubles	From 2 to 10%, but maximum 35,000
From 500,000 to 2,000,000 roubles	From 1 to 7%, but maximum 800,000 roubles
From 2,000,000 to 5,000,000 roubles	From 0.7 to 4%, but maximum 150,000 roubles
Above 5,000,000 roubles	From 0.5 to 3%, but maximum 2,000,000 roubles

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CO-OPERATION OF CMEA MEMBER-STATES IN SCIENCE AND TECHNOLOGY

INTRODUCTION

The CMEA member-states view the development and all-round expansion of scientific and technological coopration as one ofthe major means for attaining prompt raise of social production efficiency and acceleration of S&T progress.

Heightened and qualitatively new character of the requirements attributed to the scientific and technological cooperation is conditioned by several factors associated with the transition of the countries' economies to the intensive mode of development and further deepening of the socialist economic integration. During the current and coming five-year plan periods the CMEA member-states must solve entirely new and complicated tasks of raising the role of intensive factors in total increment of production. At present many vital tasks of economic and social development cannot be solved without wide, ample and accelerated realization of modern achievements of S&T revolution.

Under new conditions, S&T progress must assure that the production is simultaneously labour-saving, resource-saving and ecologically harmless. These highly categorical, sometimes reciprocally excluding, requirements never combined with each other in the past. Now they determine the tasks faced by science and technology.

Reconstruction and modernization of the technological basis of production carried out in the CMEA member-states is oriented, first of all, towards utilization of entirely new technologies resulting from fundamental scientific research. It is necessary to ensure that the formation of scientific stock for the entire science and technology cycle include new technology introduction

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Presented by A.A. Popoudin

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stage; this sets new requirements for proportionate allocation of resources (cadres and finance) for various areas of scientific research.

In the majority of the countries the scientific-technological tasks which grow in volume, complexity and importance are being solved at a relative stability of the resources allocated for scientific activities. This necessitates a search for new forms of science organization and an accelerated technological re-equipment of work of all people engaged in scientific activities.

Being influenced by these factors the CMEA member States actively search for and practically formulate new ideas of their science policy as well as more efficient forms of interaction of their scientific and technological potentialities. New approaches to science economics, and new forms of programmed and complex organization of scientific-technological activities are being developed. Systematic improvement of science resources management and utilization are considered to be one of the most important orientations in bringing all national economy management mechanism to perfection.

PRINCIPLES OF CO-OPERATION

The state science policy pursues not an increment of expenditures on science per se or an increase of number of scientists involved in the sphere of co-operation but the effects achieved on the basis of full and expedient use of scientific knowledge resulting from fundamental research, its materialization and application.

The necessity of reinforcing the influence of the mutual cooperation and integration on scientific and technological progress requires at present a more profound study of actual processes taking place in the sphere of science and technology of the cooperating countries. In this respect a particular significance is placed on the analysis of the status and development dynamics of the S&T potentiality, especially its resources.

Acceleration of S&T progress and the increasing influence of science on the process of reproduction in the countries of socialist community have resulted in a considerable raise of expenses on R&D activities as well as the member of personnel working in this sphere.

COMPARATIVE FEATURES

On the basis of growth of material and manpower resources involved in R&D activities scientific-technological complexes are being formed within the national economy framework of separate countries, and science and technology become to a greater degree an independent branch of their national economy. The growth of S&T resources and further complication of S&T internal structure are accompanied by the growth of aggregate S&T potentialities of individual CMEA countries as well as their influence on material production.

The past decade witnessed a continuous growth of absolute R&D expenses in all European CMEA member States. In 1970-1980 they raised by 2.1 times in Bulgaria, 2.8 times in Hungary, 1.8 times in the German Democratic Republic, 3.3 times in Poland, 1.8 times in the USSR and 1.6 times in Czechoslovakia.

At the same time the analysis of expenditures of these countries on R&D activities during two last five-year periods indicates a definite trend of slowing down their growth rates. Thus, the increment of expenditures during 1970-75 and 1975-80 periods respectively was 48.4% and 42.0% in Bulgaria, 80% and 56.4% in Hungary, 150% and 34% in Poland, 39.3% and 15.3% in Czechoslovakia.

The index of specific share of R&D expenditures in the national income of a country is often used to characterize the dynamics of S&T progress. In the majority of the European CMEA member-states this index was growing during 1971-75 period after which it became stable. As a whole during the past decade the share of R&D expenditures in the national income of Bulgaria incresed from 2.1% to 2.3%, in Hungary - from 2.8% to 3.7%, in the German Democratic Republic - from 3.9% to 4.3%, in Poland - from 1.8% USSR - from 4.0% to 4.7%, and in Czechoslovakia - from 3.6% to 3.8%.

The tendency of reducing R&D expenditures growth rates during the past five-year plan period as compared with the preceding period is explained to a certain extent by the fact that the CMEA member States have recently taken the course of intensifying their activities in the field of science. Consequently, one may suppose that during the coming years the R&D expenditures share in the national income of the majority of the European CMEA member States will remain at approximately same level which signifies that R&D expenditures growth rates in absolute terms will correspond to the national income growth rates of these countries.

For comparison it will be appropriate to point out that the majority of industrially developed capitalist countries is characterized by slower growth rates of the increment of R&D expenditures in recent years. During 1972-77 period the share of R and D expenditures in the gross national product of the Federal Republic of Germany and France was approximately at the same level - 2.1% and 1.8% respectively. In other industrially developed capitalist countries this index for 1978 equalled 1.3% in Belgium, 0.9% in Italy, 1.0% in Canada, 2.0% in Netherlands, 2.0% in the United States and 1.9% in Japan.

In the last decade there was a significant rapproachement of levels of expenditures per one scientific worker (expressed in comparable values) in the European CMEA member-states reducing the anterior gap by more than two times. In this respect it is necessary to underline that the process of leveling and optimizing the volumes of R&D financial resources per one scientific worker in the socialist countries is being carried out under the influence of target oriented S&T policy which is formulated proceding from the concrete conditions S&T development targets. This is also manifested in various trends and dynamics of changing this index as compared with an average level of expenditures per one scientific worker formed for a given period in the CMEA member States. This index grew at higher rates in those countries which continued to create and reinforce their R&D research basis during the period of 1970-80 (Bulgaria, Hungary and Poland).

The stabilization of this index in other countries (the USSR and Czechoslovakia.) can be explained to a certain degree by the fact that before the 70s they achieved a definite optimum in forming their S&T potentiality which was maintained by balanced growth of both constituent elements of the index (expenditures and scientific personnel) during the subsequent years.

Preservation of optimum proportions between the various types of R&D activities (fundamental research, applied research and development) expressed as ratios of current expenditures by the above types constitutes an important prerequisite for organic coordination of S&T policy and structural policy of a country. In the 70s in the majority of the European CMEA member States these proportions on the average were 15%, 33% and 52% respectively. At the same time there is a tendency to reallocate R and D resources in favour of applied research and developments. Consequently the share of expenditures on fundamental research has become lower.

For comparison one can point out that lately the relative share of resources allocated for the development of fundamental research in the majority of industrially developed capitalist countries was somewhat higher than in the European CMEA member states. For example, in 1975-76 the share of fundamental research resources in the total R&D resources allocatins was 26.1% in the Federal Republic of Germany, 21.4% in France, 23.0% in Canada, 20.6% in Italy, 20.1% in Finland, 19.8% in Norway and 19.0% in Sweden.

In principle the optimum ratios between the types of R&D activities depend on many factors among which it is necessary to take into account the level and existing orientations of scientific and technological development of a given country, the specialization of R&D activities, the development level of production potentiality ensuring the materialization of new knowledge, etc. Nevertheless, the common principle applicable to any country underlines that progress in the field of S&T depends in many respects on the development of fundamental research as it is a source of new ideas, its results from the basis of applied research, experimental and design development, and introduction in practice. It also defines major directions of a long-term scientific and technological strategy and prospects of structural policy of individual countries.

While comparing the volumes of R&D resources allocated in the CMEA member States and industrially developed capitalist countries it is necessary to bear in mind the fact that relatively low share of fundamental research expenditures of the former is compensated, to a certain degree, by the intensive exchange of the results carried out on a free of charge basis, especially within the framework of co-operation of their academies of sciences.

Under such conditions co-ordinated scientific-technological policy designed for optimum use of the aggregate resources of the CMEA member States allocated for R&D activities acquires major significance. Co-ordinated reallocation of resources alloted for concrete types of R&D activities in the countries makes it possible to maintain a high level of research in strategic directions of S&T, and avoid unjustified duplication of the countries' efforts in solving scientific-technological problems. Objectively this conditions the necessity of taking into account domestic factors and peculiarities of the development of each country as well as the possibilities of scientific-technological specialization and cooperation which becomes available under conditions of the socialist economic integration.

Under present conditions the rational utilization of potential abilities of personnel engaged in R&D activities is connected with the necessity of a constant growth of allocated capital assets, especially various equipment, apparatus, devices, etc. This is necessary to raise the efficiency and results of fundamental research, applied research and development, to shorten terms of carrying out these activities, and finally to raise the labour productivity of R&D activities.

The provision of equipment and apparatus for scientific personnel is quantified by capital labour ratio. It is quite obvious that in order to ensure the increase of this ratio the capital assets growth rates should exceed growth rates of the personnel engaged in R&D activities.

On the whole the majority of the European CMEA member States witnessed more than two-fold increase of R&D capital assets (expressed in value) in the past decade.

One may note a progressive tendency consisting in the fact that during 1970-80 period the growth rates of R&D capital assets excelled those of all national economy capital assets as well as production capital assets. This shows the redistribution of the national economy capital assets in favour of R&D activities. The growth of R&D capital assets is accompanied by the growth of value of their active part (apparatus equipment, devices etc).

Speaking about potential reserves of scientific manpower of the CMEA member States it is ncessary to point out that the aggregate number of personnel engaged in R&D activities in these countries reached 5.5 million persons in 1983 (2 million in 1960) including 1.6 million scientific personnel which amounts to about 40% of the world figure.

By the number of scientific workers per 10,000 of population the countries of the socialist community are practically situated at the same level as the industrially developed capitalist countries.

The increase of total number of personnel engaged in R&D activities was typical for all CMEA member States in the past decade. This manifested in absolute growth as well as in the share of this category of workers in the total number of workers and employees engaged in the state and cooperative sectors of these countries' national economy. In 1970-80 the growth of this categoy of workers was 190% in Roumania, 147% in the German Democratic Republic, 146% in the USSR, 142% in Bulgarian People's Republic, 133% in Hungary, 123% in Czechoslovakia and and 109% in Poland.

The highest growth rates of this increment were observed in 1970-75. In the second half of the 70s the majority of the CMEA member-sates witnessed somewhat slower growth rates of the R&D personnel which is explained by a general demographic situation in these countries.

The share of R&D in the total number of people engaged in the state and cooperative sectors of the national economy of the CMEA member-states witnessed a constant growth during the past decade. Significant increase of this share was observed in Hungary (from 1.8% to 2.12%), Romania (from 1.15% to 1.5%), the German Democratic Republic (from 2.07% to 2.43%), the USSR (from 3.32% to 3.89%), and Czechoslovakia (from 2.6% to 2.85%).

As a rule, in the 70s in all CMEA member States the number of scientific workers (the most creative part of personnel engaged in R&D activities) was growing at higher rates than the total number of personnel engaged in R&D activities, which indicates qualitative improvement of the employment structure in R&D sphere.

During the same period there was also a considerable improvement of qualification structure of scientific workers as a result of increase of the share of persons holding doctor or candidate of sciences degrees.

Dynamics of growth of number of scientific personnel by separate branches of science reflect to a certain degree the existing trends of science development, goals and priority targets of scientific and technological policy of the CMEA member States. In this respect it is worth noting that in 1980 in technological sciences, the development of which is associated with S&T progress, there was engaged about 50% of all scientific workers of the CMEA countries. A considerable share of scientific workers is engaged in natural sciences as well as social and humanitarian sciences - by 15-20% of their total number on the average.

The aforesaid allows to arrive at a conclusion that the rational use of the CMEA member States scientific and technological potentialities requires a scientifically justified optimum ratio between human and material-technical resources appropriated for R&D activities. This optimum can be achieved either by the expansion and improvement of the material-technical basis or by the improvement of qualification structure of personnel, redistribution of human and material resources taking into account the necessity of their four main directions of S&T progress.

It is obvious that the determination of required proportions of these two components of S&T progress falls under the prerogative of the national organs elaborating and implementing scientific and technological policy taking into account all demostic and external factors as well as the peculiarities of modern stage of the country development. Nevertheless, it becomes more and more evident that even today and in the immediate future the socialist community countries have no other alternative for the acceleration of S&T progress than a persistent course towards integration and concentration of their scientific resources for the intensification of R&D activities. In solving this task an increasing importance is being attached to coordination utilization, and synchronized interaction of their scientific and technological potentialities on the way of implementing the coordinated policy of scientific and technological development. Lately these problems legitimately rest in the centre of attention of all state and party organs of the countries, all CMEA bodies.

ASPECTS OF COORDINATION

The principal role of organizer and co-ordinator of scientific and technological co-operation carried out by the CMEA member States on the multilateral basis is performed by the CMEA Committee for scientific and technological co-operation, an organ of the Council of Mutual Economic Assistance.

The Committee ensures the organization of implementation of measures in the field of scientific and technological co-operation included in the Complex programme, as well as implementation of long-term target programmes of the CMEA member States cooperation; it promotes the co-ordination of science and technology policy of the interested CMEA member States; organizes multilateral scientific and technological co-operation to ensure fuller and more efficient utilization of scientific and technological potentialities of the countries in sciving major problems of the national economic development; promotes the acceleration of scientific and technological progress in the CMEA member

States on the basis of division of labour, co-ordination, co-operation and joint implementation of scientific and technological research of mutual interest.

In its work the Committee attributes a considerable importance to the organization of mutal consultations on major problems of scientific and technological policy of the countries to ensure the co-ordination of urgent problem and long-term orientations of multilateral scientific and technological co-operation; the multilateral co-ordination of the national economy development plans of the CMEA member States by major science and technology problems of mutual interest for five-year and long-term priods; the organization of co-operation of interested countries in the field of R&D activities in major scientific and technological problems of great importance for long-term development of the national economy in order to achieve out stripping rates in developing new national economy branches and types of production in the CMEA member States and first of all in developing research and working up major interbranch problems ensuring from the long-term target co-operation programmes.

The Committee organizes the preparation of draft multilateral agreements between the CMEA countries in the field of scientific and technological co-operation, and in particular, promotes the creation in the established order of international scientific research institutes, designing organizations, joint laboratories (departments), temporal scientific research groups, scientific-production associations and other organizations of multilateral scientific and technological co-operation (including councils of authorized representatives and co-ordinating centres).

Together with these activities the Committee promotes the co-ordination of problems of multilateral scientific and technological co-operation of the CMEA countries with bilateral co-opration of these countries in the field of science and technology in order to ensure the exchange of information on the most important measures of scientific and technological co-operation elaborated and carried out under bilateral agreements.

The Committee activities envisage the elaboration of proposals for the CMEA countries co-operation in the field of utilization of scientific and technological innovations and progressive production experience; organization of the information exchange on the application of modern methods of forecasting, planning and management of S&T, as well as organizational work of the interested CMEA countries for complex planning of cooperation is solving particular scientific and technological problems through co-operation programmes covering all stages of scientific research, development and introduction of the results of joint work in production.

The Committee organizes co-operation in the analysis of the world achievements of S&T and joint forecasting of the development of selected areas in the field of S&T; in training and qualification improvement of scientific and technical personnel;

in exchange of scientific and technological information and development of international system for scientific and technological information exchange of the CMEA countries; in environmental protection and enhancement as well as in the development and organization of production of special apparatus and instruments, equipment and critical materials necessary for scientific research.

The Committee organizes its work in close interaction with other CMEA bodies on adjacent and complex problems; it co-ordinates scientific and technological co-operation on major problems in the framework of permanent CMEA commissions and meetings of representatives (department chiefs) of the CMEA countries; takes measures to eliminate injustified parallelism and duplication in executing scientific and technological co-operation programmes; generalizes the results of work of these organs and works out measures eliminating certain hindrances observed during the process of co-operation.

When deemed necessary the Committee creates permanent and ad hoc working organs on problem areas which fall under its competence.

These organs include the Council of scientific and technological co-operation in the field of fuel-energetics problems, the Council on environment protection and enhancement, Permanent group on scientific instruments, Permanent group on training and qualification improvement of scientific personnel, Working group on co-operation in the field of S&T forecasting, a group of experts from the CMEA countries on contacts with international organizations in the field of S&T.

At present the main content of the CMEA activities is determined by the Complex programme of further deepening and improvement of cooperation and development of socialist integration of the CMEA member-states and by long-term target cooperation programmes adopted by CMEA session.

IMPACTS OF COOPERATION

Scientific and technological co-operation is an important integral part of these programmes. Their implementation has allowed to a considerably degree the CMEA countries to achieve definite success in creation of powerful scientific and technologica potentiality, organize a wide network of scientific research and designing organizations, set up experimental basis equipped with advanced technology and train a considerable number of highly qualified scientific personnel able to solve the most complicated problems of modern science.

In the process of implementation of tasks set by the Complex programme, and other programmes and plans of scientific and technological co-operation during the past decade the scientific research and designing organizations of the CMEA countries accomplished over 16 thousand theoretical and applied developments.

At present about 3,000 scientific research organizations of the CMEA countries take part in multilateral cooperation programmes. About 1,200 themes are being elaborated jointly by scientific research and economic organizations of the countries. In recent years the the annual number of completed themes reached 2000. Annually they create 200-300 types of new or modernized machines, devices and equipment, develop or improve 100-150 technological processes, produce 100-120 new types of materials and preparations. The results obtained in the process of scientific and technological cooperation are introduced in rpoduction giving a definite economic effect. They serve the basis for assortment renewal of various types of produce, modernization of production and promote further expansion of international specilization and cooperative production of the CMEA countries.

The CMEA member States carry out successfully the work oriented towards the fulfillment of the long-term target programme of cooperation in the field of power, fuel and raw materials elaborated till 1990. In 1982 significant success was achieved in joint development of electric power stations utilizing magnetic hydro-dynamic methods of energy conversion which have high efficiency and make it possible to reduce fuel consumption by 20-25%. The cooperation in the field of utilization of nonconventional sources of fuel resulted in about 40 developments of major practical importance.

The USSR and the German Democratic Republic joint efforts have resulted in modernization of large accessory enterprises in both countries allowing to ensure the production of the most deficient and labour-intensive types of pipeline accessories to meet the demand.

In 1982 specialists of these two countries started the work on creating of new highly productive plants and equipment for high pressure polyethylene production on the basis of unique processes developed as a result of cooperation.

The USSR and Czechoslovak specialists striving for improvement of jointly created entirely new line of spindle-free spinning have begun the development of highly productive machines of new generation and complex spindle-free spinning line. Work in also being done on the development of automated technological line for ammonia production with a capacity of 800,000 tons per year on the basis of previous results.

Agreements on co-operation in the development and wide utilization of micro-processing technology in the national economy and on the development and organization of specialized and co-operative production of industrial robots, adopted by the XXXVI session of CMEA in 1982 play a significant role in the development of sophisticated technology branches revolutionizing modern production. These agreements have a complex character and envisage joint scientific research, designing, organization of specialised production of automated technological complexes equipped with the newest electronic devices. Realization of the planned measures creates possibilities for transition from *individual automatic control systems to mass automation of* production processes.

The CMEA countries have achieved positive results in solving the problem of saving material resources representing one of major directions in shifting the national economy branches to intensive way of development.

Numerous examples show that scientific-technological potentiality of the CMEA countries allows to develop such technology which is equal to the best world prototypes and sometimes excels them. The main task consists in ensuring high efficiency of mass introduction and dissemination of scientific-technological achievements both in separate socialist countries and the socialist community as a whole.

Taking into account all urgency of the problem of realizing S&T achievements in the national economy the CMEA countries are attributing now great importance to working out the ways of solving this problem.

In this respect they consider the idea of creating within the CMEA framework a single system comprising such elements of scientific and technological progress as the introduction and dissemination of innovations. This must result in the acceleration of scientific and technological progress and free country-to-country transfer of the newest technology prototypes. Alongside they consider the possibilities of organizing international science and technology information bank, a single patent system, creation of new technology introductory firms, consulting organizations and expansion of direct links between scientific research and industrilized organization.

Naturally all this requires a considerable amount of organizational work for the development and interaction of scientific and technological potentialities and the coordination of S&T policy. Underlayed solution of these problems plays vital role for the socialist community countries.

Gradual rapproachment and leveling of national economy of the socialist countries, as it is stated in the complex programme, is a historically objective process in the development of the world socialist system. This process is conditioned by the character of socialist production relations in these countries and the development of political, economic and scientific-technological cooperation between them as well as mutual assistance.

To this end the Complex programme in the field of scientific and technological cooperation envisages technical assistance to industrially less developed socialist countries in project preparation; mounting and commissioning of projects till their full mastering and series production; participation of these countries in scientific research and designing activities by means of co-ordination, co-operation and joint implementation; transfer to them of technical documentation, prototypes, licenses and other results of R&D activities either on free of change basis or under conditions of financial compensation; transfer of production and professional expertise including missions of qualified personnel; and assistance in carrying out geological surveys, utilization and processing of natural resources.

All round assistance rendered by the European CMEA member States to Viet Nam, Cuba and Mongolia is a vivid example of co-ordinated interaction of the CMEA countries. This co-operation and assistance have acquired a new quality after the aforesaid countries became the CMEA members. The multilateral cooperation accelerates their social and economic development, reinforces their national scientific and technological potentiality.

This is manifested in the achievements of social economic development of Mongolia which has become an agro-industrial socialist state. Mongolia is a country of universal literacy, it has the academy of sciences, the university and many mouern scientific and cultural centres. Only during last fifteen years 12 new scientific research projects including genetics, radio-electronics, thermal engineering, construction ceramics laboratories and a centre of scientific and technological information were created in the country with the assistance of the CMEA countries. Mongolian scientific rsearch organizations took part in the development of 60 pressing research problems in the framework of several multilateral agreements on scientific and technological cooperation. The CMEA member States have transferred to Mongolia over 2,000 sets of technological documentation, about 80% of which on a free-of-charge basis. 930 mongolian students, 150 post-graduate students and many probationers were admitted to higher education establishments of the CMEA countries on the same free-of-charge basis. Presently in accordance with the long-term directions of social and economic development of Mongolia for the period ending in 1990 the Programme of development of scientific-experimental basis of Mongolia for 1981-85 has been elaborated which envisages participation of the CMEA countries.

Co-operation with other socialist countries plays an important role for the economic development and growth of scientific and technological potentiality of the Republic of Cuba. Regularly held consultations of experts and scientific-technological assistance of the CMEA countries allowed to solve many problems related to the devlopment of certain industrial production branches of the republic. A greater part of equipment used by the institutes of the Cuban Academy of sciences was furnished by the academies of sciences of the CMEA countries. In 1980 the general agreement on co-operation of the CMEA countries in the implementation of the Plan for accelerated S&T development in Cuba for a period up to 1990 was signed. The Plan comprises 17 sub-programmes related, in particular, to sugar cane cultivation, agro-industrial development of citrus plants, cattle-breeding and fodder production, use of littoral ores, electric power production, studies of corrosion problems under tropical conditions, studies of sea resources, etc. The implementation of this plan envisages carrying out necessary scientific research ensuing from the economic development programmes of the Republic of Cuba. The plan is mainly oriented towards the development of those spheres of S&T which ensure maximum use of natural resources of the country forming the basis for its long-term development. The plan takes into account both the national interests and the interests of further deepening of integration with other CMEA countries.

Viet Nam joined CMEA in July 1978. This act opened new prospects for the development of the republic's economy, science and technology, and further reinforcement of co-operation with other CMEA member States. A particular role is being attributed to scientific and technological ties which become stronger and develop from year to year. Free transfer of more than 2,000 sets of scientific-technological documentation from the Soviet Union to Viet Nam has resulted in successful porject preparation and construction of national economy projects in the republic. A considerable assistance is rendered to Viet Nam in the field of training national scientific and technical personnel. Only with the USSR assistance more than 60 thousand vietnamese specialists and qualified worker were trained in the past decade, over 11 thousand citizens of Vietnam graduated from higher education establishment and secondary technical-vocational schools. Early in 1981 the General agreement on cooperation with the CMEA countries for assistance in accelerated development of S&T in Viet Nam till 1990 was signed. In accordance with the agreement the programme of work envisages solution of several power and raw materials problems, including the study of possibilities of using the atomic power for peaceful purposes. The CMEA countries participate in constructing and equipping several scientific research institutes including coal, electric power and nuclear power institutes.

Thus, the assistance rendered to the less industrially developed CMEA countries in the field of S&T on the long-term planned basis and founded on the principles of the socialist internationalism, fraternal mutual assistance and respect of sovereignty, promotes their accelerated economic development and reinforcement of natioanl scientific-technological potentiality.

CONCLUSION

Today in compliance with the decision of the CMEA organs the Complex programme of scientific and technological progress of the CMEA countries for a period of 15-20 years is being elaborated. The programme will specify the ways and methods of collective realization of scientific and technological tasks set by the actual development stage of the socialist community. The implementation of the Complex programme will allow to increase efficiency of itneraction of the fraternal countries, to raise the socialist economic integration to a qualitatively new level making it deeper, universal and operative. This will reinforce th economy of all CMEA countries, promote further scientific-technological and socio-economic progress, and reinforce the untiy and solidarity of the socialist states.

In attributing utmost importance to the development of their all-round cooperation the CMEA countries do not fence themselves off the world experience and scientific and technological revolution. Scientific and technological progress has objective international character and the related problems require mutually beneficial co-operation of all countries and regions for their efficient solution. Every autarky under conditions fo scientific and technological revolution results in slowing down S&T development and superfluous expenses of material and other resources. Just this approach is professed by the CMEA countries in their mutual relations with other states including the developed capitalist countries. In doing so the socialist countries proclaim that such scientific and technological relations should not be used as a means of political pressure and should be founded on mutual benefits, observance of the principles of full equality and non-interference in doemstic affairs of the countries.

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USSR ASSISTANCE IN STRENGTHENING SCIENTIFIC AND TECHNOLOGICAL CAPABILITIES OF DEVELOPING COUNTRIES

INTRODUCTION

Attainment of technological independence represents an integral part of the struggle waged by developing countries to overcome their economic backwardness. The absence of scientific and technological potential in the majority of developing countries and the lack of qualified personnel pose a serious obstacle in solving this problem. However, the acceleration of economic growth rates, solution of complicated social and other problems are not possible without active adherence to modern science and technology.

In the Charter of Economic Rights and Duties of States adopted by the United Nations 10 years ago it is clearly stated that every state has the right to gain advantages from science and technology achievements for the acceleration of its economic and social development. In this respect article 13 of the Charter underlines that all the States should promote international scientific and technological cooperation and technology transfer, and in particular, facilitate the access of developing countires to these achievements, the technology transfer and development of local technology for the benefit of developing countries in such a form in conformity with such procedure which comply with their economy and requirements. It is foreseen that developed countries shall cooperate with developing countries in creation, strengthening and development of their S and T infrastructure as well as in their activities in scientific research and technological fields in order to assist them to expand and transform their economy.

These principles of the Charter of Economic Rights and Duties of States are being steadily put into practice by the Soviet Union which together with other socialist countries advocates actively elimination of any restriction for free access of developing countries of Asia, Africa and Latin America to modern technology on favourable and non-discriminate terms and widely transfer its own technologies.

Presented by T.V. Teodorovich

The Soviet Union practices all types and forms of modern technology transfer excluding only those which are related to direct capital investment in the economy of developing countries. As it has been repeatedly pointed out by many international experts, the direct investment of foreign capital leads to creation of production entities of enclave type which, in its turn, threatens the independent economic development of the countries which do not have their national scientific infrastructure and qualified manpower potential.

PRINCIPLES OF CO-OPERATION

An analysis of the experience of industrial development of the USSR, Japan and India, explains the factors behind successful assimilation and fast expansion of application of foreign technology. These relate to the special care which given to the mechanism of technology transfer including rejection of foreign investment, full control over imported technology, development of local capacities to reproduce the imported types of products, creation with full governmental support of powerful scientific research institutions and due attention to the formation of cadres of national personnel.

The creation in developing countries of foreign enterprises of transnational corporations or joint enterprises with the participation of foreign capital signifies, as a rule, only transportation of foreign technology in a developing country without its real transfer and without actual assimilation of such technology in the country. Hence, the Soviet organizations do not share the view that joint enterprises are the best forms of technology transfer and confirmed by their real experiences. As an example one may refer to the work of a bauxite mining complex in Guinea constructed with economic and technical assistance of the USSR.

The exploitation of this complex was started towards the end of 1974 and two years later the volume of mined bauxites reached and even exceeded the design output whereas the cost in 1978 was only about 40% of the world market price. It must be noted that local specialists working at the complex admit that during the initial stage not many of them believed in the possibility of reaching the design output during the second year of operation of the complex. However, as it was pointed out by the Guineans, the assistance of the soviet experts, their rich experience and readiness to pass their knowledge and production skills made the Guinean specialists and workers believe in their own forces and achieve high production results. In 1983 there were 1510 Guinean engineers and workers and 96 soviet specialists working at the complex and the output of bauxites was 108% of the design output.

The traditional forms of technology exchange between developed countries through selling licenses and patents are not suitable for developing countries, as their efficient use requires the presence of developed production potential and, in the first place, machine-building branches as well as qualified manpower able to master new technology on its own. In developing countries these prerequisites are lacking requiring more active forms of technology transfer such as those widely used by soviet organizations in their economic, scientific and technological cooperation with developing countries.

SOVIET CO-OPERATION: SOME EXAMPLES

Rendering assistance in creation of national designing organizations has become a specific form of technology transfer to developing countries. Owing to the work of soviet specialists in these organizations and the use of soviet normative and other documentation new technology developed in the Soviet Union is being directly introduced into industry of developing countries. As an example of this one may cite successful operation of Indian designing organization "MECON" specialized in designing with the participation of Soviet experts projects of ferrous and non-ferrous metallurgical enterprises, machine-building and other enterprises.

This national organizations was created in 1967 with the assistance of specialists from "Gipromez" and other soviet designing institutes which elaborated for MECON instruction materials on designing technology which incorporated the experience accumulated by Soviet designing organizations during many years, prepared recommendations on organizational structure, passed over 20 technological recommendations on new processes and equipment used in the ferrous metallurgy of the USSR. About 20% of total number of engineers of this Indian firm was trained in Soviet designing organizations. In 1983 there were more than 3500 Indian specialists and 7 Soviet designers working in MECON. The firm has become the official consultant of the Government of India on ferrous metallurgy problems. It also renders consultancy services in carrying out large projects in other countries, in particular, in Nigeria. Another Indian engineering-technical organization created and operating with the participation of Soviet specialists is a Ferrous metallurgy scientific research centre in Ranchi tackling the problems of improvement and modernization of technological processes and metallurgical equipment. In 1983 its staff consisted of more than 300 national specialist whose number will be brought up to 500 persons in the near future.

In Egypt on the basis of joint venture of soviet and Egyptian specialists in the field of elaboration of long-term programme of power development began in 1967 there has been created a national organization "Energoproject" with more than 200 specialists who design independently high-voltage and distribution power lines and transformer substations particularly for the projects of the programme of complete electrification of rural area on the basis of cheap electrical power generated by the Aswan hydro-power complex.

In the Syrian Arab Republic, the development of petroleum industry called up the necessity of creating in 1972 a special organization for designing and consultancy services which only during the first ten years of existence executed more than 100 complicated designs for large oil projects. In 1983 there were 24 Soviet designers and more than 450 Syrian specialists in this organization whereas in 1980 the number of Syrian specialists reached only 43 persons. The coopration with the Soviet Union makes it possible for Syrian specialists to master rapidly complicated technology of oil drilling. In 1981 out of 12 drilling teams operating in Rumelan and Jebisi oil fields only one team was wholly composed of Syrians, in 1983 out of 17 teams 16 were composed of national personnel.

National organizations for designing water distribution system projects (water storages, dams, irrigation systems, etc.) are alreay in operation or being organized with the participation of Soviet specialists in Cuba, Algeria, Mongolia, Angola, Iraq.

The Soviet Union renders assistance to developing countries in creating over 50 different scientific research centres, laboratories, pilot stations, etc. Among them one may cite atomic research centres in Egypt and the Libyan Arab Jamahiriya which study the problems related to peaceful utilization of atomic energy. Petroleum and mineral raw materials research laboratories are organized in Algeria, India and Egypt. A wide network of scientific organizations has been established to assist the agriculture development - pilot agricultural stations and seed growing farms in Algeria, India, the Syrian Arab Republic and the Lao People's Democratic Republic, veterinary laboratories in Afghanistan, Mongolia, Democratic Yemen, the Sudan, the Congo and several other countries. In Ethiopia there operates a scientific research phytopathological and virological laboratory whose task consists in studying a microbiological laboratory. Among other projects one may cite a network of meteorological stations in Afganistan a scientific research centre within the framework of oceanological and heliotechnical laboratory in Guinea. This list of scientific research institutions already created or being created in developing countries with the USSR assistance is far from being exhaustive.

Soviet organizations design such projects of scientific-technological infrastructure, supply them with modern equipment, instruments and devices; and Soviet scientists and specialists work on these projects together with their colleagues from developing countries sharing with them their experience and knowledge.

In solving the problems of helping the developing countries to use modern methods of production organization and efficient, scientifically based management of the national economy a considerable role is played by utilization of Soviet experience in planning and management. Work in this field is being done by a group of soviet experts and consultants in Afghanistan. Soviet planners have assisted in the elabortion of basic principles of a

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five-year plan of the Democratic Yemen for 1981-1985, a five-year plan of Congo for 1982-1986 and a draft economic and social development plan of Guinea-Bissau for 1983-86; they also took part in preparation of a ten-year economic plan of Ethiopia.

Soviet organizations assist the elaboration of general schemes of development and siting of productive units of Cuba, Mongolia and Viet Nam covering the period up to 2000 and further on. Considerable assistance is being rendered in such fields as organization of national statistical and financial services, banking, preparation of certain branch and territorial long-term and comprehensive programmes. In particular, one may point out that Soviet organizations and specialists have assisted in the elaboration of comprehensive long-term programmes of development of petroleum and gas industry in Syria, India and Iraq, the development of power grids in Libya, the utilization of water and land resources of several river basins in Iraq, the Syrian Arab Republic, Afghanistan, Mozambique, Madagascar and Ethiopia. Soviet specialists are charged with the task of ensuring oil and gas prospecting and drilling to be carried out by national organizations in Algeria and Mozambique and, in case of Angola, to help the national organizations in controlling the activities of foreign petroleum companies. In many cases the soviet organizations are requested to ensure efficient operation of the public sector enterprises built by foreign firms. This happened in Algeria, Angola, Viet Nam, Cuba, Mozambique and some other countries.

Co-operation of the Soviet Union with developing countries in the field of capital construction and complete plant deliveries has become one of the most efficient and wide channels of technology transfer. Such cooperation is connected with the transfer of great volumes of technical and technological documentation, processes, training of national cadres. As a rule, it is carried out on the basis of intergovernmental agreements which apart from complete plant deliveries envisage technico-economic feasibility studies of new projects to be constructed; laboratory, semi-industrial testing of samples of local raw materials and investigation of their processing methods; assistance in elaboration of technical assignment for designing; elaboration of technical projects and shop drawings and many other types of engineer-technical services all to be carried out by Soviet organizations. In the course of technical assistance while implementing construction work, installation and adjustment of equipment, mastering of production processes, and in certain cases, in solving production planning and organization problems Soviet specialists share willingly their knowledge, experience, production achievements and skills with local personnel. Such form of wide and active technology transfer is considered by soviet organizations to be most relevant for developing countries.

The level of Soviet technology transferred to developing countries deserves particular attention. High efficiency of their co-operation with the Soviet Union in the field of capital construction and strengthening of the national economy is ensured not only by a careful substantiation of selected projects, most conscientious attitude of Soviet organizations and specialists towards the implementation of their obligations while rendering technical assistance but also by the modern level of delivered equipment and transferred technology.

Successful operation of constructed enterprises and their real contribution to strengthening the national economy of developing countries are predetermined to a considerable degree already during the stage of selecting a project for cooperation and project preparation activities. According to the normative principles acting in the Soviet Union it is required to carry out a thorough elaboration of all problems related to substantiation of feasibility and choice of technical parameters of technical assistance projects. The technico-economic substantiation and economic sections of technological projects carried out by soviet organizations include detailed analysis of all aspects of future enterprieses embracing the provision with raw materials and manpower, prospects of marketing their produce locally and abroad, recommendations on further increase of economic efficiency and measures required to create the most favourable conditions for projects' operation.

As it is known in the second half of the 50s three metallurgical enterprises were simultaneously built in the public sector of India one of which was in Bhilai with the USSR assistance. Out of the three enterprises the Bhilai plant has appeared to be the most efficient as to its economic and technical indicators. In 1982-83 the level of utilization of the productive capacities at this plant was 1.2 times or 1.4 times in case of design capacities higher than the average indicator for the metallurgical industry of India as a whole. The Government of India has since taken a decision to continue actively the cooperation with the Soviet Union in the field of ferrous metallurgy via expanding the Bhilai and Bokaro plants and construction of a new plant in Vizakhapatanam. In 1982-1983 75% of total allocations for the development of ferrous metallurgy was designated for the projects of economic and technological co-operation with the Soviet Union.

The aluminum plant built in Nag-Hammadi according to the Soviet design and rigged with Soviet equipment has reached its design capacity in a short period of time and has become one of the most paying enterprises of Egyptian industry.

High efficiency of the Aswan hydropower complex was indicated in a statement made by the Minister of Irrigation of Egypt in 1983. This large project of Soviet-Egyptian cooperation has brought great economic benefit to the country and continues to remain the chief source of electric power and preventing repetitive and catastrophic inundations and droughts, and making it possible to organize large-scale agricultural production.

The work of Soviet geologists in India has made it possible to discover about 50 oil and gas fields. Afghanistan, Algeria, Mongolia, the Syrian Arab Republic and many countries of tropical Africa use widely Soviet geological school in developing their national raw material basis.

Possessing a developed scientific-technological and production potential the Soviet Union, if it becomes necessary, has the possibility of mobile concentration of material and manpower resources for overcoming difficulties in constructing large foreign and domestic projects, ensuring stable and reliable implementation of work, solving complicated technological tasks in short time. This has been convincingly demonstrated when the an embargo was laid on the deliveries of the equipment for the USSR export gas pipeline. A decision has been taken to install soviet-made turbine-driven pump assemblies at 22 compressor stations. Soviet designers and machine-builders organized the production of home-made gas pumping assemblies in unprecedentedly short period of time and already by September 1983, 20 compressor stations were equipped with Soviet 16-25 MW compressors. The total capacity of compressors installed on all main pipe-lines built in the Soviet Union amounts to 23 million kW out of which only 1.1 million kW or less than 5% is presented by the equipment purchased abroad.

The absence of developed scientific and technological infrastructure, the lack of qualified personnel and availability of relatively redundant unqualified labour force represent an acute socio-economic problem in the majority of developing countries. It is possible to achieve efficient exploitation of industrial and other enterprises and projects created in developing countries only through carrying out parallel programmes of training qualified national cadres capable of participating effectively both in management and in direct productive work.

Dynamic expansion of economic and technological co-operation of the USSR with developing countries has made it possible for them to rapidly increase their own manpower potential and become familiar with the latest achievements in the field of science, technology and production management.

In the process of economic and technological co-operation of the Soviet Union with developing countries various forms of mass training of national cadres have been developed. They include the formation and development of the public education system, construction of higher education and secondary specialized education establishments, vocational training centres, training of workers and specialists with the assistance of soviet specialists directly during construction and exploitation of co-operation projects as well as training of foreign citizens in the USSR.

MTTHODS OF SOVIET CO-OPERATION

While considering various forms of assistance in the field of promoting adherence of the national cadres of developing countries to modern technology, first of all it is necessary to underline the exclusive role which has been played and is still played today by the most popular and cheap method of training consisting in on-job training of local personnel by Soviet specialists working in cooperation projects built with the USSR assistance. In the course of technical assistance while carrying out construction, installation and adjustment of equipment, mastering production processes and, in certain cases, solving production planning and organization problems the Soviet specialists share willingly their knowledge, experience, production achievements and skills with local personnel. At industrial enterprises and construction sites Soviet specialists help organize short-term training courses, delivered lectures and gave consultations, organized active on-job training of local habitants. Without such assistance and given the shortage of qualified local personnel developing countries would be in no position to assure the expected economic effect from the imported technology. This training was carried out by the most experienced Soviet spcialists and workers.

Mass training of the national cadres within the co-operation projects as an integral part of technical assistance was applied for the first time in the practice of international economic relations by the Soviet Union. In doing so we used the rich experience gained during the years of first five-year plans when millions of former peasants working at various construction sites in a very short period of time acquired professions of builders and operators.

Depending on the profile, size and possibilities of a given enterprise one may use different variants of team or individual training (in-group, team-in-group, individual-in-group and individual training). In-group training is mainly used in short-term full-time courses for workers of mass professions at enterprises with well equipped production basis. At projects with great number of Soviet specialists team-in-group training is used successfully consisting of in-group theoretical training followed by production training in working teams under supervision of a production training instructor. Individual-in-group training includes in-group theoretical training and on-job production training and is widely used in projects with small volume of work.

According to the opinion of soviet organizations the technology transfer and training of the national cadres in cooperation projects by means of the most active interaction with soviet specialists is the most acceptable and useful for developing countries. This method was used in training the national cadres for construction and operation of such large projects as the metallurgical plants in Bhilai and Bokaro in India, the Aswan hydro-power complex in Egypt, the Euphrates hydro-power complex in the Syrian Arab Republic and many other enterprises and construction projects.

It must be noted that the Soviet Union always aims at using the maximum number of local specialists and workers during construction and operation of co-operation projects. As training of the national cadres goes on the number of soviet specialists is being gradually reduced. For example, in 1974, when the Isfahan metallurgical plant was commissioned in Iran, (now the Islamic Republic of Iran), there were about 500 Soviet specialists whereas in 1981 their number was reduced to about 140 specialists. Thus, the number of Soviet specialists in a 7-year period decreased 3.5 times.

At a nitrogen fertilizer plant in Afghanistan the number of Soviet specialists was around 400 persons in 1975; in 1982 this figure was decreased by 2.5 times. The reduction of Soviet specialists and gradual transition of production into the hands of national cadres is carried out by Soviet organizations on the prupose oriented and planned basis. At the majority of projects special programmes for training local engineers, technicians and skilled workers and for gradual replacement of Soviet specialists are being prepared and implemented.

By the beginning of 1984 the Soviet specialists trained over 860 thousand persons in the projects of economic and technological cooperation with developing countries. The greatest number of local workers and specialists trained through this form was in Mongola - 130,000, in the Islamic Republic of Iran - 100,000, in India - 90,000, in Afganistan and Egypt - 85,000 each, in Iraq, Viet Nam and Cuba - 60,000 each, and in the Syrian Arab Republic - over 30,000 persons.

OTHER CHANNELS OF COOPERATION

Speaking about other channels of transfer of Soviet technology it is necessary to point out the creation of technical higher education establishments, secondary technical schools and vocational-technical centres for training skilled workers. For the present day more than 300 projects of this profile have been put into operation which are provided with Soviet manuals, methodological and technical documentation. The aforesaid educational establishments have trained about 590 thousand citizens of developing countries. An initial stage the education process is carried out with wide participation of Soviet teachers and instructors of production training. Higher and special secondary education establishments built with the assistance of the Soviet Union in several countries have beocme their major source of training antional engineers and technicians. In 1984 50 higher and secondary education establishments created with the assistance from the USSR trained about 100 thousand specialists of developing countries (in many cases with the participation of soviet teachers).

Hanoi polytechnical institute started its work in 1956 and since that time it has trained more than 20 thousand specialists with higher education. It has become one of the largest technical higher education institutions in Viet Nam and South East

Asia. Today the institute has 72 chairs, its 10 faculties train about 10 thousand students in 61 specialities.

With the assistance of the Soviet Union in Algeria there have been created the National institute of oil, gas and chemistry together with a secondary technical school (3,000 students aotogether) where training is done in 37 specialleties; the National institute of light industry also with a secondary technical school with 2,500 students (both institutes with their technical schools are located in Boumerdese); a mining-metallurgical institute within Annaba university with 3,000 students. The aforesaid educational establishments are equipped by Soviet laboratory equipment and teaching aids and have Soviet professors, teachers, instructors of production training among their teaching staff. By the end of 1983 these institutes trained almost 10 thousand engineers and technicians for oil, textile, mining and other industrial branches.

The Soviet Union has built and passed over as a gift to Afganistan a polytechnical institute and automechanical secondary technical school in Kabul as well as mining and oil secondary technical school in Mazari-Sherif. These three educational institutions have already trained more than 3.3 thousand specialists. In 1983 the number of students in these institutions amounted to 2,980 persons. Although, various educational establishments of Afghanistan trained with the participation of Soviet teachers 25.5 thousand Afghan specialists, including 3,585 specialists who received higher and special secondary education in 1983.

The polytechnical institute in Bahr-Dar was built in 1963 and passed over to the people of Ethiopia as a gift of the people of the Soviet Union. The institute gives education to around 500 students which are distributed among 6 faculties: agricultural mechanization, chemical technology of wood treatment, textile production, metal working. The first specialists graduated from the institute in 1967. To this date the institute has trained over 1,600 qualified specialists for various branches of the national economy of Ethiopia. A considerable group of Ethiopian teachers from the institute has been trained in the Soviet Union. 15 Soviet teachers are working with their Ethiopean colleagues at the institute.

The polytechnical institute in Conakry, Guinea, is operating already for the second decade. Annually it admits 300 students. The institute has modern laboratories and represents in itself the first higher education establishment of this type in West Africa. 4,500 students attend classes of various faculties, including phsics and mathematics, construction, mining and geology, agriculture, social sciences, electrical engineering, chemistry and pharmacent'cs, medicine and administration. The first graduates left the institute in 1968.

The Rangoon technological institute has become the first technical higher education establishment in Burma. Its 8 faculties trained more than 6 thousand specialists in construction, mechanics, chemistry, electricity, etc.

In some cases national technical institutes are created on the basis of technical secondary schools and professional-technical training centres built with the USSR assistance. As an example one may cite Nigeria where in 1975 in a training centre in Varri classes were opened to train 500 skilled oil-workers; in 1976 the centre was transformed into a petroleum institute. Beginning with 1978 the country annually receives its own specialists who graduate from the institute and work in the petroleum industry - the main branch of the national economy. They include specialists oil and gas recovery, servicing of refinery equipment, etc. Parallel to training Nigerian students the Soviet teachers and specialists mounted and put into operation the necessary equipment, improved teaching programmes and lectures and trained Nigerian teachers and instructors so that they would be able to carry out educational process independently. During 1975-83 period more than 900 graduates from the six faculties of this unique educational establishment for training engineers for the leading branch of the Nigerian economy received their diplomas. In 1983, 500 more students, some of them from other African countries, were studying at the Institute in Varri.

The Soviet Union renders assistance to 29 developing countries in designing and constructing 470 professional-technical training centres out of which more than 250 are already in operation. By the end of 1983 the training centres prepared altogether over 490 thousand skilled workers in mass and the most needed trades, including about 170 thousand workers in Egypt, 100 thousand workers in Cuba, 65 thousand workers in Mongolia, 35 thousand workers in Algeria, over 30 thousand workers in India.

By the beginning of 1984 in Cuba alone 125 training centres were put into operation which annually train over 20 thousand skilled workers. In Mongolia there exist 21 vocational-technical schools which can train simultaneously 10,155 persons. Actually in 1983 they trained 13,130 citizens of Mongolia.

In Algeria 3 secondary technical schools have been set up or re-equipped with the assistance of the Soviet Union. At present more than 30 training centres are being organized to train skilled workers for several branches of the national economy of the country. In recent years over 20% of all skilled workers who join the production for the first time constitute the graduates from training centres created in cooperation with the Soviet Union.

Due to the acute shortage of skilled cadres the training centres are often overloaded surpassing to a considerable degree the design number of trainees. In 1983, in Aden, in the centre for training building workers of Democratic Yemen, 480 persons were enrolled against 300 persons envisaged by the design documentation; and in Mukalla centre for training repair shop workers there were 267 trainees against the rated enrollment of 100 persons. In Iraq, the centre of petroleum industry in Baghdad in 1980 ensured accelerated training of about 3,500 workers and proved to be the best training centre in the Near East.

Many training centres are being set up directly in the projects constructed with the USSR assistance. In Pakistan a training centre at Karachi metallurgical plant began its training activities and by the end of 1983 trained about 5,000 workers in 80 trades which ensured to a considerable degree successful commissioning of the metallurgical plant and active utilization of its productive capacities. Starting in 1970 a coal-mining training centre at Kerman coal basin in the Islamic Republic of Iran trained more than 3,600 workers.

At present Angola pays a particular attention to training the national technical cadres needed for reconstruction and the country's economic development (during military actions tens of thousands of Portguese and other foreign technicians and skilled workers left Angola). A considerable contribution to solving this problem has been made by the Soviet Union. Soviet organizations have established an automobile vocational training centre in Lobitu, three agricultural vocational training centres in Lubango, Ngunza and Malanje each for 200 students, industrial-pedagogical secondary technical school for 600 students in Uambo, a school for training skilled workers at Lobitu shipyard and a school of mechanizers-cotton growers in the province of Luanda. A number of training centres has been organized with the USSR assistance in Mozambique whose economy also experiences acute shortage of qualified teaching staff and skilled workers.

Besides rendering assistance to developing countries in creating their proper systems of training highly qualified personnel the Soviet Union carries out on a wide enough scale formation of specialists from these countries at its higher and special secondary education establishments including a target stipened programme as well as through the production-technical training and consultations at Soviet large industrial enterprises, and scientific research and designing institutes. Such training makes it possible for the representatives of developing countries to receive quickly andon the most advanced level the required scientific knowledge.

In 1980, the University of Friendship named after Patrice Lumumba celebrated its twenty years during which it trained about 9 thousand specialists from 100 countries. At present the University gives education to more than 6.5 thousand students, post-graduates and probationers (including Soviet youths). Annually 100-150 specialists from Asian, African and Latin American countries work on probation in the University. The University has become a large scientific centre: during 20 years it published more than 360 monographs, 290 collections of scientific works and over 11.5 thousand of scientific articles. The post-graduate department of the University prepared over 500 candidates of sciences from developing countries. At present more than 50 thousand students from Asian, African and Latin

American countries are studying in the Soviet Union. They are provided with stipends, hostels, free social and medical services. Upon arrival to the Soviet Union the students get warm clothes free of charge.

Recently the increasing role in the system of training spcialists for young states is played by production-technical training and consultations in the USSR. For this purpose annually the ministries and departments (general suppliers specify up to 200 enterprises, organizations, designing and scientific research institutes. Among them one can find such large enterprises with modern technology as metallurgical plants "Azovstal" and "V.I. Lenin" plant in Zhdanov, Cherepovets, Nogolipetsk and "Zaporozhstal", production amalgamation "Electrosila" in Leningrad and other enterprises. The greatest number of probationers for training and consultations come to the Soviet Union from Vietnam and Mongolia, Afghanistan and India, Pakistan and Democratic Yeman, Cuba and the Syrian Arab Republic and other countries.

The Soviet Union participates in training personnel from developing countries through the UN system. It organises various seminars, symposia and training courses. During last 15 years over 7.5 thousand United Nations fellows of middle and high rank from Asian, African and Latin American countries passed through this form of training.

It must be especially pointed out that the relations of the Soviet Union with developing countries of Asia, Africa and Latin America totally exclude the brain-drain. This partially is one of the reasons why devleoping countries send willingly their representatives to study in the Soviet Union.

Owing to creative combination of various methods and forms of training the Soviet organizations manage to solve successfully the whole complex of personnel problems including the provision of skilled workers and specialists for the construction and exploitation of co-operation projects in developing countries. To this date the USSR assisted in training more than 1,600 thousand engineers, technicians, qualified workers from developing countries.

The experience fo the Soviet Union and its co-operation with developing countries in the field of training and technology transfer gives them the capability to actively use this co-operation against any forms of discrimination and restrictive actions, and in their cause of successful overcoming technological dependence on former metropolies.

PART THREE

REPORT ON THE INTERREGIONAL SEMINAR ON THE VIENNA PROGRAMME OF ACTION: PLANNING AND MANAGEMENT OF SCIENCE AND TECHNOLOGY: METHODS, PROSPECTS AND TRENDS

Organized by the

Centre for Science and Technology for Development
and the
Department of Technical Cooperation for Development

of the United Nations Secretariat

in cooperation with

the State Committee for Science and Technology,
the State Committee for External Economic Relations
and the
State Planning Committee
of the

USSR

Moscow, USSR
8-27 October 1984

I. ORGANIZATION OF THE SEMINAR

1. The Interregional Seminar on "The Vienna Programme of Action - Planning and Management of Science and Technology: Methods, Prospects and Trends" was held in Moscow, USSR from 8 to 27 October 1984. The Seminar was organized by the United Nations Centre for Science and Technology for Development (UNCSTD) and the United Nations Department of Technical Co-operation for Development (UNDTCD) in co-operation with the Higher Economics Courses of the USSR State Planning Committee, the USSR State Commmittee for Science and Technology and the USSR State Committee for External Economic Relations. The Seminar was funded mainly from the UNDP/USSR Trust Fund. The Agenda for the Seminar is shown in Annex I.

2. The participants included senior officials involved in policy-making and planning for science and technology (S&T), policy analysts and development experts from several organizations and institutions of developing countries, Hungary and the USSR besides the representatives of some of the organizations of the United Nations System. The list of participants is shown in Annex II.

3. The following officers were elected by the participants:

Chairman	:	Prof. A.I.Rogov
Vice-Chairman	:	Mr. C. Arthachinta
		Mr. J. Elizondo Alarcon
		Mr. A.I. Naguib
Rapporteurs	:	Mr. L. Birke
		Mr. P. Dewan
		Mr. Emilio Garcia Capote

4. In his opening statement Prof. Amilcar Ferrari, the Executive Director of UNCSTD explained the scope of the seminar in the context of the implementation of the Vienna Programme of Action and its operational plan, whose main emphasis is on strengthening the endogenous scientific and technological capacities of developing countries. Ability to develop viable S & T policies and plans is an important attribute of such a capacity. Recognizing this need, the United Nations Advisory Committee on Science and Technology for Development (ACSTD) initiated an in-depth examination of this topic through a panel of experts convened in Kuwait in January 1983. This seminar is one of the follow-up steps to its recommendations, which were submitted to the Intergovernmental Committee on Science and Technology for Development at its fifth session. He hoped that the deliberations of this Seminar will provide an understanding of the concepts and methodologies in evolving S and T policies and plans based on the

experiences of the participants and experts and lead to an appreciation of their utility for their specific situations in different developing countries.

5. Welcoming the participants, Mr. L. Gomez, Director, UNDTCD, described the main features of the Seminar and the mutual benefits that are derived by exchange of views and experiences not only among the experts from developing countries but also between them and those from the host nation through such seminars

6. Mr. S. Tsukanov, Director, Department of International Organizations, USSR State Committee for Science and Technology extending his welcome emphasized the complex nature of the topic of the Seminar in the context of the development objectives of the developing countries in science and technology and outlined the initiatives taken by his organization in supporting the efforts of developing countries in various ways through substantial cooperation with the United Nations.

7. Prof. A. Rogov, Director of Higher Economic Courses USSR State Plannign Committee, in his welcome statement, described the interest of his organization in reinforcing the broad range of activities for widening and deepening the spirit of cooperation among nations of the World and the extent of services rendered by them through their courses and seminars involving high-level expertise from a variety of institutions of USSR.

8. Mr. V. Sklyarov, Deputy Director, Department of UN Technical Assistance, USSR State Committee for External Economic Relations, while welcoming the participants, provided an overview of the nature of supports rendered by his organization to all worthwhile programmes initiated jointly by the Soviet Union and the Organizations of the United Nations System in furthering the cause of development.

9. While recalling the efforts of the USSR in international cooperation for dealing with the global and specific S & T problems faced by the developing countries, Mr. M.G.Kruglov, Deputy Chairman of the USSR State Committee for Science and Technology, stressed the importance of mutual and beneficial international cooperation in order to effectively supplement the national endeavours. Achievement of progress calls for innovative mechanism of cooperation in the light of the trends in world economy and dynamic changes in Science and Technology. He noted that such a progress depends to a great extent on success in disarmament and elimination of arms race.

10. Discussing the characteristics of endogenous S & T capacities of developing countries, Prof. I. Ivanov, Deputy Director, Institute of World Economy and International Relations, drew attention to the linkages of development problems with the advances in S & T in modern society. Policies and plans for development of such capacities should also include efficient means of acquiring the knowledge of frontier technologies, such as biotechnology and micro-electronics, in order to avoid

further deterioration in the adverse balance of technology trade in developing countries. He further pointed out the need for S & T policies and plans to deal with the problems of migration of talents from developing countries.

II. SCOPE OF THE SEMINAR

11. The Vienna Programme of Action places considerable emphasis on the need for formulation and implementation of national policies and plans on science and technology for development. The Operational Plan recommends several measures for improving the capacities of developing countries for this purpose. It also calls for international cooperation in the development of necessary analytical techniques, diffusion of knowledge on the concept and methodologies, and research efforts in policy issues of specific relevance to developing countries.

12. Many recent studies have described the progress in S&T policy-making and planning endeavours of some developing countries as well as some of the existing lags and inadequacies. The Kuwait Panel of the Advisory Committee suggested several approaches to improve the current situation, including a high-level seminar to analyse specific problems, methods, trends and experiences.

13. Based on these considerations, the following objectives were set out for the Moscow Seminar:

(a) to assess, through national reports, case studies and expert-papers as well as reports by relevant United Nations organizations, the nature of functions and organizations in S&T policy-making and planning;

(b) to gain an understanding of the range of problems and prospects in achieving progress in this area in the developing countries;

(c) to enhance awareness about the implications of S & T policies and plans on development goals;

(d) to evolve specific recommendations which could (i) stimulate national interest on S & T policies and plans (ii) lead to new policy studies and methodologies (iii) identify nature of national and external supports required and (iv) utilize the interests of interntional organizations.

14. Consistant with these objectives, the Seminar dealt with the following issues relating to S&T policies and plans:

(a) their status in developing countries;

(b) their influence on development of S&T infrastructure and human resources;

(c) their relationship to S&T financing;

(d) their impact on transfer, adaptation and utilization of technologies;

(e) their role in S&T cooperation with other countries;

(f) conceptual and methodological approaches and

(g) approaches to S&T forecasting

(h) recommendations

15. The Seminar initially discussed these issues in the individual national contexts based on the presentations of the national papers. Recognising some of the characteristic regional features and trends, the participants from the African, Asian and Latin American regions further deliberated upon these issues in the light of their particular regional situations. This report synthesizes these deliberations, taking into account the presentations by the Soviet experts.

III. ANALYSIS OF THE ISSUES

Current Status

16. The national papers presented by the participants revealed a variety of situations in the status of S & T policies and plans among the developing countries. Some countries have had long traditions, extending over a decade or more, in setting out S&T policy objectives and plans while at the other end there are many countries which are yet to undertake such initiatives. In between, there are countries with explicit and limited S&T policies not supported by detailed plans, some with specific S&T plans not supported by corresponding policies, and some others in various stages of evolving them, either comprehensively or for specific sectors of interest.

17. Despite these variations, the general opinion of the participants of the Seminar was that every developing country was conscious of the need for S&T policies and plans which are reflected, either explicity or implicity, within their development planning efforts. Keen interest exists in these countries to assess the experience of other countries and their institutions to undertake further adjustments and improvements to their own policies and plans.

18. The discussions brought out the differences in the level and functions of the existing formal political, legal and institutional framework in the developing countries. An illustation of S&T policy machinery in some of the developing countries is shown in table 1.

19. Though the objectives that are embodied in the S&T policies and plans of the countries were stated differently, their main thrust may be summarized as follows:

- to integrate S&T activities in harmony with main economic and social objectives

- to strengthen the development programmes either comprehensively across several sectors or to selectively imrpove selected social and economic programmes in sectors such as agriculture, health, industries, natural resources, energy, environment, etc. through a rational mix of technologies

- to increase technolgical self-reliance including study, adaptation and assimilation of foreign technology

- to increase the public-awareness of the role of S&T and improve education and training and extension services

- progressive development of fundamental research capabilities.

20. With these objectives, the policies and plans reflect the specific contributions which S&T can make for priority areas of the countries. Examples of such areas which appeared to be significant are:

Agriculture and food production, processing, transporation and nutrition

Transport and communication

High-technology-intensive industries (e.g. electronics)

Capital goods and manufacturing industry

Energy

Petrochemical industry

Mining

Housing, health, rural development and environment

Status of S&T system

21. The growth of the national S&T system should reflect the importance attached to science and technology in socio-economic policies and plans. In most developing countries S&T systems had been initiated by the national governments, although it is only recently that intensive efforts are being made to device formal mechanisms to link them with the socio-economic objectives or to utilize Research and Development (R&D) resources

in the productive system. In some developing countries, allocation of resources to other priority development programmes led to delayed growth of S&T systems. An illustrative description of the S&T resources in some of the developing countries is shown in Table 2.

22. The most serious problem in many developing countries is the lack of S&T human resources and S&T infrastructure. This is particularly true in most countries of the African region. In Asia and Latin America, this problem exists in some countries while others have a relatively large number of R&D institutions and S&T personnel. While there has been considerable improvement in the linkage between educational and S&T systems of these countries, their linkages to productive systems still remain largely inadequate. Investments in science and technology require a long period of maturation. Attention to S&T policies and plans becomes necessary to reduce the current imbalances and inadequacies and to derive ultimate self-generative effects.

Approaches to transfer, adaptation and utilization of technolgies

23. A main trend in many developing coutnries is to pursue a selective approach to transfer of technologies and adapting them to their particular needs. Some of the important constraints in these efforts are: lack of adequate information; competent personnel and institutions for choice and adaptation of technologies; lack of legislative framework for regulation, incentives and investments; and lack of adequate international norms for the transfer of technology from developed countries to developing countries. Experiences in many countries in the Asian and Latin American regions demonstrate their ability to progressively overcome some of these constraints. The capacity of many other countries, especially in the African region, is far from satisfactory in this respect.

S&T Co-operation

24. One of the ingredients of a sound S&T policy for developing countries lies in facilitating S&T cooperation with other developing countries as well as with developed countries. In recent years there has been a conscious effort at political level to seek cooperation with other countries under bilateral and multilateral schemes as an integral part of economic cooperation agreements. The number of such agreements has been growing considerably in recent years. Many developing countries have S&T agreements with as many as 20 to 50 countries in fields of their individual priorities such as agriculture, medicine, energy, industry and communication. However, there are potentials for widening the scope of these agreements and for improving the arrangements aimed at greater effectiveness of their performance.

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Concepts and methods

25. The analysis of the existing situations in S&T policies and plans among the developing countries demonstrated the need to understand in detail the concepts and methods behind policy-making and planning. Some of the possible approaches were presented by the Soviet experts, based on their experiences in their own national context as well as through their interactions with other countries.

26. According to the Soviet experts, the principle of a single S&T policy, established and directed at the highest level of the government, is conditioned by the public ownership of means of production in planned systems of economies. It facilitates the process of allocation and management of national resources within the overall planning process and achieve coordination and upgrading of quality of technological developments in the production process. The planning concepts associated with such a S&T policy prescribes the content, forms and methods of solving national economic problems. This process includes forecast of principal directions of S&T progress, justification of priorities and targets, assessment of their possible socio-economic consequences and incorporation of urgent measures.

27. Some of the techniques used in conjunction with S&T policies and plans require sophisticated analysis in order to include a complex set of variables which influence the evaluation of results. A number of techniques developed and used by the Soviet experts were presented.

28. It was emphasized that the experiences of USSR in planning and management of S&T, establishment of the system of S&T development plans and methods of their elaboration, use of methods of programme-targets in solving main S&T problems are of interest for many developing countries. It was noted that ideas, concepts and methodological approaches applied by Soviet planners and policy-makers in the field of S&T had been used in some countries. Attention was drawn to the unique USSR experience in the implementation of S&T plans and stimulation of interest and participation of scientists, planners, etc. through economic, social and moral incentives.

29. A range of factors influencing the S&T policies and plans were discussed. This included such considerations as organization and management of fundamental scientific research, forecasting and socio-economic assessment, introduction and mastery of new equipments and technologies, allocation of resources for S&T, planning for S&T human resources, economic efficiency of investments and incentives for stimulation of S&T progress.

30. There was a general consensus among the participants of the Seminar from the developing countries that the Soviet experience might be useful and could be applied, if appropriate, in certain types of S&T activities. It was also noted by some of the participants that the activities of the USSR in the

technology transfer reinforce indirectly the bargaining power of the developing countries. Examples of a number of specific experiences of the Soviet Union with developing countries in their efforts to strengthen the S&T capacities serve as evidence of this point, though some of the participants gave suggestions for further improvement of these efforts.

IV. RECOMMENDATIONS

31. Based on the presentation of papers and deliberations of the Seminar, the following recommendations were made towards evolution of further measures in the formulation of S&T policies and plans by developing countries.

1. <u>Strengthening S&T policy-making and planning capacity</u>

a) Efforts should be made to strengthen the policy-making and planning capacity of developing countries through formulating and conducting training programmes and seminars in S&T policy-making, planning and management. Such programmes should be conducted in developed as well as developing countries. Participation in such programmes should include not only scientists and technologists but also high-level policy-makers, planners and managers.

b) Such seminars should progressively deal with specific issues such as techniques of evaluation of plans and strategies, modes of internal and external S&T financing, role of emerging technologies, and comparative analysis of typical S&T policies and plans for development.

c) Information systems aimed at securing the necessary knowledge for policy-making should be established.

d) Sustained support should be provided by concerned international organizations in these efforts; a higher level of expertise than currently provided should be made available to the developing countries from the most appropriate sources available. Prefernces should be given to the national expertise whenever possible.

e) In case of countries where constraints of scale sometimes do not permit elaborate S&T policies, plans and mechanisms, the national centres created for promotion and performance of R&D could progressively be strengthened to undertake S&T policy-making and planning functions.

2. <u>Stimulation of interest in S&T policies and plans</u>

a) Popular support for national S&T policies is an essential element in achieving success and obtaining feedback for further improvement. Hence popularization of

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science and technology especially at the grass-root level through innovative mechanisms should be promoted.

b) Adequate incentives should be given to scientists, industries and consumers to encourage their participation in the effective implementation of S&T policies; and to obtain an optimum balance between import and endogenous generation of technologies.

c) Issues of S&T policies as a basis of endogenous capacity building should be highlighted in the international forums including the intergovernmental meetings of national leaders.

3. Development and improvement of methodologies

a) The development of methodologies for formulation of S&T policies and plans for developing countries poses many challenges and sometimes could be very different from those used in developed countries. Hence participation of experts from developing countries in the studies and development of methodologies as well as diffusion of main results should be facilitated.

b) These methodologies should aim at such features as development of a comparative system of S&T budgets; incorporation of technology in an explicit form within the production function; characterization of costs of import of technologies in terms of dependency aspects; creation of alert systems for emerging technologies; adoption of techniques of forecasting; and development of scientometric approaches.

4. Implementation of S&T policies and plans

Ultimately, the success of S&T policies and plans will be determined by the process of implementation and the results achieved thereby. Hence,

a) S&T plans should be appropriately linked with socio-economic development plans to ensure optimum development and utilization of a country's resources and a sustained overall growth.

b) Creation of a favourable environment for growth, dissemination, absorption and assimilation of technologies developed endogenously is an essential requirement of the implementation process. This would also call for financial support to the S&T activities to a level recommended by the Vienna Programme of Action and its Operational Plan through favourable terms of assistance.

c) National organizations facilitating or regulating transfer of technologies both from internal and external sources should be promoted.

d) International norms for technology transactions should be adopted to facilitate the more coherent elaboration and implementation of national S&T policies and plans.

e) Even though there are severe limitations in the S&T capacities of individual developing countries, there are yet considerable unexploited possibilities if we consider their joint S&T potential. Hence, promotion of technical cooperation among developing countries should constitute one of the major elements in the elaboration and implementation of S&T policies and plans.

5. Evaluation mechanisms

There should be a built-in mechanism in S&T policies and plans for monitoring and evaluation of their implementation through the use of task-forces of experts consisting of scientists and technologists and others. Appropriate tools of evaluation should be developed to facilitate the comparison between successes and failures of S&T for development.

Table 1

ILLUSTRATIVE LIST OF S&T POLICY AND PLANNING MACHINARY

Name of country	Name of organization	Existance of explicit S&T policy statements	Existance of S&T plans
Angola		no	no
Argentina	Secretaria de Ciencia y Tecnica	yes	no
	Consejo Nacional de Ciencia y Tecnologia		
China	The State Science and Technology Commission	yes	Medium plan 1981-86 Longer plan 1986-2000
Cuba	Academia de Ciencias de Cuba	yes	1981-85
Egypt	Academy of Scientific Research and Technology	no	1983-87
Ethiopia	Ethiopian Science and Technology Commission	no	1985-94
Ghana	Council of Scientific and Industrial Research	no	1984-86
India	Department of Science and Technology; Departments of Atomic Energy, Space, Electronics, Environment, Ocean Development, Non-conventional Energy, other sectoral ministries Council of Scientific Industrial Research	Scientific Policy Resolution and Technology Policy statement	1980-85
Malaysia	Ministry of Science, Technology and the Environment	Under preparation	Under preparation

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Table 1 (continued)

Name of country	Name of organization	Existance of explicit S&T policy statements	Existance of S&T plans
Mauritius		no	no
Mexico	Consejo Nacional de Ciencia de Tecnologia	1983-88	1984-88
Nigeria	Federal Ministry of Education, Science and Technology	draft	1981-85
Pakistan	Ministry of Science and Technology	approved in 1984	1983-88
Peru	Consejo Nacioal de Ciencia y Tecnologia	long, medium and short term	no
Thailand	Ministry of Science, Technology and Energy		
United Republic of Tanzania		no	no

Table 2

ILLUSTRATION OF S&T RESOURCES IN DEVELOPING COUNTRIES

(A = adequate; I = not yet adequate; U = information unavailable.)

Country	R&D Institutions			Human Resources in S&T			S&T financing (% of GNP in a given year)
	Approximate Number	Linkage to		Appr. number (full time equiv.)		Level/ composition	
		Prod.	Educn.	R&D	Prod.		
Angola	5 (of which 3 in univ)	I	I	I	I	I	I
Argentina	U	I	A	U	U	A	0.6 (1983)
China	9000	I	A	U	U	I	1.6 % of national industrial and agri. output (1983) (see note 1)
Cuba	150 plus 250 branch units	I	A	8000	U	A	1.0 (1983)
Egypt	75	I	A	A	A	I	I
Ethiopia	14 plus 7 research stations & 27 sub res. stations	I	A	I	I	I	I
Ghana	16	I	A	A	A	I	I
India	130 (specialised labs. & inst.) & 700 (units in enterprises) & 150 (units in consulting orgn.)	A	A		U	A	0.67 (1983)

Mongolia	45	I	A		U	A	0.9 (1983)

Note 1 : This amounts to 7400 million yuan excluding R&D expenditure in institutes of higher learning.

Table 2 (continued)

ILLUSTRATION OF S&T RESOURCES IN DEVELOPING COUNTRIES

(A = adequate; I = not yet adequate; U = information unavailable.)

Country	R&D Institutions: Approximate Number	R&D Institutions: Linkage to Prod.	R&D Institutions: Linkage to Educn.	Human Resources in S&T: Appr. number (full time equiv.) R&D	Human Resources in S&T: Appr. number (full time equiv.) Prod.	Human Resources in S&T: Level/ composition	S&T financing (% of GNP in a given year)
Mauritius	3	A	A	I	I	I	I
Mexico	1000	I	A	20000	110000	A	0.55 (1983)
Nigeria	26 (of which 3 not yet operational)	I	I	I	I	I	I
Pakistan	20 plus 30 research stations	I	I	I	A	I	U
Peru	350	I	A	8000	U	A	0.3 (1983)
Thailand	U	I	I	5200	I	I	0.3 (1983)
United Republic of Tanzania	1 plus 2 research stations	I	I	I	I	I	I

ANNEX I

Agenda and organization of work

I	Registration of participants and distribution of documents	8 Oct. 1984
II	Opening of Seminar	9 Oct. 1984
	(a) Statements by: Mr. Amilcar F. Ferrari, Executive Director UNCSTD Mr. Louis Gomez, Director, UNDTCD Mr. S.V. Tsukanov, Director, USSR State Committee for Science and Technology Mr. V.M. Sklyarov, Deputy Director, USSR State Committee for External Economic Relations Prof. A.I. Rogov, Director, Higher Economic Courses, USSR State Planning Committee	
	(b) Address by: Mr. M.G. Kruglov, Deputy Chairman USSR State Committee for Science and Technology Prof. I.D. Ivanov, Deputy Director Institute of World Economy and International Relations	
III	Presentation of national papers by the partipants from Angola, Argentina, China, Cuba, Egypt, Ethiopia, Ghana, India, Malaysia, Mauritius, Mexico, Mongolia, Nigeria, Pakistan, Peru, Syria Arab Republic, Thailand, United Republic of Tanzania, Viet Nam and Yemen	10 Oct. 1984 to 13 Oct. 1984
IV	Presentation of discussion papers (a) by USSR experts (b) from UNCSTD, UNESCO, UNCTAD, UNIDO	15 Oct. 1984 to 19 Oct. 1984
V	Consideration of Case Studies	22 Oct. 1984 to 27 Oct. 1984
VI	Preparation of the report and recommendations of the Seminar	

ANNEX II: List of participants

Country	Name/Position/Address
1. Angola	Carlos Alberto Abreau Soreno Head, Chemical Engg. Department Angola University, P.O.Box 1756 Luanda
2. Argentina	Guillermo Luis Vitelli Executive Secretary, Studies on Policy and Management of Technology Secretariat of Science & Technology Ministry of Education & Justice Arzobispo Espinoza 55, Piso 12, Dpto C 1157 Buenos Aires
3. China	Yao Erxin Programme Officer, Dept. of Intl. Cooperation State S and T Commission Beijing
4. Cuba	Carlos Fernandez de Cossio Dominguez Specialist, Dept. of Intl. Organizations Ministry of Foreign Affairs Havana
5. Egypt	Ahmed Ibrahim Naguib Under Secretary of State for Specialized Councils Affairs, Academy of Scientific Research (ASRT) 101 Kasr el Aini Street Cairo
6. Ethiopia	Lakew Birke Chairman, Food and Agriculture Research Council, Ethiopian Science and Technology Commission, P.O. Box 2490 Addis Ababa
7. Ghana	Joy K.B.A. Ata Technical Director, Ministry of Industry, Science and Technology P.O. Box M.39 Accra
8. India	Parvez Dewan Under Secretary to Government of India Ministry of Finance (Dept. of Economic Affairs), North Block New Delhi-110001

9. Malaysia	Mohamad Noor Ajala Deputy Secretary-General Ministry of Science, Technology and Environment Kuala Lumpur
10. Mauritius	Francois Georges Carver Pro-Vice-Chancellor and Head of School of Industrial Technology University of Mauritius Redult
11. Mexico	Jorge Elizondo Alarcon Planning Director, National Council of Science and Technology, Circuito Cultural Ciudad Universitaria Mexico City
12. Mongolia	Tsagaanbaatar Myagmar, Head of Dept. for Scientific Research State Committee for Science and Technology Ulaan Bator
13. Nigeria	Richard Enlang Chief Scientific Officer Federal Ministry of Education, Science and Technology, PMB 12793 Lagos,
14. Pakistan	Altaf Ahsan Beg Deputy Scientific Adviser Ministry of Science and Technology Islamabad
15. Peru	Gerardo Ramos General Director Office of Scientific Affairs National Council for Science and Technology Lima 11
16. Syrian Arab Republic	Mahmoud Warde Vice-Dean of Faculty of Civil Engg. Damascus University Damascus
17. Thailand	Chirapandh Arthachinta Director, Office of Science, Technology and Energy, Policy and Planning Office of Permanent Secretary Ministry of Science, Technology and Energy Bangkok

18. United Republic of Tanzania	Ladislaus Marijani Zonal Chief Inspector of Schools Eastern Zone, P. O. Box 9403 Dar-es-salaam
19. Viet Nam	Nguyen Dinh Tuyen Research Fellow Inst. for Science Management State Committee for Science and Technology 39, Tran Hung Dao Street Hanoi
20. Yemen	Ali Gamaan Salim El-Shekeil Dean, Faculty of Science University of Sanaa San'a

OBSERVERS

1. Cuba	Emilio Garcia Capote Director, Study Centre for the History and Organization of Science, Cuban Academy of Sciences, P.O. Box 70 Havana 1
2. Hungary	Toro Ferenc Adviser, Embassy of Hungary in the USSR Moscow, USSR

UNITED NATIONS SYSTEM

1. UNCSTD	Amilcar Fugeira Ferrari Executive Director, UNCSTD 1 UN Plaza, DC1-1022 United Nations New York, NY 10017, United States
2. UNDTCD	Luis Maria Gomez, Director Natural Resources and Energy Division DTCD, 1 UN Plaza, DC1-0818 United Nations New York, NY 10017, United States
3. UNCSTD	Vladimir Karpovich Pavlov Deputy Director, Policy, Analysis and Research Division UNCSTD, 1 UN Plaza, DC1-1048 United Nations New York, NY 10017, United States

4. UNCSTD

M. Anandakrishnan
Senior Officer
Policy, Analysis and Research Division
UNCSTD, 1 UN Plaza, DC1-1040
United Nations
New York, NY 10017, United States

5. UNESCO

Vladislav Kotchetkov
Programme Officer
Division of S&T Policies
UNESCO, Place de Fontenoy
75700 Paris, France

USSR ADMINISTRATION

1.

Anatoly I. Rogov
Director
Higher Economic Courses of the USSR
State Planning Committee
M. Gnezdnikovsky per 2/4
Moscow

2.

Leonid G. Zheleznjak
Deputy Director
Highe Economic Courses of the USSR
State Planning Committee
M. Gnezdnikovsky per 2/4
Moscow

3.

Natalia N. Kudrjashova
Senior Officer
Higher Economic Courses of the USSR
State Planning Committee
M. Gnezdnikovsky per 2/4
Moscow

USSR EXPERTS

1.	V.S. Boytchenko	Deputy Chief of Subdivision USSR State Planning Committee
2.	Y.I. Bryzgalov	Deputy Chief of Subdivision USSR State Planning Committee
3.	A.I. Chubarenko	Chief of Department USSR State Planning Committee
4.	V.A. Disson	Deputy Head of Department, USSR State Committee for Science and Technology
5.	K.A. Efimov	Head of Department Institute of Economic Problems

6. A.A. Gorin	Deputy Chief of Department USSR State Committee for Science and Technology
7. A.S. Gusarov	Head of Division USSR State Planning Committee
8. I.D. Ivanov	Deputy Director Institute of World Economy and International Relations
9. V.I. Kaspin	Moscow Institute of Management
10. V.A. Kozhevnikov	Head of Division USSR State Planning Committee
11. V.F. Leontyev	Chief of Department, USSR State Commitee for Science and Technology
12. D.S. Lvov	Central Economic Mathematical Institute, USSR Academy of Sciences
13. A.A. Popoudin	International Institute of Economic Problems of World Socialist System
14. G.I. Sadovsky	Professor, Higher Economic Courses of the USSR State Planning Committee
15. N.Y. Safronov	Deputy Chief of Department, USSR State Committee for Science and Technology
16. T.V. Teodorvitch	Deputy Director, Institute of the USSR State Committee for External Economic Relations

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