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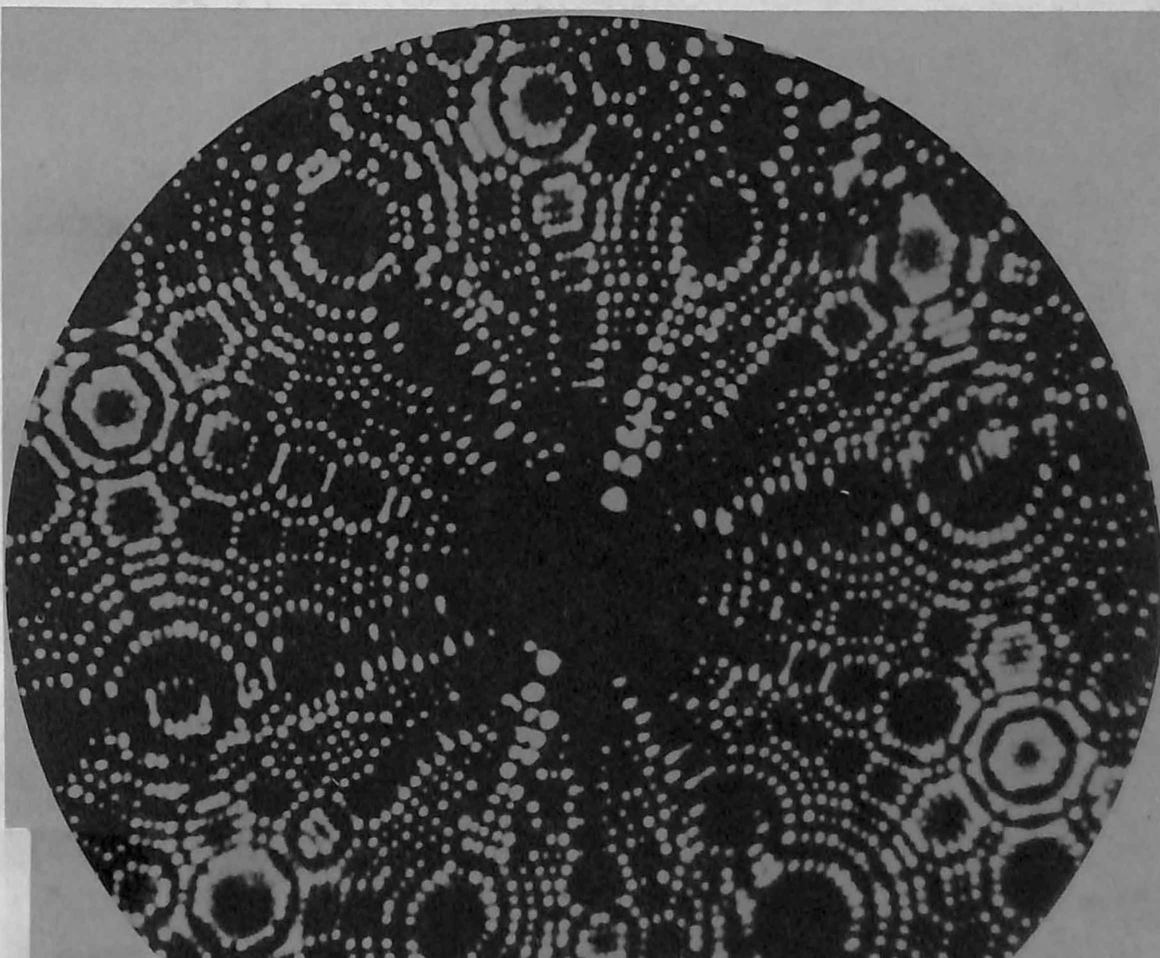
No. 5

Principles and problems of national science policies



Science policy studies and documents

Unesco

Previous publications in this series are as follows:

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No. 2. Science policy and organization of scientific research in the Czechoslovak Socialist Republic.

No. 3. National science policies in countries of South and South-East Asia.

No. 4. Science policy and organization of research in Norway.

Principles and problems of national science policies

Meeting of the Co-ordinators of Science Policy Studies

Karlovy Vary, Czechoslovakia
6 to 11 June 1966

Unesco

Printed in the Workshops of the
United Nations Educational, Scientific and Cultural Organization
Place de Fontenoy, Paris-7e, France

NS/SPS/5
AVS.66.XIII.5
Printed in France

PREFACE

This document is published in a series started by Unesco with the object of making available to those responsible for scientific research and development throughout the world a synthesis of factual information about the science policies of various Member States of the Organization.

It includes the statements presented, as well as the resolutions and recommendations adopted, at the Meeting of the Co-ordinators of Science Policy Studies undertaken under contract with Unesco by the following twelve countries up to the date of the meeting: Belgium, Czechoslovakia, the Federal Republic of Germany, India, Israel, Japan, Norway, Poland, the Union of Soviet Socialist Republics, the United Arab Republic, the United States of America, Yugoslavia.

Participants attended as individuals. The opinions expressed in their statements are not necessarily those of Unesco. However, the formal resolutions and recommendations reported in Chapter 7 were unanimously supported by all participants.

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CHAPTER 1

ORGANIZATION OF THE MEETING

I. BACKGROUND

The Meeting of Co-ordinators of Science Policy Studies was convened by Unesco in accordance with resolution 2.112 (b), adopted by the General Conference at its thirteenth session, which authorized the Director-General to "undertake comparative and pilot studies on national science policy and research organization". Project 2.112.2 of the work plan covered by this resolution provided for the organization of a meeting of experts whose task was to:

evaluate Unesco's pilot studies on the national science policies of its Member States; and

advise the Unesco Secretariat on its activities concerning: the planning of scientific development and the adaptation of research programmes to overall plans for national or regional socio-economic development.

II. AIMS

Within this general framework, the three principal objectives of the meeting were as follows:

A. to identify the common features and general principles underlying science policy in countries with capitalist, socialist or mixed socio-economic systems;

B. to determine the basic data required for the preparation of a national science policy in countries at different stages of scientific and socio-economic development; and

C. to examine the principles and methods of technical assistance for developing countries in the field of science policy.

III. HOST COUNTRY

Following the kind invitation of the Czechoslovak Government, and taking advantage of the hospitality offered by the Czechoslovak Academy of Sciences, the meeting was held at the Moskva Hotel in Karlovy Vary (Czechoslovakia) from 6 to 11 June 1966.

IV. PARTICIPANTS

The participants consisted of highly qualified specialists or the heads of national science policy bodies designated by the Director-General from those countries which had undertaken science policy studies under contract with Unesco. At the time of the meeting, the countries concerned were the following: Belgium, Czechoslovakia, Federal Republic of Germany, India, Israel, Japan, Norway, Poland, Union of Soviet Socialist Republics, United Arab Republic, United States of America, Yugoslavia.

Other Member States and Associate Members of Unesco were empowered to send observers, as were the United Nations and the Specialized Agencies having agreements with Unesco providing for reciprocal representation. Invitations to send observers were also addressed to the International Council of Scientific Unions, the Council for International Organizations of Medical Sciences and the Union of International Engineering Associations.

The Director-General of Unesco was represented by Professor Alexei Matveyev, Assistant Director-General for Science, and by Mr. Yvan de Hemptinne, Head of the Division of Science Policy.

V. OPENING

The meeting was declared open on 6 June 1966 in the conference hall of the Moskva Hotel by Academician František Šorm, President of the Czechoslovak Academy of Sciences, and by Professor Alexei Matveyev, Assistant Director-General for Science of Unesco.

VI. OFFICERS

The following officers were elected:

Chairman: Professor Vladimir Bažant, Dr. Sc. (Czechoslovakia)

Vice-Chairman: Dr. Ahmad Riad Tourky (UAR)

Rapporteur: Dr. Charles V. Kidd (U.S.A.)

VII. ORGANIZATION OF WORK

The meeting organized its work as follows:

A. Plenary meetings

Explanation by participants of their national science policies, in groups of three, followed by a general debate;
Statement by the Rapporteur;
Reports by the moderators of the working groups on their deliberations;
Adoption of resolutions and recommendations.

B. Meetings of working groups

The examination of items 5, 6, 7 and 8 of the agenda was entrusted to three working groups, each placed under the direction of a moderator.

Group I: Principles of science policy (items 5 and 6 of the agenda). Moderator: Dr. Franz Goerlich (Federal Republic of Germany).

Group II: Basic data needed for elaborating the national science policies (item 7 of the agenda). Moderator: Mr. N.I. Tyshkevich (Union of Soviet Socialist Republics).

Group III: International co-operation for the promotion of national science policies - Technical Assistance (items 6 and 8 of the agenda). Moderator: Dr. Zvi Tabor (Israel).

C. Co-ordinator between groups I and III on matters concerning relations between national science policy and social, economic and cultural development: Dr. A. Rahman (India).

CHAPTER 2

WELCOMING SPEECH BY ACADEMICIAN FRANTIŠEK ŠORM, PRESIDENT OF THE CZECHOSLOVAK ACADEMY OF SCIENCES

Ladies and Gentlemen, dear guests and friends,
I have pleasure in welcoming you to the Czechoslovak Socialist Republic, in the ancient and world-famous spa of Karlovy Vary, which in our days is gaining - in addition to its century-old reputation in the successful suppression of diseases - a new reputation as a place for international meetings and discussions helping towards a better mutual understanding between participants from different countries.

I should particularly like to welcome among us personally Professor Alexei Matveyev, Assistant Director-General for Science of Unesco, whose distinguished presence is a proof of the great importance Unesco attaches to the problems we are about to discuss at our conference.*

Our present meeting, which I now have the honour to open, and which is undoubtedly an important scientific event, is the first truly international meeting of persons responsible for the organization of science, who play an important rôle in the development of science in their respective countries. We are scientists active in different scientific fields and specializations and working within different social and economic frameworks, but there is one thing we all have in common: we are all deeply convinced of the immense social significance of science in the present stage of world development.

In his essay "Discours de la méthode" René Descartes characterized the inner incentive for scientific research as follows: "... having once learned the energy and efficacy of fire, water, stars and all the other bodies which surround us as clearly as we know the different works of craftsmen, we should be able to utilize them ... and thus become, in a way, rulers over Nature". Throughout history, the basic characteristic of science has been the endeavour to learn and master the laws governing natural and social phenomena, in order to utilize them beneficially and thus gradually to free mankind from its subjection to the uncontrolled elementary forces of nature; the objective of science is to help in transforming the surrounding world to satisfy human needs.

From experience we are aware that the efficient organization of scientific activity, together with its proper and purposeful management, can substantially facilitate the acquiring of new scientific knowledge. The difficulty arises from the fact that science management is nowadays a complex and challenging task. Besides a profound grasp of actual problems in various scientific disciplines and an understanding of general principles of scientific development, sound economic knowledge is required. From this standpoint it is quite clear that science can successfully be managed only by scientists themselves, by bodies consisting of prominent representatives of science, possessing organizational abilities and understanding the broad relations between science and social practice.

Science in Czechoslovakia, though its traditions are rooted in the Middle Ages, is, after all, relatively young. When in the year 1945 we started to organize it, we had, besides the establishments of higher education which had been overloaded with pedagogic duties, but a few research institutes with some 800 employees. We had to solve all the problems of developing science on an overall national scale, as we say, "on the march".

At the same time we became fully aware of the complexity of science management. We learned that organized research was a new field of human activity for which the internal rules and the principles of social application had not yet been worked out. Experience, however, proved that for the management of science and research, different methods had to be applied and different working conditions had to be created from those applicable, for instance, to the management of industrial enterprises. These differences arise from the higher degree of internal subjectivity, responsibility and hazards involved in research as compared with other activities. In science the human factor - the capacity and adaptability of individual workers - plays a far greater rôle; this is important for the future, since society, as a rule, adopts its principles of management from the most progressive productive sectors.

Within the Czechoslovak Academy of Sciences we founded in 1956, on the basis of the above-mentioned experience, a specialized body to help us in the exacting tasks of overall planning of science. In 1962 this body became the Institute for Science Planning and embarked upon the study of the significant new discipline, the so-called "science of science".

In our country scientists take an active part in formulating the policy for social and economic development. A representative of the Academy participates in government sessions, and a number of prominent scientists are members of the National Assembly and of the Central Committee of the Communist Party or its specialized commissions (dealing with economics, juristics, agriculture, ideology and the standard of living); they sit on various government commissions and other bodies, they act as advisers to ministries and industrial enterprises, etc. These facts support my opinion that we scientists should be able to contribute in an interchange of experience on what is nowadays called "science policy". We therefore decided to assist Unesco in organizing this meeting.

I should like to say that we have, since the very beginning, taken up a positive attitude with regard to Unesco's efforts for improving the application of science in the sphere of development. We have always supported this activity, and we shall continue to support it in the future.

Speaking on the occasion of this very important meeting, I should also like to lay emphasis particularly on this aspect of Unesco's activity and on the pioneer work of the Department of Natural Sciences and of the Science Policy Division. I hope that the meeting now about to begin will follow along the lines of this tradition, and I believe that it will usher in a new phase of co-operation for solving certain crucial problems relating to the science of science.

Dear and distinguished friends, in the name of the Czechoslovak Academy of Sciences, and in my personal capacity, I express the hope that your deliberations will prove fruitful, that they will lead to an increase in our knowledge and will contribute to the successful solution of the complex problems with which we have to grapple in organizing the development of science in our countries.

CHAPTER 3

OPENING SPEECH BY PROFESSOR ALEXEI MATVEYEV, ASSISTANT DIRECTOR-GENERAL FOR SCIENCE OF UNESCO

I. GREETINGS AND THANKS TO THE ORGANIZERS AND DISTINGUISHED PARTICIPANTS

I am extremely grateful to you, Mr. President, for your kindness in inaugurating this first Unesco Study Meeting on the problems posed by the science policies of the nations.

Your presence here in your capacity of President of the Czechoslovak Academy of Sciences and Vice-President of the State Committee for Technology confirms my conviction that this meeting will be a milestone not only for scientists but for all those to whom in the governmental hierarchy of the various States, responsibility is given for the unflagging pursuit of economic development, social progress and the cultural fulfilment of the peoples.

In this connexion, it gives me pleasure to pay tribute to the Czechoslovak Academy of Sciences for the vital work which it has done for many years past to forward the noble cause of the advancement of science and its application to development.

Science is not merely an intellectual adventure, it is also one of the most reliable ways of strengthening understanding between nations and peoples united in the brotherhood of repressing ignorance, hunger and poverty.

I should also like to take this opportunity of welcoming the presence of the eminent specialists assembled today in Karlovy Vary, and thank them for having so generously responded to the invitation of the Director-General of Unesco.

Finally, I want to extend my warmest thanks to the Czechoslovak Academy of Sciences for its generous hospitality and to the Czechoslovak National Commission for Unesco for its constant and cordial support.

Mr. President, ladies and gentlemen, it is my privilege in this introductory address to give you a brief outline of the background and objectives of your meeting and some indication of what we hope will be achieved. I hope in this way to meet your expectations satisfactorily for I know the desire which fills you to serve at once Science and Mankind.

II. BACKGROUND OF THE MEETING

Let us look first of all at the background of this meeting.

Unesco's Science Policy programme had its genesis around 1952-1953 in a study of the organization and scientific and technical potential of States belonging to the Organization who wanted to concert their research efforts at international level. The outcome was the organization, as early as 1955, of the first Meeting of Directors of National Research Centres in Milan at which over thirty countries were represented.

At that date, most of the scientifically advanced countries were only beginning to install the governmental machinery for determining their national science policies; while the developing countries, for their part, were rapidly attaining political independence.

Thus every quarter of the world presented problems in the matter of that development of nations which is now known to be the outcome of two simultaneous phenomena: growth and change.

Leaving the study of the questions relating to growth to the economists, the scientists and engineers were called on to turn their minds to the process of change in contemporary societies under the combined impact of discoveries and innovations and their practical application in the life of the people.

It was then - in 1963 - that the United Nations convened its Conference on the Application of Science and Technology for the Benefit of Less-Developed Areas, generally known as UNCSAT.

The scientists attending, more than 1,600 strong, and representing all disciplines and all regions of the world, conceded from the outset the important rôle of the import of techniques to the developing countries. But they also agreed, even more strongly, on the importance - for all countries - of creating the conditions for the endogenous development of science and technology in their societies; which, incidentally, was Unesco's working principle and its appointed task.

Therewith, resounding confirmation was given to the first of the recommendations arrived at in the publication prepared at Unesco Headquarters in 1960, under the direction of Professor P. Auger, on "Current Trends in Scientific Research", namely, that national science policy should be a prime concern of governments.

On the practical plane, the requirements are to develop a country's scientific and technical potential and to apply the creative and assimilative forces it conceals to the ends of cultural, economic and social progress. These are the two main aspects of any genuine government science policy.

It is in the frame of reference of Unesco's programme for the promotion of Member States' national science policies and in pursuance of the decisions adopted by the General Conference of Unesco at its thirteenth session that this meeting is being held.

As you are aware, this programme comprises two main categories of activity: assisting those Member States who request it to devise and institute government science policies and, in addition, promoting intellectual co-operation between the various countries on the theoretical and practical aspects of these questions.

III. AIMS OF THE MEETING

Let us now consider the motives behind the organization of the present meeting.

With a heavy task laid on it, Unesco began as early as 1960 to seek the assistance of the science policy agencies of the countries most advanced in this domain.

The outcome was agreement by a dozen countries - the countries of the specialists meeting today in Karlovy Vary - to carry out a multidisciplinary project towards the publication by Unesco of a factual and objective study research of their national science policies.

While eschewing any dogmatic doctrinaire approach in this respect, the Unesco Secretariat has already identified some of the guiding principles of such policies, which enable it to orient its technical assistance programmes in the matter of science policy and to provide its experts with a collection of directives setting their personal experience - necessarily limited to their own countries - in an international perspective.

With the number of Member States seeking Unesco's assistance - currently more than twenty - increasing - and techniques for the planning of science policy taking shape, Unesco feels it an imperious duty to seek the views of the best qualified specialists on the matter.

It is for this reason that the Director-General asks you today to concentrate on three main objectives during the discussions which are to take place.

First objective. Identification of the general principles and common features of the national science policies prepared and put into effect in countries belonging to different political systems.

This inquiry will be the subject of items 5 and 6 of the agenda and will be given a good start by the participants' introductory statements on the salient features of science policy in their respective countries. Unesco has deliberately abstained from suggesting an outline structure for participants' papers, desiring thereby to open the door to a wide range of ideas on anything from the ethic and social motivation of scientific activities to the organization and productivity of research.

In this connexion, the Unesco Secretariat has submitted to your attention some "Considerations on the Concept of Science Policy" (document no. 105) and a draft study on the "Integration of Scientific Planning and Socio-Economic Planning" (document no. 103).

Second objective. Determining what basic data are necessary and adequate for the preparation of a national science policy, having regard to the level of scientific development of the country concerned, and to its geographic, economic and demographic dimensions.

The Director-General of Unesco attaches the greatest importance to this question. The position is that, thanks to the various studies of national science policy you have produced, the Secretariat is now able to submit to your critical examination a handbook of guidelines (document no. 85) which will serve to orient the science policy organizations of the countries which have informed Unesco of their willingness to contribute to this international programme of comparative science policy studies in the years ahead.

Additionally, the guidelines should make it possible to agree on concepts, classifications and definitions in various languages.

In this connexion, the Secretariat likewise submits for your consideration an annotated plan of an "International Glossary of Science Policy" which Unesco began compiling some years ago (document no. 106).

Finally, the guidelines will serve to steer the interested countries' evaluation surveys of their scientific and technical potential. For this purpose, it may perhaps be necessary to suggest simplifications and a measure of adaptation in the case of the developing countries. Unesco leaves this to you.

Third objective. Consideration of the principles and methods applied by Unesco to promote the science policies of its Member States. This programme is in no sense limited to States seeking Unesco's assistance, as is frequently thought to be the case, but it is a fact that at the present time the most difficult problems confronting the organization are those posed by technical assistance activities, at the levels of governing principles and ways and means of execution alike.

The historic period in which the United Nations agencies are now living - I mean the Development Decade - demands that Unesco give priority attention to these questions.

To facilitate your deliberations on this matter, the Secretariat has prepared three separate documents. The main document on which we hope you will give your views in the form of recommendations, concerns the principles, objectives and methodology of Unesco's programme for the "Promotion of National Science Policies" (document no. 107). The other two documents supplement it and are designed to put this programme in perspective: one of them traces the Organization's activities in the matter of national science policy over the last ten years (document no. 100), while the other outlines the proposed programme for the next two years which will be submitted to the General Conference of Unesco in October (document no. 117).

IV. ORGANIZATION OF WORK

The complex tasks which the Director-General has set you leave us to suggest, Mr. President, ladies and gentlemen, that you discuss the guiding principle for science planning and for its integration with general development planning in plenary meeting. It will also be in plenary meeting that you will adopt your final resolutions and recommendations.

However, all of you know from experience that the drafting of texts is only practicable in small working groups. It is for this reason that we suggest that a special working group be formed for each of the three main objectives set for this meeting.

The intention would be for the working groups, at the instance of their own members or of any participant in this meeting, to formulate a certain number of "resolutions" or "recommendations" from which the Member States and Unesco could alike draw ideas. In the case of the first working group, these resolutions would concern the principles, organizations, methods and implementation of national science policy and would be addressed generally to all those in science or government administration or using research, who have occasion to acquaint themselves with these problems in their own daily work.

A working group is also suggested for each of the two other main objectives of your meeting:

determining the basic data required for the preparation of national science policies; and

examining Unesco's principles and working methods for the promotion of the science policies of its Member States.

Here again, we would rely on your individual initiative for the submission of proposed "recommendations" to the Director-General of Unesco who, as I would remind you, looks to your meeting for unambiguous guidance towards the execution of the Organization's programme.

V. FINAL REPORT AND RESULTS OF THE MEETING

Before I conclude, Mr. President, ladies and gentlemen, may I permit myself a few anticipatory remarks on the results which may fairly be expected from your proceedings?

To begin with, normal practice requires that a report of the meeting be written, widely distributed in Unesco's working languages and put on sale in Member States. This report will contain the full texts of your statements on science policy in your respective countries plus main working papers prepared by the Unesco Secretariat. It will also contain the resolutions and recommendations which you will be adopting at your closing meeting and which, we hope, will make this report a source document on science policy for future years.

Additionally, Unesco hopes, with your assitance, to bring out a publication, "Selected readings on Science Policy", in 1967. We know that countries embarking on the planning of a government science policy feel the need to supply their planning specialists with a selection of the best articles published on the subject. Unesco is appealing to each of you regarding the making of the selection, asking you to direct your choice preferentially to articles - ten at most - published in your own countries and national languages.

The Unesco Secretariat will set iself the task of obtaining the necessary translation and reproduction rights and will see that the work is properly presented in the light of your counsel and the actual substance of the articles selected.

Last but not least, Unesco hopes that the Karlovy Vary meeting, the first encounter between the most eminent specialists of countries with disparate political systems, will prove to have permitted the establishment of co-operative relations on a world-wide scale whatever the level of development reached in your respective countries.

For its part, Unesco will examine with the closest attention the proposals emerging from your discussions about the rôle which the Organization could play in the future to perpetuate and strengthen this co-operation.

VI. CONCLUSION

We feel, Mr. President, ladies and gentlemen, that Unesco's primary mission - to contribute to the maintenance of peace - cannot be better served than by promoting the convergence of the ideas of those whose labours must build a genuine "World of Men" for the generations to come, I mean those who have the responsibility of blueprinting the future.

It is my earnest hope that your labours, with their window on this prospect, will be crowned with success.

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CHAPTER 4

NATIONAL SCIENCE POLICY AND THE ORGANIZATION OF SCIENTIFIC RESEARCH. STATEMENTS BY PARTICIPANTS

I. Belgium

(Statement presented by Dr. J. Spaey)

A. STRUCTURE

The main features of the structure of science policy in Belgium may be summarized as follows:

1. Centralization of the functions of information, planning and decision-making, involving the following aspects:
   - inventory of scientific potential
   - analysis of the science budget
   - formulation of development programmes for university education, fundamental and applied research and technological development
   - organization and operation of the university apparatus and the apparatus for fundamental and applied research
   - careers and status of science personnel.

2. Decentralization of executive functions in respect of direct promotion, financing and control, is ensured as follows:
   - by direct intervention by the administrative bodies concerned (Education - Economic Affairs - Agriculture - Public Health);
   - by indirect intervention by bodies which promote fundamental and applied research, acting by delegation of authority.

3. The institutions responsible for science policy in Belgium have comprehensive and integrated functions:
   - they cover both university education and fundamental and applied research in all disciplines;
   - the entire range of national scientific activity (public and private) is progressively directed and planned by the central bodies responsible to the Prime Minister, namely:
     - the National Science Policy Council, in charge of programming and planning,
     - the Ministerial Science Policy Committee, the decision-making body,
     - the Inter-Ministerial Science Policy Commission, responsible for administrative co-ordination in cases where several ministerial departments are involved in the decisions.

4. Science policy as the product of co-ordinated or corporate effort

We believe this to be essential to its success, since joint action must be based on common conviction. However, it should be pointed out that there are two aspects of participation by the circles concerned (academic, economic and social) in the formulation of science policy:
- participation on the basis of special qualifications. This concerns the opinions of experts as to the feasibility of a scientific programme, and the value or necessity for scientific progress;
- participation on the basis of responsibility. This concerns the opinions of the leading administrative officials responsible for the academic, economic or social sectors as to the advisability or necessity of the programme in relation to the aims pursued and the resources available (priorities).

To sum up, it might be said that science policy is formulated with the advice of experts and by the responsible authorities.

B. BASIC DATA

These are essential for the formulation of science policy. Several aspects are involved:

1. The inventory of the national scientific potential covers the whole range of public and private education and research institutions, with particular emphasis on their main characteristics, namely:
   - the size and qualifications of their staff,
   - their work and fields of scientific study,
   - the material and financial resources at their disposal,
   - the research projects which they would like to be able to undertake.

The inventory is made every two years. It was made in 1961 and 1963. The data collected during the 1965 survey are at present being processed.

2. Budget analysis is carried out annually in accordance with the following criteria and under the following heads:

(a) the composition of the budget, i.e. the consolidation of allocations for scientific work appearing in the budgets of the various ministerial departments.

(b) study of the initial or presumed destination of allocations, grouped under five headings:

(i) allocations for teaching and research at universities (directly financed),

(ii) allocations for the indirect or parallel financing of fundamental research at universities,

(iii) allocations for financing industrial and agricultural research (public financing). Private industrial financing is on approximately the same scale,

(iv) allocations for financing of public services or research of national interest,

(v) allocations for financing international scientific co-operation.

(c) *Identification of the beneficiary institutions and in particular:*

the universities and faculties of similar rank,
state scientific establishments,
scientific services in industry,
international organizations.

(d) By studying the consumption and utilization of allocations, it is possible to determine the extent to which scientific work contributes to the attainment of the nation's scientific, economic or social objectives. The latter can be listed as follows:

education,
development of fundamental knowledge,
industrial production,
agriculture and animal husbandry,
health and hygiene,
the organization of social life,
art and culture
national defence.

Analysis of the utilization of allocations for the financial year 1963 revealed a discrepancy between initial destination and utilization, i.e. between intention and reality. This discrepancy is not altogether normal, in that it gives evidence of the necessary flexibility to be maintained in organizing scientific work. In some fields, however, the existence of a wider discrepancy is seen as an indication of shortcomings in organization and management.

3. A third very important aspect of basic data is the study of international reference material in order to adjudge the country's efforts in comparison with those of its neighbours with whom it is engaged in economic competition. On this point, three main difficulties are encountered:

unfortunately, the terminology and the sense of certain words are not entirely comparable from one country to another;

the data obtainable are neither sufficiently comparable nor sufficiently numerous for trends to be discerned with sufficient certainty;

the structure of science policy in some of the countries is not sufficiently co-ordinated to provide a clear enough picture of scientific work going on there.

4. Finally, we are making monographic studies regarding certain fields or questions which involve particular difficulties or call for further or stronger action. The following three examples will serve as illustrations:

University expansion. A sociological study on this subject has pinpointed the requirements and criteria for the creation of universities;

The relationships between industrial research and economic growth;

Studies of growth points in the basic sciences.

5. The difficulties involved in these four tasks of information and study, though many and varied, are far from insuperable. The main ones, judging from our own experience, are as follows:

the technological and methodological difficulties inherent in any new undertaking;

the psychological difficulties arising in scientific circles unfamiliar with the problems of organization and jealous of their autonomy;

the difficulties of presenting studies and their findings in a form suitable for the scientific public, the political public and for the general public;

the shortage of staff competent to carry out the work involved in the "economics of science".

C. PROGRAMMING OR PLANNING

1. Our scientific planning has no ideological slant or purpose.

(a) We do not regard science as merely an objective or an aim in itself. Science has become both the cause and the method of progress, and hence an essential instrument of "policies".

(b) We look on planning (with all its approximations and even errors) as a necessity for development rather than as an ideological or political choice.

Planning is essential in all circumstances where certain sets of conditions exist - in particular, complexity of the situation to be dealt with and relative scarcity of resources available. In the especially complicated and costly field of science, the smaller countries need to make particularly careful use of their resources, and therefore have to plan their scientific development programme in even more specific terms than the major countries. This, we repeat, is a question of necessity, rather than political preference.

(c) Finally, we believe that the best programme is one which can be and is carried into effect, not one which might theoretically be the most logical. Viewed thus, the programme or plan is based on concern for realistic and effective action, and is in no sense the outcome of a desire to force reality into the straitjacket of a theory or an abstract system.

2. The specific problems of science planning in Belgium

(a) The overall effort

The least unreliable index of a nation's scientific effort would appear to be the ratio of expenditure allocated for science to the gross national product (GNP).

(i) By comparison with other countries, the situation seems to us to be as follows (1966):

The great nations of western Europe devote an average of 1.90% of their GNP to research, figure for the smaller nations is 1.74%, the figure for Belgium is 1.13%.

(ii) The target we have set ourselves is gradually to bring the national figure up to 2% of GNP in 1972, with the State providing about 50% of the amount.

(b) Sectoral targets

Below are some recent data on the targets scheduled for the period 1967-1972. It should be noted that these are to be revised annually and if necessary adapted in accordance with results observed.

(i) University education

We still lack sufficient data in Belgium for an accurate assessment of the requirements of university development (nor have we come across much more accurate data elsewhere). Failing a better assessment, we shall be adopting an annual growth target of 10% for the period 1967-1972, corresponding with the foreseeable growth of the student population. This naturally means 10% at constant prices, which is equal to about 14% at current prices (in Belgium).

(ii) For the parallel financing of fundamental research carried out in the universities, there will be two limits under the programme for 1967-1972:

the total amount of this financial aid is not to exceed 10% of the total budget of the universities and faculties of equivalent rank;

one-fifth (20%) of the allocations are to be renewable annually for use for new programmes.

The reason for these limits is our belief that a considerable part of fundamental research should continue to be carried out in the universities as an indispensable background to higher education. We consider that when faced with a task and given the resources for rapid growth, the universities should improve and adapt their organization and management to fit those new demands; and we also feel that a justified but limited augmentation of their resources will act as a practical incentive to them to carry out those reforms.

It should be pointed out that higher education and fundamental research in the universities have not up to the present been subject to compulsory guidance or to planning proper. Incidentally, these sectors absorb nearly 65% of public expenditure on science.

(iii) As regards international scientific co-operation, we note that it accounts in 1966 for over 11% of the public expenditure on university education and research. We feel that this figure should not exceed 12% in 1967-1972: the transfer of our resources to the international level would otherwise hamstring our national organization and limit our economic and cultural independence.

(iv) Some 22% of the budget will thus remain available for financing two groups of activities:

public services research (the State scientific establishment),

industrial and agricultural research.

We have so far not set a specific target for the development of public services research, since they are due for review and for co-ordination of their tasks in 1967, and their growth will most probably be limited to 10%.

On the other hand, we shall try to free as large a part of the budget as possible for technological research (at least 12% of the budget), providing for a growth of more than 10%.

(v) For technological research, we have set sectoral targets for individual branches of the economy. In determining the share to be allotted to each sector, we have been guided by two criteria:

International references, i.e. the apportionment observable in other countries, the assumption being that Belgium might very reasonably draw inspiration from the example of comparable neighbouring or partner countries.

Nevertheless, we have also taken account of Belgium's industrial structure, in the belief that our country's economic structure cannot be revolutionized overnight or its economic and social traditions abandoned without harm being done.

In other words, we question the existence of an ideal pattern of development valid for all countries and at all times. We wish to evolve in the direction of the future and of progress, while being firmly rooted in the past.

Specifically, the sectoral targets (expressed as percentages for the main sectors) are as follows:

agriculture	24%
chemical industry	8%
iron and steel metallurgy	6%
non-ferrous metallurgy	14%
engineering	4%

electronics	28%
building	4%

(c) However, attention should be drawn at this point to two difficulties met with in carrying out the technological research development programme.

(i) The research allocations are all too easily channelled into the improvement of existing products and processes in traditional industries which thus seek to maintain their profitability margins in order to survive.

(ii) In order to evolve a dynamic research policy aimed at innovation, i.e. the development of new products and processes, it is not enough to pour in men and money. The enterprises using these allocations must also, before all else perhaps, develop clean-cut and integrated forms of organization and development so that the industrial research is closely correlated with firm's production and with its commercial and social policy. Not all our enterprises have made this effort, the importance of which to technological development has been rightly stressed (e.g. in the U.S.A.). While Belgium's resources are limited, she hopes, by making a determined, sustained, and carefully thought-out effort, to play her part in the development of the sciences and technologies which are today the essential factors of progress and prosperity.

II. Czechoslovakia

(Statement presented by Professor V. Bažant)

A. INTRODUCTION

In recent years new processes have radically changed the structure of production and greatly exceeded all previous achievements of mankind. The flow of scientific knowledge and its social utilization in production is constantly growing; technological innovations, which in the early years of our century brought productivity increases in the range of 5-20%, in our time can raise productivity tenfold or even more.

Science has an all-round effect on economic and social development. The advancement of society is based on a very intricate interaction between science and other social activities. A systematic study of the complex processes starting from some new scientific discovery and leading to its practical application is the most topical problem of our time. To create optimum conditions for the expansion and application of science is a problem faced by every country, be it large or small, advanced or developing. Therefore we appreciate the initiative of Unesco in its comprehensive approach to the questions of scientific development.

Allow me to give a short outline of the situation in Czechoslovakia and mention some problems we are encountering. The term "scientific policy" has yet to be defined. In our context we understand scientific policy namely as the relations between bodies administering society on one side and science on the other. These relations, naturally, have many aspects: economic, administrative, organizational, sociological and psychological, etc.

Being aware of the complexity of science management the Czechoslovak Academy of Sciences set up the Institute for Science Planning, which is partly an executive body of the Presidium of the Academy and partly engaged in research. This Institute has, on the one hand, to perform executive and administrative functions connected with the elaboration and control of the State plan of scientific and technological advancement, especially in the field of fundamental research, and on the other, to study some aspects of the social function of science.

The Institute concentrates its attention on the economic effects of science and on some methodological questions related to mangement and planning of research. This activity has brought about several partial results. In some spheres of theoretical and methodological research carried out in COMECON countries the Institute is leading co-ordinator. The Institute is engaged for instance in problems of science statistics, organization of science, efficiency of science, scientific documentation, etc. In the study of some aspects of research efficiency and in the field of science statistics, where conditions for setting up standard indicators for the evaluation of research and development in COMECON countries are investigated, certain achievements may be noted.

From the beginning in this field it became evident that problems of science management and planning had to be studied in the broader context of science itself. It is not feasible to manage research without thoroughly investigating the basic aspects of scientific research, especially the ways and means of achieving the required or expected results and their optimum implementation with maximum economy. The Presidium of the Academy has taken the initiative of elaborating a complex research programme on the rôle of science in contemporary society in which a number of scientists from different fields will participate. This programme may be roughly divided as follows:

1. Theory of science, i.e. philosophy of science, logical and methodological problems of scientific knowledge.
2. Sociological and psychological aspects of scientific work and life.
3. Scientific documentation, data processing and retrieval, automation of these processes, etc.
4. Socio-economic conditions of scientific development and of exploitation of scientific achievements.

5. Management and planning of scientific and technological progress.

Besides this broad research programme, in co-operation with other institutions partly engaged in studying the social function of science (as for instance the chair of science and technology at the Economic College or the Institute for Economics of Technological Development - part of the State Commission for Technology) a project had been included in the State research plan, dealing with economics and management of scientific and technological progress. This project aims at a complex study of the main economic relations of scientific and technological progress to individual aspects of social production.

B. MANAGEMENT OF SCIENCE IN CZECHOSLOVAKIA

When reviewing the problems of management and planning of research in Czechoslovakia from the widest angle we should mention the following bodies and institutions directly or indirectly engaged:

(1) the National Assembly and Government;
(2) the Czechoslovak Academy of Sciences as the supreme scientific institution of Czechoslovakia;
(3) the State Commission for Technology as the government authority for planning, co-ordination, financing of technological development;
(4) the State Planning Commission as government authority for general problems of economic development;
(5) the Ministry of Education and Culture, as the government authority for higher education policy;
(6) other ministries and other central authorities of the State administration, responsible for the respective branches of the national economy.

Scientific research is carried on in the following research and development institutions: (see Chart 1)

(1) scientific institutions of the Czechoslovak Academy of Sciences and of the Slovak Academy of Sciences;
(2) faculties of the universities;
(3) sectoral research and development institutes and organizations subordinated to the ministries;
(4) sectoral experimental and control institutes;
(5) sectoral institutes of scientific, technical and economic information;
(6) independent research and development institutes of industrial enterprises;
(7) research and development institutions within industrial enterprises;
(8) testing and pilot plants.

These research institutions, their number amounting to 1,850 (of which about 20% are independent organizations) represent the research and development system of Czechoslovakia. The types of institutions listed under 1-4 account for about 40% (they are centrally financed from the State budget) while the institutions under 5-8 (institutions operating on a commercial basis and/or financed by individual enterprises) account for about 60% of the capacity of the Czechoslovak research and development (if calculated according to the number of workers) (see Chart 2).

The Czechoslovak Academy of Sciences has a particularly significant rôle in management and planning of science.

The establishing of the Academy with its own research institutes has enabled a higher degree of concentration of research projects than is encountered in Western universities. The Academy of Sciences had for a prolonged period been the co-ordinating centre for all research; later, after the State Commission for Technology had been established, it took charge of the application of scientific knowledge to the needs of economic development and is responsible for investment policy. Since then the Academy remains the planning and co-ordinating centre for fundamental research.

The delimitation of research projects between the Academy and establishments of higher education is determined mainly by the personnel and material equipment of the institutions in question, namely by the employment of highly-trained scientists.

A common feature of the Academy and of establishments of higher education is their provision for graduate education and training of scientists for other sectors.

A close link between the Academy and the universities is realized through personal relations. In 1965, for instance, one-fourth of the scientific workers of the Academy were also engaged in teaching at the universities. The majority of members of the Academy are university professors and the most promising scientists among the teaching staff of higher education are invited to work also at Academic institutions to give them better possibilities for pursuing complicated research problems.

The Czechoslovak Academy of Sciences is entitled to request other than its subordinate institutions (namely institutions of the universities, research institutes subordinated to the governmental authorities and the like) to supply information, and suggestions concerning the scientific activities of such institutions. The Czechoslovak Academy of Sciences is the government's chief adviser on the main scientific problems and in this capacity it closely co-operates with a number of authorities and institutions, especially with the State Committee for Higher Education and the State Commission for Technology (see Chart 3).

The supreme body of the Academy is the General Assembly of its members, which is convocated as a rule once or twice a year, to decide on the basic programmes of the Academy, and to determine the principal trends of further activity and development of the Academy. The General Assembly elects the Presidium of the Academy for a period of four years.

The Presidium sets up the scientific boards called "collegia". It appoints to them members of Academy, other prominent scientific workers from academic and university research institutes and other institutions.

The boards are engaged especially in planning and control of more important research activities, in co-ordinating work between the institutes of the Academy, higher education and specialized institutions, in so far as they perform fundamental research. They take care of the training of scientific workers in the respective scientific branches, survey the publishing activity, the organization of scientific conferences and international relations. The boards contribute to ensuring the further development of scientific and research activities at the institutes of higher education and confer the scientific degrees of Candidate and Doctor of Sciences.

C. PLANNING OF RESEARCH

Science has two basic functions: acquiring knowledge in order to achieve an ever more exact, objective picture of the world, and the application of this knowledge, thus putting it to social use.

The contemporary growing importance of science in society, and particularly in production, appears at first sight as a strengthening of the application function of science in society. But on the other hand the hazardous expansion of the application of science is inseparably linked with its function of acquiring knowledge. Besides the social demand for the investigation of scientific and technical problems, the results of which can be rapidly exploited, the investigation and solution of complex problems systematically advancing scientific knowledge enables the anticipation of social needs before the demand for their solution has become imminent.

The problems of research, springing from the known concrete needs of economic and social development, whose object is to maintain technology at an international level, or to ensure its rapidly attaining the level of existing scientific knowledge in the world are incorporated in the State Plan by the State Commission for Technology. In the solution of these problems, institutions of basic and applied research, as well as institutions engaged in developmental activities participate (see Chart 4).

The selected problems of basic research result both from the prospective needs of society and from the internal needs of the development of science. These problems of fundamental research are investigated mainly in the Czechoslovak Academy of Sciences and at universities.

In the planning of research, besides laying down research projects, measures to ensure that they are carried out in respect of the required personnel and material aspects are also covered.

Experience gained so far in management and planning of science in Czechoslovakia reveals certain tendencies:

In the first place, the planning of science must always be prospective and its continuity must be assured. The planning of science must concord - as to the time-period - with the other plans for economic development.

In the management, planning and control of basic research scientists and scientific institutions (scientific boards, commissions of the Presidium, scientific institutes and faculties of the universities as the co-ordinating and principal institutions) must increasingly take part. The share of the administration then automatically decreases.

The structure of the research plan must be based on the immediate needs of the scientific work proper; the co-ordination of research then ceases to be a formal affair and concentrates on problems the synthetic elaboration of which promises to achieve a higher degree of knowledge.

The investigation of principal problems, often requiring co-operation and involving a concentration of material and personnel resources as well as expensive equipment, demands the co-operation of large institutions.

Finally, the method of planning must also be adapted to the domain of the research in question. It has been demonstrated that it is not practicable to apply the same planning régime to programmes of basic research, applied research and development. The planning method in basic research must leave possibilities open to carry out flexible changes in the orientation of research, in accordance with the first results obtained.

The planning of science in the Czechoslovak Socialist Republic is part of an entire system of plans for overall economic development. Certain parts of this system of plans fit personnel, material and financial resources for the development of science.

The plan comprises (see Chart 5):

The State Plan for Scientific Research called the A-plan, set up by the Czechoslovak Academy of Sciences and covering basic research in all economic branches.

Contributions to the plan "A" represent an average of 65% of the capacity of all the institutions of the Academy - in terms of the number of working hours of all the scientific, technical and specialized workers of the institutions of the Czechoslovak Academy of Sciences.

The Plan for Scientific Research is elaborated for five-year periods. It is reviewed and approved by the government, which authorizes the Czechoslovak Academy of Sciences to make the necessary improvements in the course of its fulfilment.

The State Plan for Research and Development called the K-plan is linked with important long-term programmes of capital construction, production and exports. They cover research, development and introducing new products and technologies into production, and lay down the

Chart 1. ORGANIZATIONAL CHART OF SCIENTIFIC RESEARCH AND DEVELOPMENT IN CZECHOSLOVAKIA

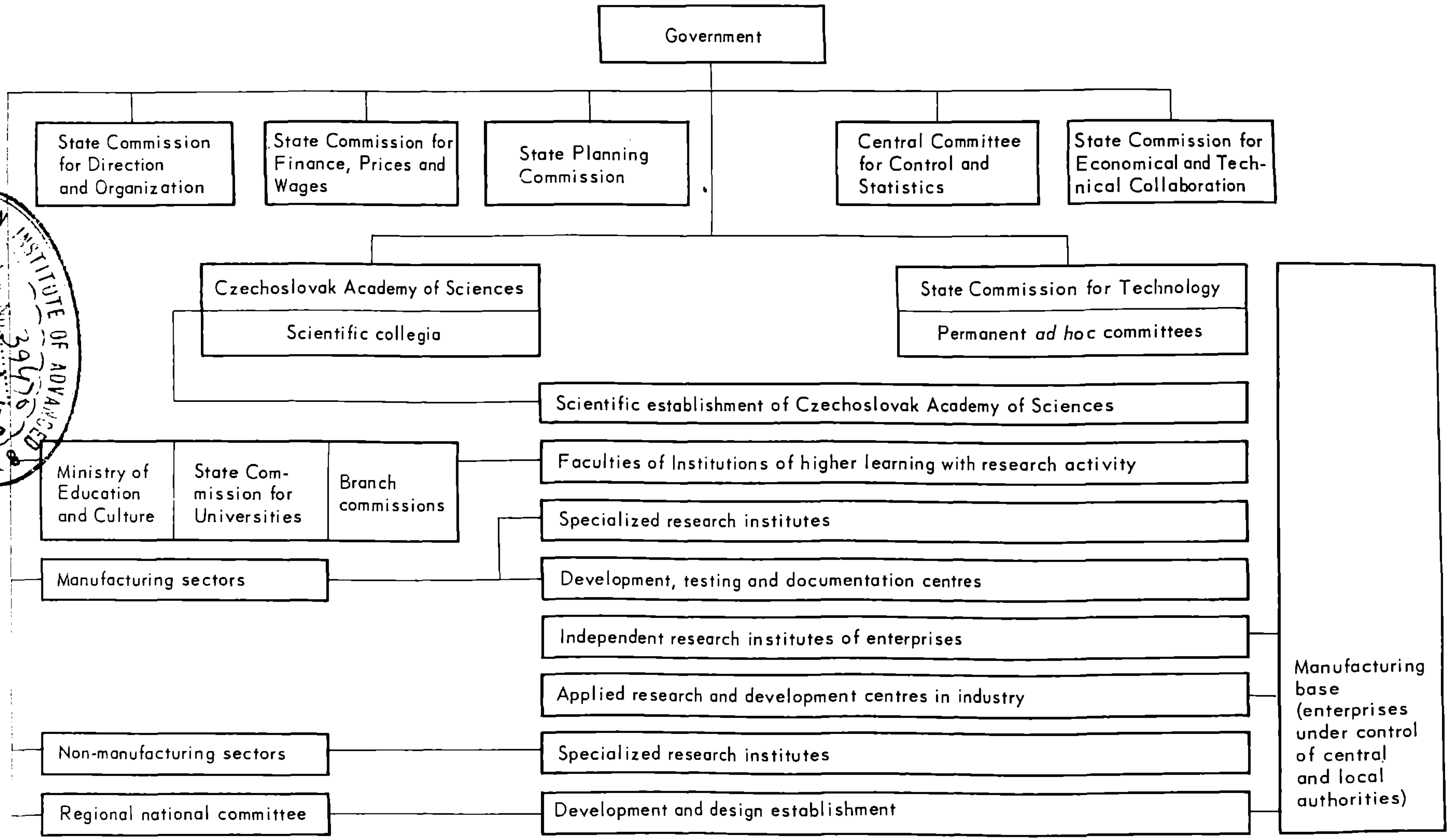
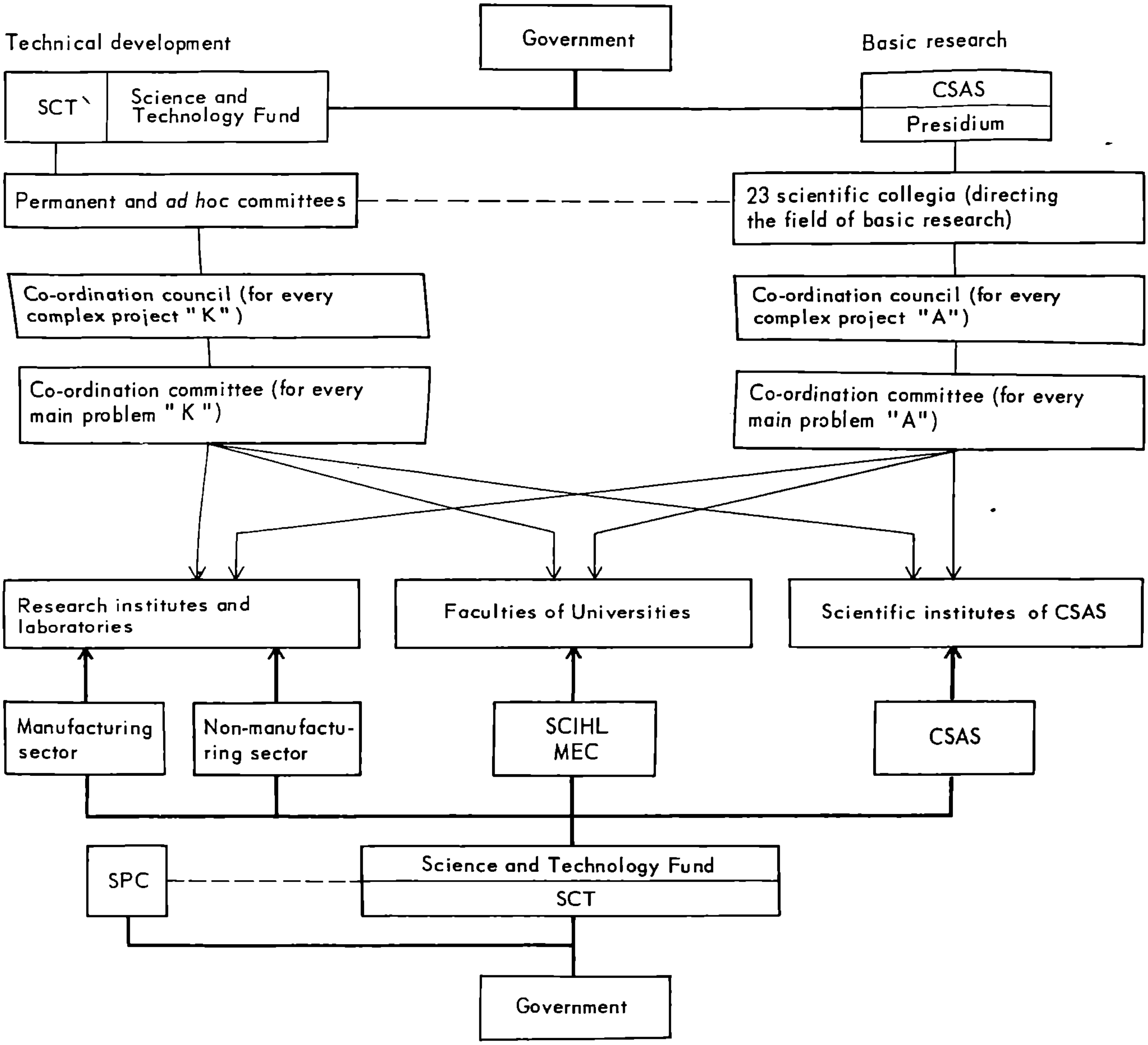


Chart 2. OPERATIONAL CHART OF THE STATE ORGANIZATION FOR RESEARCH IN CZECHOSLOVAKIA



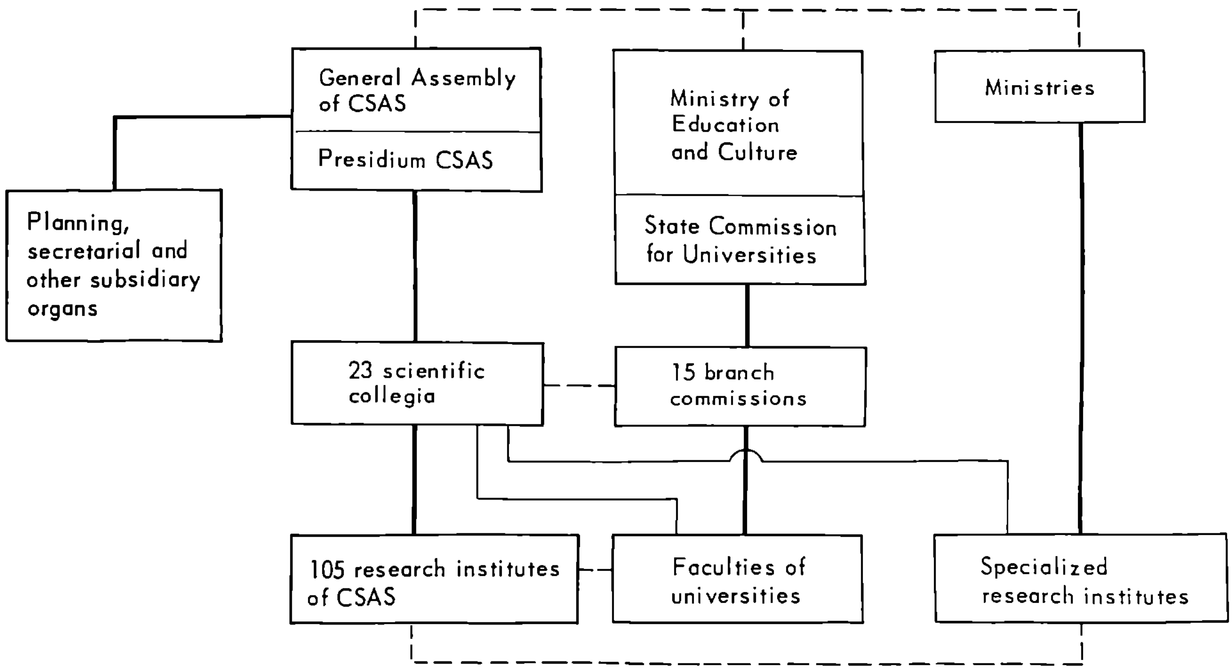
KEY

▬▬	Organizational subordination
——	Expert direction of research
– – –	Co-operation

CSAS Czechoslovak Academy of Sciences
SCT State Commission for Technology
MEC Ministry of Education and Culture
SCIHL State Committee for Institution for Higher Learning
SPC State Planning Commission

State plan "A" = of basic research
State plan "K" = of new technology

Chart 3. **OPERATIONAL CHART OF THE ORGANIZATION OF THE CZECHOSLOVAK ACADEMY OF SCIENCES**



——— organizational subordination

——— management of basic research activities

– – – – – co-operation

Chart 4. PLANNED DEVELOPMENT OF RESEARCH

Planned development of research resources				
Number of scientific workers				
	1965		1970	
Overall	128 160		163 000	
CSAS	11 420		13 900	
Universities	1 700		5 100	
Others	116 040		144 000	
Percentage of total number of scientific workers				
	1965		1970	
	Graduates (B.Sc. and M.Sc.)	Scientific workers (Ph.D. and D.Sc.)	Graduates (B.Sc. and M.Sc.)	Scientific workers (Ph.D. and D.Sc.)
Overall	22.8	3.8	27.3	6.5
CSAS	38.7	18.5	40.5	25.8
Universities	54.8	22.9	33.9	10.8
Others	20.6	2.0	25.8	4.5

Chart 5. STATE PLAN FOR SCIENCE AND TECHNOLOGY AND ITS PART PERFORMED BY THE CZECHOSLOVAK ACADEMY OF SCIENCES

State plan for science and technology			
State plan for basic research projects	State plan for applied research and development projects	Plan for science and technology funds	Plan for education of scientific workers

Institutes of CSAS (= 100 %)			
Themes of plan "A"	Themes of plan "K"	Unspecified activities (planned only at the level of institutes)	Other then research activities
65 %	9 %	19 %	7 %

dates to be observed, and economic effectiveness which is to be achieved. The State Plan of Research and Development also includes tasks co-ordinated on the international level by the Standing Commission for the Co-ordination of Scientific and Technical Research of the Council of Mutual Economic Assistance. Furthermore, it covers technical and economic studies. The five-year Plan brings more precise adjustments and new tasks are added to it in the detailed plan. Like the plan of scientific research, the State Plan of Research and Development is also divided into comprehensive tasks and independent principal tasks.

The Financial Plan for Science and Technology stipulates the amount of resources to be spent on the development of science and technology. In the five-year Plan, these resources are laid down and reserved for the purposes in question in the Plan for capital construction, in the financial plan, the personnel plan, the foreign trade plan. These resources are separately allocated to the State Commission for Technology and the Czechoslovak Academy of Sciences. According to the various ministries, the resources available to science and technology are allotted only in the detailed plan.

The tasks of the State Plan for Graduate Education are part of the five-year Plan. They are expressed by the rough numbers of prospective applicants for graduate education, and by background information on the improvement of structure of workers in research and development according to their qualifications. This Plan is worked out by the respective ministries and other central bodies on the basis of the proposals submitted by all the institutions of research and development, and on behalf of all of them. A summary draft of the five-year Plan including the measures to be taken by the institutions responsible for training is worked out by the State Commission for Technology, taking into account the opinions of the Czechoslovak Academy of Sciences and Ministry of Education and Culture.

D. FORMS OF FINANCING SCIENTIFIC DEVELOPMENT

For organizations depending directly on the State budget the source of financing will be the State budget, the same applying to the State programmes; funds which are at the disposal of the respective enterprise for financing technical development cover the resources for the remaining programmes. Other resources will be provided by the income for work performed for other research institutions and enterprises and other grants from superior bodies.

E. CONCLUSIONS

The long years of experience of the Czechoslovak Academy of Sciences in overall management and planning of research indicate that the management of science is most efficient when scientists themselves take an active part to the greatest possible extent. I do not hesitate, now that science is becoming the decisive factor in all socio-economic advancement, to postulate an ever-increasing participation of scientists in overall policy-making.

One of the main tasks of "administrators of science" is to ensure that research scientists are perfectly informed about future needs of social and economic development and about the possibilities of international co-operation in science. It is evident that every scientist, if he has to take an active part in science management, must have, besides the profound knowledge of his own discipline, a broad socio-economic outlook and organizational abilities.

Institutions engaged in science management have a responsible task. They must, in active co-operation with scientists, create optimum conditions for the advancement of science and its harmonious development and participate in assessing such research projects that correspond to the specific needs of the country's economic and cultural development.

The work of these institutions must be based on results of analyses of the social function of science and their creative application in the entire process of management.

I wish to point out that any investigation of the social function of science, as well as the entire management of science require adequate statistical data and indicators. Science statistics now being constituted encounter many serious problems. Our experience shows that the choice of statistical indicators characterizing research must result from careful considerations. Adequate statistics are an important tool for both the management of science and overall policy-making, in which scientists have to play the decisive rôle.

Finally, allow me to express my appreciation of Unesco's initiative in this field and to assure you of our readiness to share our acquired experience in science management and the results of our investigations in the social function of science with Unesco or any interested country.

III. Federal Republic of Germany

(Statement presented by Dr. F. Goerlich)

Mr. President, Ladies and Gentlemen

The comments I have to make on activities in science policy concern:

(a) the advancement of scientific and academic life in Germany after the Second World War,
(b) the new system of science policy, comparatively independent from the government, inaugurated, for historical reasons, after the Second World War.

This situation, I feel, may be of interest to you and may give ideas to other countries.

A. THE ADVANCEMENT OF SCIENTIFIC AND ACADEMIC LIFE IN GERMANY AFTER THE SECOND WORLD WAR

(1) General comments

The reforms initiated after the Napoleonic wars are still very evident in the structure of German education and research. In particular, the concept of Wissenschaft (science), embodying the cross-fertilization of ideas and emphasis on human sciences, as opposed to narrow specialization, has developed into the major philosophical basis for any planning in German education and research. History as well as physics is Wissenschaft; the university budgets in their entirety, as well as the budgets of the specialized laboratories, are considered under the general heading of Wissenschaft.

The competence of the Federation and the Länder (states) in questions of science and research is laid down in the Constitution (Basic Law) of the Federal Republic(1).

Articles 70 to 75 of the Basic Law divide the right of legislation between the Federation and the Länder. Legislation is within the competence of the Länder so long as it is not reserved to the Federation by the Basic Law. There is a difference between: (a) exclusive legislation of the Federation in domains where only the Federal Government can enact laws; (b) concurrent legislation where both Federation and Länder can enact laws - the Länder, however, only so long and in so far as the Federation makes no use of its legislative right; (c) skeleton legislation when the Federation can, under certain circumstances, issue general provisions, whereupon the legislative details are left to the Länder; (d) exclusive legislation of the Länder in domains where laws may be enacted only by the Länder and not by the Federation.

In principle, the Basic Law of the Federal Republic gives legislative and administrative powers to the Länder in cultural and educational matters and functions. According to Article 74,13 of the Basic Law, the Federation has only concurrent legislative powers in the promotion of scientific research. The exercise of all other government powers and of the government-controlled functions in the domain of higher education is the affair of the Länder. The freedom of teaching and research is expressly guaranteed in Article 5, P.3 of the Basic Law.

The Federation discharges the functions devolving upon it with the assistance of the departments for educational affairs in the Federal Ministry of the Interior and the Foreign Office. In addition, there is a Cabinet sub-committee for science and research under the chairmanship of the Chancellor. All Federal ministries whose work includes the promotion of science and research are members of this committee. Its function is to increase the exchange of experience, to co-ordinate the measures taken by the various ministries for the promotion of science and research and to deal with all research problems in so far as they concern the Federation and are of basic importance. Some of the Federal ministries have special scientific advisory councils to assist them. Some of these are purely advisory bodies which establish the scientific point of view for the general work of the ministries; others deal directly with problems of the promotion of research for the ministry in question and are consulted on the distribution of available funds (e.g. German Atomic Energy Commission, Commission for Space Research).

In December 1962, the title of the Federal Ministry of Atomic Energy was changed to "Federal Ministry for Scientific Research". Its sphere of activities was established by the Federal Chancellor(2).

The Länder have their own ministries of education with special departments on higher education to discharge the functions devolving upon them. The Standing Committee of Cultural Ministers (Ständige Konferenz der Kulturminister) is another institution at the disposal of the Länder to deal with "matters of educational and cultural policy of more than regional significance in order to achieve a common viewpoint and purpose and to represent common interests". The plenary assembly of the Committee of Cultural Ministers consists of the 11 Cultural Ministers of the Länder and West Berlin. It meets about every six to eight weeks. Four special technical committees, among which the Committee on Higher Education (Hochschulausschuss), are responsible for questions of science and research and work on preparing the decisions of the plenary assembly. The committees are generally composed of the heads of the different special divisions of the ministries of education.

Länder boards, study groups for research or research councils are active in the promotion of research in the individual Länder. Furthermore, in March 1949, the Länder of the Federal Republic concluded a treaty known as the "Königsteiner Abkommen" (Königstein Agreement) for financing scientific research installations. Under this agreement, the

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(1) This study covers the situation in the Federal Republic of Germany, including West Berlin.
(2) On 1 March 1963.

Länder undertake the responsibility of financing larger research establishments of more than regional importance through joint contributions. At first, the main purpose of this agreement was to assist the scientific institutes of the former Kaiser-Wilhelm-Gesselschaft (Kaiser Wilhelm Society), the present Max-Planck-Gesselschaft (Max Planck Society), as well as various large research establishments for all disciplines in the individual Länder. Later, Länder contributions to the Deutsche Forschungsgemeinschaft (German Research Association) also came under this agreement. Decisions in conjunction with the Königsteiner Abkommen are made by the Länder Ministers of Education and Finance. An administrative committee consisting of a representative of the Ministry of Education and the Ministry of Finance from each Land prepares these decisions.

Autonomous organizations (Selbstverwaltungs-organisationen) in the field of higher education and research play an important rôle in determining national scientific policy, especially the Deutsche Forschungsgemeinschaft and the Westdeutsche Rektorenkonferenz (West German Committee of University Vice-Chancellors). Because of their expert qualifications, they are frequently called upon by government bodies for advice and appraisals.

(2) Institutions

There are several institutions having to do with scientific policy and the promotion of science. Three of the most important are briefly sketched here.

(a) Wissenschaftsrat (Science Council)
An executive agreement between the Federation and the Länder established the Wissenschaftsrat on 5 September 1957. After a first extension in 1960, the agreement is now valid through 1968.

The Wissenschaftsrat is composed of two commissions, an administrative commission in which six representatives of the Federation and 11 Länder representatives sent by their governments participate, as well as a scientific commission with 16 scientists and six representatives from public life. The scientists are appointed on the joint recommendation of the Deutsche Forschungsgemeinschaft, the Max-Planck-Gesellschaft and the Westdeutsche Rektorenkonferenz; the representatives from public life and the governments are appointed on the joint recommendation of the Federal Government and the Länder governments, by the Federal President, for a period of three years.

The Wissenschaftsrat has the following functions:

(a) to work out a comprehensive programme for the advancement of science on the basis of plans drawn up by the Federation and the Länder in fields in which they are competent, hereby co-ordinating the plans of the Federation and the Länder and noting the focal points of the priority list;
(b) to draw up an annual priority programme;
(c) to make recommendations for the use of those funds which have been made available by the budgets of the Federation and the Länder for the advancement of science.

In November 1960 the Wissenschaftsrat presented the first part of its recommendations for the expansion of scientific establishments; this first section deals with institutions of higher education and was supplemented in 1962 by a number of suggestions for the creation of new institutions of higher education. Since 1961, the Wissenschaftsrat has concerned itself with the situation in research establishments outside universities.

As far as the preparation of the Federal and Länder budgets is concerned, the Wissenschaftsrat has limited itself up to now to recommendations on individual items, such as the financing of the Deutsche Forschungsgemeinschaft.

(b) Deutsche Forschungsgemeinschaft
(German Research Association)
The Deutsche Forschungsgemeinschaft was founded in 1920 as the Emergency Society for German Sciences (Notgemeinschaft der Deutschen Wissenschaft). It is the central organization for the promotion of scientific research in the Federal Republic. Its legal status is not that of a government agency, but of an association registered under private law. As an autonomous corporation in the field of German science, it makes its own by-laws and elects the scientific members of its governing bodies.

The Deutsche Forschungsgemeinshaft has the following functions:
it supports individual research projects,
it promotes co-operation among research workers,
it advises government authorities on scientific problems,
it encourages contact between German scientists and science in other countries,
it endeavours above all to assist and train the rising generation of scientists.

Members of the Deutsche Forschungsgemeinschaft are:
the 31 institutions of higher education in the Federal Republic and West Berlin,
the four Academies of Science in the Federal Republic,
five scientific societies and associations:
Max-Planck-Gesselschaft zur Förderung der Wissenschaften (Max Planck Society for the Advancement of Scientific Research),
Deutscher Verband Technisch-Wissenschaftlicher Vereine (German Association of Technological Societies),
Gesellschaft Deutscher Naturforscher und Ärzte (Society of German Naturalists and Physicians,

Physikalisch-Technische Bundesanstalt (Federal Institute for Physics and Technology),
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung (Fraunhofer Society for the Advancement of Applied Research).

The Deutsche Forschungsgemeinschaft receives its funds from three sources:
from the Federation (budget of the Federal Ministry of the Interior),
from the Länder (in accordance with the Königsteiner Abkommen),
from industry (through the Stifterverband für die Deutsche Wissenschaft).

In 1965 the Deutsche Forschungsgemeinschaft had approximately 150 million marks at its disposal.

Financial assistance to research on the part of the Deutsche Forschungsgemeinschaft is given mainly under two programmes:

1. Normal programme (exclusively on the initiative of the individual scientist),
2. Priority programme (co-ordinated aid in individual special fields on the basis of plans worked out by the Forschungsgemeinschaft, Within the framework of this programme, the individual scientist is free to apply to the Forschungsgemeinschaft for assistance in the work he wants to carry out).

The Forschungsgemeinschaft does not commission research projects. In the past years it carried out several special-aid programmes, such as the "large-size apparatus programme" (the procurement of especially costly research apparatus: electronic calculators, electronic microscopes, ultra-violet and infra-red spectrographs, etc.).

The co-ordinating and advisory function of the Deutsche Forschungsgemeinschaft is evident in several spheres:

1. in arranging seminars and meetings for scholarship holders; in bringing research workers together under the priority programme;
2. in the activities of the scientific commissions which cover important areas in research and public health. The results of the commission's work are placed at the disposal of government agencies for their own use (e.g. health legislation);
3. in the publication of memoranda on the situation in various fields of science;
4. in advising government agencies on numerous scientific problems.

The functions of the Forschungsgemeinschaft are discharged by a number of institutions:

1. Members' Assembly (annual meeting of all members);
2. Executive Committee (one President, four Vice-Presidents);
3. Senate (33 scientists responsible for planning in science);
4. Board of Trustees (Senate, six Federal representatives, 11 Länder representatives, five representatives of the Stifterverband - responsible for the budget);
5. Main Committee (15 members of the Senate, six Federal representatives, six Länder representatives, two representatives from the Stifterverband - responsible for financial aid to research and deciding on which applications to accept).

Advisory Committees of the Forschungsgemeinschaft are as follows:

1. 26 scientific committees with more than 300 experts (evaluation of applications);
2. Library Committee (consultation on libraries);
3. Publications Committee (advice on questions of publications in the field of science);
4. Committee for Applied Research (advice on problems of applied research);
5. Liaison representatives at each institution of higher education. The Deutsche Forschungsgemeinschaft issues a number of publications.

The Deutsche Forschungsgemeinschaft does not maintain research institutes of its own.

(c) Westdeutsche Rektorenkonferenz (West German Committee of University Vice-Chancellors).
In 1949, the universities and institutions of higher education in the Federal Republic with "Rectoral Constitution" (Rektoratsverfassung) and the right to confer doctorates joined together in the Westdeutsche Rektorenkonferenz. The Rektorenkonferenz is based on the agreement between the universities and institutions of higher education to clarify matters of mutual interest in regular discussions and to act jointly on these matters. The institutions of higher education are represented by their Vice-Chancellors.

The organs of the Westdeutsche Rektorenkonferenz are:
the Plenary Assembly (the Vice-Chancellors of the institutions of higher education who elect one of their circle as President),
the Executive Committee (former President and three members elected from the circle of Vice-Chancellors to assist and advise the President),
the Länder Committee (consisting of the Chairmen of the Länder Committees of Vice-Chancellors - a Vice-Chancellor delegated by the member institutions of higher education in one Land - for the discussion of urgent problems in the interval between plenary sessions; an agency for maintaining contact with the Committee of Ministers of Education).

The Westdeutsche Rektorenkonferenz has a permenent secretariat. There are commissions to cover different fields. The most important of these commissions are: the commission for questions of higher education at the international level; the commission for legal aspects of higher education; the commission on schools as well as the committee on examination and study regulations (this together with the Committee of Ministers of Education). The Westdeutsche Rektorenkonferenz has large archives on problems of higher education in Germany. It is also responsible for representing the interests of institutions of higher education in the Federal Republic on an international level.

(3) International scientific relations

The close relationship between German science and research in other countries is marked by personal contacts between individual scholars, co-operation between institutes in the same or related fields, lecture tours, participation in congresses, brief or more extended visits by foreign scientists, the exchange of scientific publications and joint work and research projects on a wide international scale.

Some institutions, such as the Deutsche Academische Austauschdienst (German Academic Exchange Service) and the Alexander von Humboldt-Stiftung (Alexander von Humboldt Foundation), work exclusively in the field of international relations. A large share of the activities of others, such as the Deutsche Forschungsgemeinschaft, the Westdeutsche Rektorenkonferenz, the Max-Planck-Gesellschaft, is devoted to international co-operation.

The Federal Republic is represented in international non-governmental organizations. The Deutsche Forschungsgemeinschaft is the national member for the Federal Republic of the International Council of Scientific Unions. The member unions of the Council are represented by the competent technical society and by a national committee established for this purpose. This is also true for the International Council for Philosophy and Humanistic Studies (ICPHS). Scientific contacts within the framework of treaties between governments are maintained through the agency of various Federal ministries or the Foreign Office, such as, for example:

with the OECD, through the Federal Ministry of Economics which is advised on questions in connexion with the Committee for Scientific Research (CSR) by the Deutsche Forschungsgemeinschaft;

with Unesco and NATO, through the Foreign Office which is advised and assisted by a Cabinet sub-committee. Its meetings are attended by the Standing Committee of Ministers of Education and also from time to time by representatives of the autonomous organizations and the Wissenschaftsrat;

with the Council of Europe and the European Conference of Ministers of Education, through the Foreign Office, together with the Standing Committee of Ministers of Education;

with the international organizations for nuclear research, through the Federal Ministry for Scientific Research.

The Federal Republic does not maintain scientific attachés in its diplomatic posts abroad.

B. RESEARCH ESTABLISHMENTS AND FINANCING OF RESEARCH

(1) The research establishments and those who finance them

The varied organization of research and its financing is a result of the historical development and the federal structure of the Federal Republic.

Research establishments are:

1. the institutes of the universities (wissenschaftl. Hochschulen), and
2. the institutes of the Max-Planck-Gesellschaft,
3. the Academies of Science in Göttingen, Munich, Heidelberg and Mainz,
4. the Federal research stations (Bundesforschungsanstalten),
5. various Länder research institutes and experimental stations,
6. institutes supported by municipalities or semi-official establishments (such as agricultural boards),
7. establishments owned by industry and other private institutes.

(a) Universities and other institutions of higher education

At present there are 18 universities, eight technical universities and institutions of higher education, a medical college, a veterinary college, a mining school, a college of agriculture, and a school of economics in the Federal Republic. There are also a number of theological seminaries which are financed partly by the state, partly by the churches. The establishment of additional institutions of higher education and medical colleges is being planned on the basis of recommendations by the Wissenschaftsrat(1).

The institutions of higher education (general term for universities, technical universities and institutions of higher education of university rank specializing in certain fields) are characterized by a close unity in research and teaching, by administrative autonomy with a so-called "Rectoral Constitution" (Rektoratsverfassung) and the right of the professors themselves to appoint new professors, as well as the right to confer doctorates and the degree qualifying for teaching at university level (habilitation).

The highest official body of a university is the Senate; it elects the Vice-Chancellors (Rektor, Prorektor). Faculties are headed by deans who are also elected.

Although the institutions of higher education are established by the government, they are protected by the Constitution as institutions for independent research, teaching and education.

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(1) Empfehlungen des Wissenschaftsrates zum Ausbau der wissenschaftlichen Einrichtungen, Teil I, p.51 ff, Anregungen des Wissenschaftsrates zur Gestalt neuer Hochschulen.

Financing - In contrast to many institutions of higher education in other countries, the German institutions of higher education generally do not have important assets of their own. They are supported by the Länder of the Federal Republic. The budget of the institutions of higher education is part of the Länder budget in which the incomes and expenditures of the institutions of higher education are stipulated. The institutions of higher education have a say in drawing up their budgets. The Länder of the Federal Republic contributed a total of approximately 1,600 million marks for the expenses of the 31 institutions of higher education in 1962. Of especial importance among other contributions are the funds from the budget of the Federal Ministry of the Interior (for new buildings recommended by the Wissenschaftsrat). At least 50% of the funds necessary for this purpose are to be raised by the Länder and up to 50% by the Federation. In accordance with this arrangement, the Länder contributed 280 million marks and the Federation approximately 200 million marks in 1962.

In addition, university teachers receive grants from the Deutsche Forschungsgemeinschaft, among others, to carry out research projects for which there is either no or insufficient provision in the university budget (see p. 23 ff). Further contributions come from private sources, especially from industry. Part of these funds is distributed by societies for the encouragement of research to individual institutions of higher education, but part of them is also given directly to the institutes. On the average, approximately 50% of the money spent by the institutions of higher education defrays personnel expenses.

(b) Max-Planck-Gesellschaft (Max-Planck Society). The Max-Planck-Gesellschaft is the successor of the "Kaiser-Wilhelm-Gesellschaft der Wissenschaften, e.V." (Kaiser Wilhelm Society for the Advancement of Science), which was founded in 1911 at the suggestion of Adolf von Harnack on the occasion of the hundredth anniversary of the University of Berlin. The purpose of its establishment was to create and maintain research institutes especially in the field of the natural sciences where leading scientists could devote themselves exclusively to research, free from the obligations of teaching. The Society was supported chiefly by donations from industry and was free to set up and carry out its tasks, being responsible only to the governing bodies elected by its member scientists. Under its first Presidents, von Harnack, Planck, Bosch and Vögler, the Society rapidly developed into a research institution of world-wide reputation. Since it was no longer possible after the defeat of Germany in 1945 to continue the Society under its old name, the Max-Planck-Gesellschaft was founded in Göttingen in 1948 to carry on the tradition of the old Kaiser-Wilhelm Gesellschaft. In course of time, the Max-Planck-Gesellschaft took over all the institutes of the Kaiser-Wilhelm-Gesellschaft which had been liquidated in the meantime and also established new ones. At the present time it maintains 41 institutes and research stations, some of which are themselves legal entities, throughout the Federal Republic. They have a staff of more than 5,000 persons, more than 1,000 of whom are professional scientists. The institutes of the Max-Planck-Gesellschaft belong neither to the government nor to industry and conduct research in complete freedom and independence.

The main emphasis in the research work of the Max-Planck-Gesellschaft is still on natural sciences and medicine. The only institutes devoted to the humanities are the Bibliotheca Hertziana in Rome, the Max Planck Institute for History in Göttingen and the Max Planck institutes for foreign and international private law in Hamburg and for foreign public law and international law in Heidelberg.

Members of the Max-Planck-Gesellschaft are as follows:

Patrons (individuals or legal entities);
Scientific members (members of the Max Planck institutes on the basis of special achievements in science; scientists not in the MPG under special circumstances; both groups are appointed by the Senate);
Ex Officio members (members of the Senate, directors of the institutes, independent department heads);
Honorary members (scientists and patrons on the basis of special contributions).

The Max-Planck-Gesellschaft receives its funds from four sources:
from the Federation (budget of the Federal Ministry of the Interior);
from the Länder (via the Königsteiner Abkommen);
from industry (through the agency of the Stifterverband für die Deutsche Wissenschaft and directly from industry);
from its own earnings.

In 1965, the Max-Planck-Gesellschaft had approximately 170 million marks at its disposal.

The organs of the Max-Planck-Gesellschaft are:

1. the President (Chairman of the entire administration);
2. the Senate (representatives from the scientific world and leading figures from industry and the government);
3. Administrative Council (President, two Vice-Presidents, two members of the Senate, the directors of the general administration);
4. General Assembly (members of the Society);
5. Scientific Council (President, member sci-

entists of the institutes, directors of the institutes);
6. General administration.

The Max-Planck-Gesellschaft issues a number of publications (year-books, notes). Some institutes have publications of their own. A list of publications appears in the year-book.

(c) The Academies of Science

The four Academies of Science in Göttingen (1751), Munich (1759), Heidelberg (1909) and Mainz (1949) are public corporations. They are amalgamated in the Working Group of the West German Academies (Arbeitsgemeinschaft für Westdeutsche Academien). In general, the academies have divisions for the humanities and the natural sciences. As stated in the by-laws of one of the academies, their function is to encourage science, to expand it by research work and to foster and support scientific activities. The academies are financed primarily by the Länder in which they are situated. Under the budget of the Federal Ministry of the Interior, the Federation gives grants to the individual academies. From time to time they also receive funds on a lesser scale from private sources.

(d) Federal research establishments (Bundesforschungsanstalten)

There are Federal research establishments, i.e. research institutes maintained as Federal institutions, under the authority of:
the Federal Ministry of the Interior,
the Federal Minister of Economics,
the Federal Minister of Food, Agriculture and Forestry,
the Federal Minister of Transport,
the Federal Minister of Labour.

The Federal research establishments do research work, but also have functions in the practical fields of testing and surveying. Furthermore, some of them have to fulfil certain official government functions, e.g. in the field of food control and vegetable pest control methods and materials. The Federal research establishments are agencies subordinate to the Federal ministries. With varying statutes, some of them set up their research programmes independently, while others are more closely bound by the instructions or approval of the ministry in question. At the present time there are about 40 Federal research establishments, as well as a number of institutes which, although not having the legal status of Federal agencies, are financed entirely or largely by the Federation.

(e) Various Länder research institutes and experimental stations

In addition to the institutions of higher education, the Länder also maintain a number of research institutes and experimental stations, which are in some cases under the authority of the Ministries of Education. The majority, however, are under the authority of the special ministries, especially the Länder Ministries of Food, Agriculture and Forestry, and of Economics. The experimental stations devote themselves primarily to the field of practical experimentation, i.e. the precise application of the results of scientific research to practical problems which are often subject to regional conditions. Many of them also serve as schools for higher technical training.

(f) Institutes financed by municipalities or by semi-official institutions (e.g. Agricultural Boards)

In some cases, municipalities also help to support institutions of higher education; to a lesser extent they also finance individual scientific institutes. The agricultural boards (Landwirtschaftskammern) maintain a number of experimental stations whose work consists mainly of practical application in the field of agriculture).

(g) Industrial research

Privately supported research institutes in the Federal Republic are to be found mainly in the sphere of industry. There are three different types:

(a) Research at the plants and research institutes belonging to private firms. A number of large enterprises maintain research departments and laboratories of their own. Examples of this type of research are to be found chiefly in large firms in the chemical, electrical, optical and steel industries. Their expenses for research, as well as the results, are published only in part.
(b) Joint industrial research conducted by associations. Many branches of industry, mainly medium-sized and small firms, which cannot afford a large-scale research programme of their own, have founded research associations.

The largest of these is the Arbeitsgemeinschaft Industrieller Forschungsvereinigungen - A.I.F. (Organization of Industrial Research Associations). The A.I.F. was created in 1954 by the Federal Ministry of Economics as a non-profit organization. Its aims are to promote co-operation, co-ordination and the exchange of experience and knowledge among the research organizations comprising its membership, as well as to advise industry, to make it research-minded and to maintain contacts with government organizations. Some 60 research organizations are members of the A.I.F. at the present time. The aims and functions of the 60 organizations are described in detail in a publication issued by the A.I.F.

Three-fourths of the operating funds of the A.I.F. are contributed by industry; the remainder comes from public finances. The entire sum is distributed among numerous laboratories; for example, in 1961, the A.I.F. supported 190 research projects, of which 77 were carried out in laboratories under A.I.F. control, 67 in universities or other institutions of higher education, 25 in Länder, Federal or Max-Planck Institutes and 21 in other institutes. Altogether, this represents the allocation of funds to 97 individual institutes.

(c) There are a number of private institutes in the Federal Republic which conduct research work on a commercial basis. Details of their goals, the extent of their activities and the funds at their disposal are not known. It may be assumed, however, that they have only a minor share in the research capacity of the Federal Republic. The most important of the institutions to work on a non-profit basis are:

1. Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung (Fraunhofer Society for the Advancement of Applied Research), Munich;
2. Battelle-Institute e.V. (Battelle Institute), Frankfurt;
3. Vermittlungsstelle für Vertragsforschung bei der Deutschen Forschungsgemeinschaft (Service for Contractual Research at the German Research Association), Bad Godesberg.

The Fraunhofer-Gesellschaft was established in 1949. Its function is to arrange and make possible research work in the fields of natural sciences and technology for the benefit of industry. The Society has eight institutes, which conduct independent research usually supported by the government and which are at the service of the general public for contract research. The funds of the Fraunhofer-Gesellschaft are derived from government subsidies, from contributions and from the proceeds from contract research carried out by the institutes.

The Battelle-Institute was founded in 1952. The Institute has eight scientific divisions and employed approximately 580 persons in 1961 (32% of whom were professional scientists). In the same year the turnover amounted to 11.4 million marks. The Vermittlungsstelle für Vertragsforschung bei der Deutschen Forschungsgemeinschaft was founded by the Deutsche Forschungsgemeinschaft together with the Stifterverband and other high-level business organizations. It has an extensive register of institutes and scientists and provides information to interested persons.

(2) Promotion of research

(a) General comments

With the exception of a few private institutes, which work exclusively on a contract basis, the research establishments have a regular budget, the so-called "Etat", in which the sponsor in question provides the funds for the running expenses of the institute. In the last few years, the budgets of the institutions of higher education covered, in addition to the regular operating costs and expenses for teaching, only a relatively small share of the expenses for research. In contrast, the Max-Planck institutes and the Federal research establishments have more generous budgetary allotments for research. Nonetheless, they too are dependent upon additional assistance for very costly research projects. The budgets of the Länder establishments are, with a few exceptions, geared primarily to expenses for teaching and testing and permit research on a limited scale only. Privately-supported institutes, in so far as they are backed by business groups or individual private firms, receive the funds necessary for their research work with little difficulty. At the same time, there are smaller private institutes and individual scientists without regular incomes whose possibilities for work are limited.

Funds for the advancement of research over and above the normal payments by the agency responsible for the regular financing are mainly obtained in three ways:

1. Contract research for government,
2. contract research for industry,
3. aid from government and various institutions, in particular, the Deutsche Forschungsgemeinschaft and the large foundations.

As in other countries, contract research for government and industry is especially important in the field of applied research. In contrast, the promotion of research by a central research organization, for instance, such as the Deutsche Forschungsgemeinschaft, is part of a system for financing science in every field. Because fixed costs such as permanent appointments and appropriations are involved, the current budgets of the institutes cannot always be fixed at the highest level of their research capacity. This means that the regular allotments by the agency responsible for the financing may not be large enough to suffice for every research project which might be conceivable within an institute's sphere of activity. However, a scientist can receive special aid by applying at any given time.

The principle of scientific freedom is fulfilled when scientists themselves have a voice in the distribution of these funds. This is accomplished most effectively by the Forschungsgemeinschaft as an autonomous organization and by the boards of the foundations. Representatives from the scientific world are also consulted by various Federal and Länder ministries on the distribution of funds for research.

(b) Institutions

(i) Deutschen Forschungsgemeinschaft (see p. 23).

(ii) Foundations.

The number of scientific foundations is in no way comparable to that in other countries, especially in the United States of America. There are a number of smaller foundations whose aims are specialized and directed to a particular field. Three institutions of far-reaching importance must be noted: The Stifterverband - although it is not a foundation in the true sense of the word - the Fritz Thyssen Stiftung and the Stiftung Volkswagenwerk (Volkswagen Foundation). The present Stifterverband was founded in 1949. The idea behind its establishment was to acquaint industry with the importance of scientific research, to remind it of the direct relationship between business life and scientific research and to call upon its competence to give contributions of a general nature to science and research, over and above its own business interests. During the past years, the Stifterverband has become a general meeting place for industry and science. More than 3,700 societies, firms and individuals from industry, trade and commerce are members of the Stifterverband. The funds collected by the Stifterverband fall into two categories:

(a) non-committed funds, which are received as "staff contributions" from the industrial associations (0.20 Deutsche marks per employee per year), as "membership fees" from firms (at least 500 Deutsche marks annually) or individuals (at least 100 Deutsche marks annually), or as "donations" (Stifterverband suggests 1% of the dividends paid).

(b) committed funds, i.e. donations from firms or individuals for a certain scientist, institute or project.

In general, the Stifterverband gives aid in a lump sum to central scientific institutions which distribute these funds in accordance with their budgets (approximately 70% to the Forschungsgemeinschaft). Since its foundation, the Stifterverband has been able to raise more than 150,000,000 Deutsche marks for science.

The Thyssen Stiftung came into existence in 1959 as a private foundation. The aim of the foundation is the direct promotion of science at institutions of higher education and research establishments, primarily in Germany, with special emphasis on the younger generation of scientists and scholars. The Stiftung had approximately 12,000,000 Deutsche marks at its disposal in 1961.

The Stiftung Volkswagenwerk was created in 1961, as a foundation under public jurisdiction. The goal of the foundation is to encourage science and technology in research and teaching. It has approximately 75,000,000 Deutsche marks at its disposal annually provided that dividends remain the same.

Ladies and Gentlemen,

This was a short summary of the present situation in German science policy. This situation is characterized by transition and the strengthening and intensifying of all aspects of activities in science policy. We try to keep well informed on research and science policy in Germany and do the best possible within the limits of our means; and we thank Unesco.

Table of the actual total expenditure for scientific research and development (in million DM)

Funds used by:		Total
1. Institutes of higher education,	1,379	
including university hospitals	590	
		1,969.8
2. Scientific organizations		209.7
3. Scientific institutes of the Federation and Länder		177.8
4. Nuclear research establishments		254.3
5. Industrial firms and associations		2,208.8
6. Libraries and archives		607
7. Other scientific or science-promoting institutions		337.7
8. International organizations and establishments		78.5
9. Students stipends		197.5
10. Defence research		384.1
		5,878.9

IV. India

(Statement presented by Dr. A. Rahman)

A. INTRODUCTION[1]

In terms of scientific personnel, investment in research and level of work, India is an advanced country, but in some respects it is a developing country.

Her trained scientific personnel, of graduate level and above, may number over 300,000, and as facilities increase, the number is rising very fast; every year over 220,000 enrol for bachelors degree courses in science, 18,000 for M.Sc. courses and about 2,500 enrol for Doctorate research.

The expenditure on scientific research is rapidly growing: it was about 120 million Rupees in 1952-1953, it became of the order of 700 million Rupees in 1965-1966. The rate of growth of this expenditure is over 15%. It increased in the last years and in general is much higher than the rate of expenditure on other development projects.

The distribution of the expenditure on scientific and technological research of the Central Government ministries and departments was as follows, in 1963-1964 (defence exclusive):

atomic energy	30%
science and technology	26.2%
agriculture	14.5%
geological survey	9%
health	6.3%
irrigation and power	4.5%
miscellaneous	9.5%

B. HISTORICAL DEVELOPMENTS

India differs from other developing countries in that it had a flourishing scientific tradition in ancient and medieval times. The development of modern science is complicated by social and political factors. It also represents a sharp break with earlier traditions in that modern science does not represent an evolution of such traditions, but was implanted by the British, and was introduced in a language which was not that of the country.

Modern science developed with the gradual conquest of the country by the British. Consequently, the impact of science on the country is uneven. The areas which first came under British domination received the first impact and were later to develop a larger number of organizations and institutions for science and technology than those which were the last to be conquered.

The factors contributing to the development of science were also diverse and lay in the activities of the engineers and scientists employed by the East India Company, the apparatus built up by the Company and later by the government to meet the demands of the State, the army with its engineering and medical corps, the educational and technical institutions set up to reform education or to meet the technical demands of the State and the scientific societies which came into existence as a result of a number of British scientists.

These developments though taking place on Indian soil, and even attracting a few Indians, were really undertaken by the British in India as an extension of thinking and developments in England on the one hand and the policies adopted by the Government in India on the other. They become Indian developments only when a sufficiently large number of Indians had been trained in science and had begun to take part in scientific activities. The beginning of the present century might be considered as a starting point for this purpose.

Developments since the beginning of the present century may be divided into two categories. Firstly, those connected with government policies and secondly those arising from the aspirations of Indians. The first might be summarized as the "containment" of science and technology, as a result of dependence upon government policy developments in England, while the second aimed at broadening the basis of science and technology through more educational and research facilities, development of industries and the placing of Indians in positions of responsibility. The two attitudes and points of view have been adequately summarized in the report of the Indian Industrial Commission of 1916-1918.

The subsequent development of science and technology in India is a result of these two trends. The Second World War brought about a major change in scientific and technological research in India. The government, being cut off from England, was forced actively to develop local resources in order to meet the demands of war, and considerable impetus in the way of encouragement and research grants was given to existing research institutions and universities.

At the end of the war, as a result of an initiative taken by scientists, particularly the Fellows of the Royal Society, a major effort was made to evolve policies for the promotion of scientific and technological research in India. The mission of Professor A.V. Hill and his report[2] had a major influence on British Government policy and on developments since Independence.

At the time of Independence, India was fortunate to have Jawaharlal Nehru as its first Prime Minister, for he was committed to the promotion of science and technology. He set up the Ministry of Scientific Research and Natural Resources under his direct responsibility, and embarked upon the task of laying the foundations of scientific and technological research by establishing a chain of national

(1) Editor's note: The figures on research expenditures are adapted from the study "Scientific Research in India, its development, organization and policies".

(2) Scientific research in India, Professor A.V. Hill, 1945.

laboratories and encouraging research in the universities and government departments. Prior to that, as a leader of the national movement, he had organized the National Planning Committee, and had projected the idea of using science and techology as an instrument in the social and economic development of the country.

As a result of the policies followed by the government since independence, active steps have been taken to encourage education in science and technology by expanding the facilities for teaching and research, by creating a chain of national research laboratories and promoting research through co-operative research associations, research grants, fellowships and linking up research with industrial developments.

A brief description is given in the pages which follow.

C. ORGANIZATION OF SCIENTIFIC RESEARCH

Scientific research in India is organized under seven discreet groups each having its history, organizational pattern, facilities and conditions of work. These are:

1. Universities and institutes of technology.
2. Semi-autonomous or autonomous organizations of research, including co-operative research associations.
3. Atomic Energy Commission.
4. Research and Development Organization of the Ministry of Defence.
5. Independent research institutions.
6. Research organized under various institutions of different Ministries of the government.
7. Research in industry.

(1) Universities

India has 55 universities, 49 of which teach science, five of which are agricultural universities and one an institute of agriculture of university level, seven institutes of technology and one statistical institute of university level. The facilities for science teaching are limited in most of the universities to a few subjects like physics, mathematics, chemistry, biology and geology.

The universities, with the exception of Delhi, Aligarh and Banaras, are supported by State Governments, though research grants may be available to them from the University Grants Commission. The universities are of two types - residential as well as affiliating. The conditions of work and facilities vary widely between the two. In order to promote research, the University Grants Commission has established 15 centres of advanced study at various universities - three for physics, two for chemistry, two for botany, two for zoology, two for geology, three for mathematics and one for astronomy.

Research in the universities is carried out mainly through special research grants from the Council of Scientific and Industrial Research (CSIR) and the University Grants Commission (UGC). Recently, considerable grants have also been made available through PL 480 funds of the US Government in India or through international agencies or organizations.

In addition to the research grants, the CSIR and the UGC also grant research fellowships to students who wish to take up research as a career.

Research in the universities for which professors or senior teachers are responsible, is organized through special research schemes of the CSIR or as part of the doctoral course of students. There is no separate budget for research in a department nor separate accounting for the work done. The practice of research sponsored by industry or contract research from government has not yet penetrated into the universities.

With regard to research itself, it may be worth while to reproduce here some of the conclusions of a recent study(1):

"Scientific research, so far as can be judged from the information given in the annual reports, is limited to few areas of science. Each university is specializing in a limited field within a particular branch of science. This may be due to a certain amount of 'in-breeding' in the universities. An effort was made to collect data as to how many members of the staff of a particular university were students of that same university. In a few universities where data were available, it appeared that a majority of the members were alumni of the same university. It may be interesting to study this point and its impact and consequences on university research in detail.

The study also revealed that research in the universities is limited to what might be termed classical branches of science. Further, research in these branches is limited to a few areas. There is, therefore, a need for reinforcing research in areas which are neglected. This is of utmost importance if the universities are to play a major rôle in the organization and development of fundamental research.

The pattern of organization of research is by and large individual; where there is collaboration, it is usually between a member of the research staff and the head of the department.

Nor does there appear to be any evidence from published papers of collaboration between the members of staff of the university and other research institutions in the country.

(1) Scientific research in Indian Universities, Survey Report No.6, SPSR Unit, CSIR, 1965.

The list of research workers compiled as a result of this study indicates that the number of staff members actively participating in research is limited. It was not possible to establish whether the research activity was part of the normal activity or was induced by special research grants from various sources.

It would be worth while to find out how many papers were published as part of the research programmes supported by special research grants and otherwise. Such a study would have some impact on the organization of research policies in the university."

(2) Semi-autonomous or autonomous organizations

There are three semi-autonomous organizations for research in India, covering three distinct fields: the Council of Scientific and Industrial Research (CSIR), the Indian Council of Agricultural Research (ICAR), and the Indian Council of Medical Research (ICMR). All three have different patterns of growth and functions, and vary widely in their organization, development, scope and conditions of work.

(a) The Council of Scientific and Industrial Research (CSIR)

The CSIR was established in 1942 as a society. It receives its grant from the Ministry of Education of the Government of India, but is governed by a Governing Body, comprising distinguished scientists, industrialists and representatives of the government, with the Minister of Education as Vice-President and the Prime Minister as President.

The Council has established 32 national laboratories, three scientific and industrial museums, and ten organizations, directorates and units to look into the various problems of organization, utilization of results of research, documentation, publication, popularization and co-ordination. Further, it supports 11 co-operative research associations.

The national laboratories may be grouped under subject laboratories, such as those dealing with physics and chemistry, commodity laboratories, covering such fields as glass, leather and food, and multipurpose laboratories, dealing with the utilization of regional resources. Each laboratory has an Executive Council which decides its budget, the major work to be undertaken and the research programme as recommended by its scientific sub-committee. These committees include scientists, administrators and industrialists, and represent a cross-section of each group.

Each laboratory has an extensive infrastructure consisting of libraries, documentation, workshops, maintenance and repair of instruments and design and fabrication of pilot plants, extension work, liaison with industry and publication facilities, and extensive facilities for research. Research is organized on a project basis and specialists from different fields collaborate in arriving at the solution of the problem. The laboratories maintain close liaison with industries, both directly and through the CSIR so as to promote the results of research and help in its utilization in the industry.

The laboratories also have survey stations, field centres, units and experimental stations to deal with specific raw materials in a particular region or investigate the problems of a region falling within the purview of the laboratory.

The purpose of the scientific and industrial museums at Calcutta, Bangalore, and Bombay is to disseminate technological and industrial information and to popularize science.

The special organizations, directorates and units have been created at Headquarters to deal with specific and general problems arising from the extension of the laboratory network; they cover the following fields: library, documentation, publications and information; research survey and planning of scientific research; research co-ordination and industrial liaison, patents, design and engineering, scientific and technical personnel, popularization of science and defence. Their function is to study the problems in their respective spheres and to assist the Director-General in their respective fields.

The Co-operative Research Associations have been established by industry, in order to meet the research requirements of industry. Fifty per cent of their budget is met by the CSIR. They cover the fields of textiles, artificial silk and fibres, cement, paint, rubber, plywood, tea, wool and jute.

The CSIR, besides managing its own laboratories, contributes substantially to the promotion and development of basic science throughout the country by means of research grants to the universities for specific research projects, award of fellowships to young scientists who wish to pursue research as a career, award of ad hoc appointments in "Pool" to Indian scientists abroad, in order to attract them back to the country, and awarding the post of Emeritus Scientist to distinguished scientists who have retired.

Taking into consideration the overall requirements of the country, the CSIR is making a major effort to tackle such problems as facilities for documentation and reprography, repair and maintenance of equipment and instruments, facilities for analytical work and screening, design and fabrication of equipment. In addition, it has recently made major contributions to the conception of science policy, planning of scientific research, questions connected with the utilization of results of research and problems of the utilization of scientific and technical personnel and in the field of international scientific collaboration. In the latter field, the CSIR has entered into bilateral agreements with both advanced and developing countries for the exchange of scientists and collaborative research in mutually advantageous fields.

(b) Indian Council of Agricultural Research (ICAR)
ICAR was established, as the Imperial Council of Agricultural Research in 1929.

The ICAR is a registered society, the Council of which includes State Ministers for Agriculture and Animal Husbandry as members and the Union Minister for Food and Agriculture as Chairman. The secretariat of the Council is an office attached to the Ministry of Food and Agriculture.

The ICAR has so far been supporting research only by giving grants to various research stations and institutions which send research schemes to it for financial support. The ICAR does not run any research establishment of its own, but aims at expanding research facilities by financing research projects in existing institutions.

The finances of the ICAR come from government sources and contributions from other sources, such as a 0.5% tax imposed on certain specified agricultural products. The amount from the last named sources is considerable.

The ICAR is undergoing a radical change at the moment and is being reorganized on similar lines to the CSIR.

(c) Indian Council of Medical Research (ICMR)
The ICMR was formed in 1949 and has developed out of the Indian Research Fund Association, which was established in 1911. The ICMR is managed by a Governing Body with the Union Minister of Health as its President. The Governing Body is assisted and advised in scientific matters by a Scientific Advisory Board of eminent scientists, doctors and health administrators. The main purpose of the ICMR is to promote medical research in the country through the establishment and maintenance of research institutes, setting up research units, and assisting existing research institutions by giving block grants for research to such institutions or by sanctioning grants for research schemes.

By and large, a greater proportion of the funds of the ICMR go towards supporting individual research schemes submitted by various research workers in colleges and institutions, and supporting centres and units for specialized research work in the existing institutions.

(3) Atomic Energy Commission (AEC)

The AEC was established in 1948. The main work of the Commission and the subsequent development in the field of atomic energy have grown out of the work of the Tata Institute of Fundamental Research, Bombay. The Commission is an advisory body to the government Atomic Energy Department. The Department functions directly under the Prime Minister. The Chairman of the Commission is the Government Secretary in charge of the Atomic Energy Department. The activities of the Department can be grouped under the following four headings:

The Atomic Energy Establishment, with its six specialized establishments dealing with physics, electronics, radiation protection, engineering, metallurgy and biology; Special Research Institutes, supported by the Department, the Tata Institute of Fundamental Research, the Saha Institute of Nuclear Physics, the Physical Research Laboratory, the Indian Cancer Research Centre, and the Tata Memorial Hospital; Special Research Projects, on space research and rocket launching; Atomic Minerals Division for survey and processing of minerals.

The Department sponsors nuclear research in universities and special projects in the institutes, awards graduate and post-graduate scholarships and fellowships, and special projects connected with its particular field of nuclear physics. It also undertakes training programmes in the field of nuclear physics and manufactures specialized equipment, which it makes available to research institutions and universities.

The Department, although a part of the government machinery, has developed its own method of recruitment and promotion of scientific workers, and offers conditions of work which are very different from those in other government departments. The research is organized by individuals, who have gathered around them a team of workers, largely trained and developed by the Department, or those who have been appointed after they have received their training abroad.

(4) Defence research and Development Organization (DRDO)

The DRDO has grown out of the Defence Science Organization and was established in 1958, formed by amalgamating the Defence Science Organization and the Technical Development Establishments of the Army and the Directorate of Technical Establishments (Air).

The Defence Research and Development Council controls and directs the DRDO. The Council has the Minister of Defence as Chairman and the Minister for Defence Production as Vice-Chairman. The Executive Committee of the Council has the Scientific Adviser to the Minister of Defence as its Chairman. The Executive Committee of the Council executes and directs programmes on behalf of the Council.

The DRDO has a two-tier organization: Headquarters are responsible for policy, control, co-ordination and direction as well as maintaining liaison with the service headquarters. Secondly, the field set up consisting of research and development establishments and the laboratories.

The DRDO has 28 laboratories, establishments, institutes, etc., dealing with armament, research and development, matallurgical research, explosive research, instrumentation, multipurpose defence laboratories, ballastic research, electronics and radar, aeronautic development, gas turbines, scientific evaluation group, food research, nuclear medicine, physiology, naval research, fire research and work study.

(5) Independent research institutions

A number of philanthropic individuals and industries have established research institutions in the country. They were previously supported by the funds created by special foundations, such as the Indian Association for the Cultivation of Science, Bose Research Institute, Shri Ram Institute, Dhar Research Institute. With the growth and development of science and the cost of research, these research institutes are now being largely subsidized by the government with research grants and have come under the purview of the general development scheme of the Ministry of Education.

(6) Research institutions under government ministries

The ministries which have research departments and institutes are the Departments of Atomic Energy, Civil Aviation, Commerce and Industry, Communications, Defence, Education, Food and Agriculture, Health, Information and Broadcasting, Irrigation and Power, Petroleum and Chemicals, Railways, Steel and Mines, Transport, Works and Housing.

Of these, the Department of Atomic Energy and the Ministry of Defence have already been discussed.

The Ministry of Civil Aviation has two departments - the Department of Civil Aviation, which has a research and development wing and the Indian Meteorological Department which controls a number of observatories throughout the country for the collection of meteorological data. It also runs an Institute of Tropical Meteorology.

The Department of Commerce in the Ministry of Commerce and Industry, has five research boards and four research institutions. The boards deal with silk, tea, coffee, rubber and coir. The Silk Board has a Central Sericulture Research Institute and two sub-stations dealing with tussore research and silk worms. The Coffee Board has the Central Coffee Research Institute while the Coir Board has the Central Coir Research Institute.

The Department of Industry in this Ministry directs the Indian Standards Institution, which has the task of evolving Indian specifications.

The Ministry of Communication has one Telecommunication Research Centre apart from a number of industries in the public sector, such as Indian Telephone Industries and Hindustan Teleprinters, which have small specialized research centres.

The Ministry of Education, apart from supporting the CSIR, sponsors the four surveys: Survey of India, which carries out different topographical surveys, Anthropological Survey of India, Botanical Survey of India, and Zoological Survey of India. It makes grants to various research institutions like the Indian Association for the Cultivation of Science, Bose Research Institute, etc., in addition to the grant given to the University Grants Commission, part of which goes to support research centres of the universities.

The Ministry of Food and Agriculture has two Departments - that of Food and that of Agriculture.

The Department of Food has a large number of research institutes and stations dealing with dairy research, grain storage, fisheries research, etc. The Department of Agriculture has established a number of commodity committees on cotton, jute, coconut, areca nut, oil seeds, tobacco, lac and sugar cane. These committees support research institutes; they also sponsor research in existing institutions and make block grants for research which falls within their field of competence. The Department of Agriculture also has seven research institutes dealing with veterinary, forest, rice, potato, arid zone, grass land and fodder research. The Board of Soil Conservation Research has seven research centres spread all over the country, to look into the requirements of the different areas.

The Ministry of Health has nine statutory bodies primarily dealing with specialized fields of medical research and teaching, including institutes of medical sciences.

The Ministry of Health has a Director-General of Health Services who co-ordinates policy in connexion with national campaigns, the state health organizations and the medical and public health organizations of the Union Territories and of the Centre. In addition to these, there are statutory and autonomous organizations under the Ministry with the specific purpose of carrying out research; there are 46 of these, and they deal with education, training and specialized research institutes dealing with specific diseases or with the application of scientific techniques such as radiology or X-ray to research on specific diseases.

Ministry of Information and Broadcasting. In order to meet requirements in connexion with broadcasting the All India Radio has a research engineer as well as a Research and Reference Division.

Ministry of Irrigation and Power. Under the water wing of the Ministry, there are two research stations - one for water and power research and the other for soil mechanics and concrete research. The power wing of the Ministry has a power research institute.

Ministry of Petroleum and Chemicals. The Department of Petroleum in the Ministry has one research and training centre to meet the specific needs of the Ministry.

Ministry of Railways. This has a Research Design and Standards Organization dealing with metallurgical and chemical research, bridges and floods, diesel design and civil and mechanical engineering research.

The manufacturing units have laboratories to meet the specific problems arising from production.

Ministry of Steel and Mines. The Department of Mines and Metals directs the Geological Survey of India with laboratories for petrological, palaeobotanical and chemical research.

Ministry of Transport. The Calcutta Port Commission has an Hydrological Study Department. Under the Department of Lighthouses and Lightships, there is an optical laboratory.

Ministry of Works and Housing. The Ministry has a National Building Research Organization with facilities for research into specific fields of housing construction, connected with the requirements of the Public Works Department.

The organization of research establishments under the ministries varies a great deal, as do also the resources, facilities and working conditions. The Secretary to the Department concerned, who is responsible for the various organizations and who is usually a civil servant and not a scientist, is the final authority for the policies, research programmes and budgeting allocations of the research institutes. Some of the research establishments under the ministries, though not all, have advisory bodies to help organize research programmes and other matters connected with the organizational matters of the establishment. It should also be pointed out that the exact functions of the advisory bodies and their composition varies considerably from ministry to ministry, and in some cases from one establishment to another within the same ministry.

(7) Research in industry

Research in industry is not made full use of. A survey(1) recently carried out, covering about 500 industrial establishments revealed that about half had laboratories for doing routine work and between 25 to 50 had facilities for research. Total investment in research by industry is extremely limited, and varies from one branch to another. The metallurgical industries have the highest rate investment, followed by dye-stuffs. The minimum investment is in the drugs and pharmaceutical industry. Industry mostly employs graduates and undergraduates in the laboratories and the number of more specialized workers is extremely limited.

D. SCIENTIFIC SOCIETIES AND SCIENTIFIC JOURNALS

(1) Scientific societies

Scientific societies in India have a long history, going back to the later part of the Eighteenth century. There are at the moment 196 societies in the country; these may be grouped as general societies for the promotion and popularization of science, specialized societies dealing with the subject of science, professional societies which also look after the interest of the various professions, and prestige societies, membership of which is a mark of distinction in the country. Most of the societies are self-supporting, but a few receive grants varying in amount, from the government. The societies have library facilities, conduct examinations for the award of professional diplomas, publish scientific journals and organize conferences and symposia. There was an increase in the number of scientific societies after Independence, particularly in the field of very specialized subjects and in the developing branches of science in the country. Most of the scientific societies are established in large cities like Calcutta, New Delhi, Bombay, Bangalore and Madras. Very few of them have their headquarters in the smaller towns. They are generally associated with either universities or research institutions.

(2) Scientific and technical publications

The scientific publications of the country have also a long history going back to the later part of the Eighteenth century. The growth in the number of scientific journals, particularly since Independence, has been considerable. At the moment 422 scientific and technical journals, from those dealing with popular science to highly-specialized and professional journals and trade journals including scientific and technological articles are published. Most of these are self-supporting, but a few receive grants from the government. Most of them are published in English, but a few are published in Indian languages, and some publish summaries in Hindi.

Most of the research organizations in the country like CSIR, ICAR, DRDO and some of the Institutes of Technology and universities publish their own journals.

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(1) Research Efforts in Industrial Establishments, Survey Report No.5, SPSR Unit, CSIR, 1965.

necessary development within the country compels foreign collaboration and the use of imported processes, such collaboration should be utilized for developing an indigenous know-how.

V. Israel

(Statement presented by Dr. Z. Tabor)

A. HISTORICAL BACKGROUND

To understand science policy in Israel - or to appreciate the difficulties in obtaining a unified policy - a clear understanding of the historical background of the development of the State both from the scientific and social points of view is necessary.

Israel became a sovereign independent state in 1948 almost exactly 50 years after the first Zionist Congress that postulated the political idea of the return of the dispersed Jewish people to its own homeland and thereby its transformation into a "normal" people. It was a characteristic of the Zionist ideology that it stressed manual work and in particular agricultural activity from which Jews had largely been barred in the Diaspora. Nevertheless, the Zionist movement was always dichotomous. There were the "men of action" and the "people of the spirit". Theodore Herzl, founder of the modern Zionist movement and usually regarded as the father of the Jewish State, was a man of great vision and clearly saw the important part science would play in the State of his dreams. Added to this the tradition of scholarship which is very deep in the Jewish people - who are often described as the "people of the Book" - it is not surprising to find that the initial steps in scientific development in Israel were taken long before the State came into being.

Thus we find that the cornerstone of the Institute of Technology (Technion) was laid in 1912, that of the Hebrew University in Jerusalem six years later(1). Agricultural research started even earlier.

The early immigrants to the country set up farming villages and communal agricultural settlements (kibbutzim). Many of these immigrants were intellectuals who had "returned to the land" and this explains why, as shown later, there was an unusually easy dialogue between farmers and agricultural research men, leading to Israel having probably the most modern agriculture in the Middle East.

The Central Agricultural Research Station was founded in 1920 (by the Jewish Agency), but even before that time much successful - though not very systematic - research had been going on in breeding new types of plants and animals and in the control of pests.

Parallel with agricultural research there had developed an intensive medical research activity, which tackled the problems of and stamped out tropical diseases in the country.

The early immigrants were, on the whole, politically active; they created many institutions such as the powerful trade union movement, political parties, cultural institutions, newspapers, etc. The later waves of immigrants (from Central and Western Europe and from America) brought commerce and banking and included many professionally-trained people.

The mandatory government prior to Independence had also added some useful institutions such as a meteorological service (which later engaged in research as well as routine), a forestry station, a veterinary institute, a hydrological institute. In 1942, they established the Board of Scientific and Industrial Research (BSIR) to deal with problems related to the war effort; in 1945 they expanded the terms of reference to include matters such as citrus, quarrying and building materials. This Board provided the background for the Israel Research Council set up shortly after Independence.

In summary, we see that the new State of Israel started its existence with a strong scientific and technological background in agriculture, medicine, physical sciences and engineering. In addition, it had numerous well founded socio-political bodies. All this would appear to bode well for a strong science policy but the negative aspect of the same background should not be underestimated: the new State started with well-established scientific and educational institutions highly jealous of their hard-won autonomous status, and with many well established economic and political groupings.

Thus the General Federation of Labour (Histadruth) was - and still is - not only a powerful and comprehensive trade union, including medical services to its members and numerous cultural activities, but is also, through its numerous Histadruth-owned industries, the largest employer of labour in the country.

The result is that any form of centralized planning is beset with great difficulties - and this includes the planning of science. When we add the effects of the Israel electoral system, which has resulted invariably in coalition governments with the ministries divided among several political parties, the difficulties of centralized planning - or more correctly the implementation of such planning - are patently clear.

Two other factors must be taken into account. The early years of the new State were faced with many pressing problems, such as the absorption

(1) Owing to the intervention of the First World War and other factors, the first Technion buildings were not completed until 1923 and the first courses started in 1929. The University was officially opened in 1925 as a research institute, and the full teaching faculty was attained in 1934.

of large numbers of immigrants that had to be housed and employed at all costs. The second factor has been recognized by sociologists, namely the great optimism and faith of that period, leading to a belief that anything was possible and an extraordinary ability to improvize in solving current problems. Such a psychology is not conducive to quiet long-term planning.

Nevertheless, as will be seen, much progress has been made in the direction of science planning as the country's leadership has become more mature and a cadre of trained and dedicated senior civil servants has been created.

Post-Independence history

In January 1949, within a year of taking office, the first Israeli Government set up the Research Council of Israel.

The Council originally comprised 12 leading scientists under the chairmanship of Prime Minister Ben Gurion and was later enlarged to include senior executives of the three major institutions of higher learning(1). A small staff of professionals under a scientific executive secretary was responsible for the execution of policy laid down by the Council, which used advisory committees to consider different branches of science and of the economy.

The Council fostered scientific research for the development of the economy mainly by creating some basic institutions. Thus it set up the Geological Institute - drawing heavily on the Department of Geology of the Hebrew University - in 1949, as a prerequisite to an appraisal of the country's mineral resources(2); a Dead Sea research laboratory to conduct research on the valuable chemical resources of the Dead Sea during a number of years, when, following the War of Independence, the Dead Sea Company was inoperative; the National Physical Laboratory, 1959, to standardize instruments, provide metrology services and conduct research in applied science; the Institute for Fibres and Forest Products, 1953(3), for research related to textiles and the utilization of natural fibres; the Negev Institute for Arid Zone Research, 1956.

The Council also attempted to encourage research associations on the English pattern of 50-50 participation with industry in the costs of such associations, but industry at the time was not very research-minded and only a very small number of associations were established (rubber, ceramics and glass, paint). The Council had some funds available for sponsoring or supporting research activities in the existing university-type institutions, but these sums were too small to make a serious impact on overall science and research policy.

In 1959, the Research Council was replaced by the National Council for Research and Development (NCRD), still within the Prime Minister's Office. However, the new Council was enlarged to 25 members and included senior civil servants from the Treasury and ministries concerned with scientific and research activities. Its executive arm included economists and its terms of reference were wider than the original Council.

Apart from the Prime Minister's Office, other ministries set up research facilities related to their activities. Thus the Ministry of Agriculture set up the Volcani Agricultural Research Station in Rehovoth, by far the largest applied research centre in the country (and working in close co-operation with the Faculty of Agriculture of the Hebrew University), based upon the pre-State Central Agricultural Institute of the Jewish Agency; a Veterinary Institute, a Sea Fisheries Institute and a Fishpond Institute. The Ministry of Development, to which the large national companies dealing with chemicals and minerals are attached, operates within these companies' research laboratories for the mining industries, the chemical, fertilizer and phosphate industry and the Dead Sea Works.

The Ministry of Health has research laboratories in the large government hospitals and a special laboratory dealing with radio-isotopes in medicine. The larger non-government hospitals also engage in medical research.

The general attitude to planning and the recognition of its importance has been growing in government circles, so that a number of instruments of planning have been created. These include the Manpower Planning Authority of the Ministry of Labour, the Centre for Agricultural and Settlement Planning (Ministry of Agriculture) and the Economic Planning Authority (Prime Minister's Office) which receives its directives from the Ministerial Economic Committee.

The problem of higher education is closely related to that of scientific manpower and also to science planning. The government therefore set up, in 1965, a top-level ad hoc committee to study higher education (usually referred to as the Sharef Committee, after the name of the Chairman). Its terms of reference were to clarify and make recommendations on the governmental or national instrument in which such matters as the progress, co-ordination, direction and planning of higher education would be lodged. The Committee recommended the establishment of an Authority for Higher Education which, among other things, would have to prepare a master plan for higher education for the next ten years. This Authority would establish the principles governing allocation of government funds for higher education(4). The committee also made recommendations concerning research and technology. These included:

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(1) The Hebrew University of Jerusalem, the Hebrew Institute of Technology - Technion, Haifa, and the Weizmann Institute, Rehovoth.

(2) The Geological Institute was later transferred from the Research Council to the Ministry of Development.

(3) The Fibres Institute is now part of the Ministry of Trade and Industry.

(4) The institutions of higher education all have, in addition, considerable non-governmental sources of income.

(i) that the place for the planning of science and technology was in the Prime Minister's Office. If the Prime Minister was unable to devote attention to this matter, it should be transferred to another minister in the Prime Minister's Office, the handling of science to be his major preoccupation,
(ii) other recommendations concerning closer ties between scientific research and economic planning, between scientific research and industry and between the different ministries involved in research and development.

To complete the background picture, one must mention the Academy of Sciences and Humanities, set up by Act of Parliament in 1961. The Act calls on the Academy to advance science and scientific activity, to represent Israeli science in the various international organizations such as ICSU and to advise the government on matters concerning research and scientific planning. This last point might seem to clash with the terms of reference of the NCRD, but a satisfactory working arrangement has been found: in practice the Academy is not active in the fields covered by the NCRD but concentrates on its strictly scientific activities.

One must also mention defence research. Prior to Independence there was some defence research but this was, understandably, an underground activity. With the creation of the State, the government had to put defence research on a proper footing and this is organized within the Ministry of Defence. While this research draws, to some extent, on the other science institutions, it is largely a closed activity, hence statistics are not available.

Because of the existence of good R & D facilities within the defence establishment, and a more favourable organizational structure, the Atomic Energy Commission has also been made administratively part of the Ministry of Defence.

B. ORGANIZATIONAL STRUCTURE OF SCIENCE POLICY

The function of the NCRD has already been indicated: because of its importance in the overall picture of science planning, the terms of reference of the NCRD are given below. These are quoted from the Cabinet decision of 15 November 1959, amended on 21 February 1960 and 30 May 1962, to read:
"Resolved:

1. There shall be established a National Council for Research and Development which shall carry out the following tasks:
(a) Advise the government on action relating to scientific research and planning, and technological development, of national significance;
(b) make recommendations to the government as to an overall policy for directed scientific research;
(c) make recommendations to the government as to the total amount to be allotted in the State budget for directed research and for development;
(d) make decisions as to the apportionment and utilization of the funds for research and development at the disposal of the government and its agencies;
(e) keep under review, and supervise, the implementation of research projects, as above;
(f) initiate programmes for scientific research and technological development projects;
(g) co-ordinate, within the framework of an overall policy of research and development, between the agencies carrying out directed research and those who avail themselves of their services;
(h) conduct a survey of the resources available for the implementation of the overall policy, from the point of view of: (1) organization; (2) funds; (3) scientific and technological personnel; (4) ancillary services.

2. The National Council for Research and Development shall consist of 16 to 25 members (including the Chairman and Vice-Chairman) appointed personally by the Prime Minister for a period of three years. One-third of the appointments shall expire in every year. The composition of the Council shall be as follows:
Chairman;
Vice-Chairman;
nine to fifteen scientists, technologists and industrialists;
the Director-General of the Prime Minister's Office;
the Director-General of the Ministry of Agriculture;
the Director-General of the Ministry of Commerce and Industry;
the Director-General of the Ministry of Development;
a representative of the Ministry of Finance;
the Director of Budgets in the Ministry of Finance;
a representative of the Ministry of Defence;
a representative of the Ministry of Labour.

3. The Executive of the National Council for Research and Development shall decide on current allocations for research projects and the modes of implementing the latter. The Executive shall be appointed by the Prime Minister from among the members of the Council and shall include scientists, technologists and representatives of ministries engaged in economic affairs. A majority of the members of the Executive shall be scientists and technologists. (The Executive shall be headed by the Chairman of the Council; the Vice-Chairman of the Council shall act as Director-General of the Council and shall be responsible for the day-to-day work).

4. Upon the establishment of the National Council for Research and Development, the Research Council of Israel shall cease to function, and its powers shall pass to the National Council for Research and Development. Research work so far carried out by the Research Council of Israel shall henceforth be carried out under the supervision of the National Council for Research and Development which shall prescribe how it shall be carried out.

5. All powers as to scientific research, other than secret defence research, which have hitherto been vested in government ministries shall pass to the National Council for Research and Development upon the establishment thereof. Specific research work by ministries or government enterprises shall require the approval of the Council."

We now see how the NCRD fits into the general organizational structure. This is shown in Chart no. 1. One of the most recent developments in this structure is the creation - at Cabinet level - of a ministerial committee for science and technology which, working with and through the NCRD, should do much to create more uniformity in science policy in the various government departments. The chart shows clearly that most of these departments are represented on the NCRD so that whilst they are not ruled by that body, at least they know what is going on and what the thinking is. The same applies to scientific manpower. The institutions of higher learning are autonomous bodies and no central agency dictates how much scientific activity to conduct or how many of any particular kind of scientist to train. One reason, apart from the autonomy, is the very great difficulty in estimating future demand for scientific manpower, though some efforts are made in this direction. In particular, the Technion (Institute of Technology) does try to estimate requirements in various technical fields in deciding its intake of students. Prior to Independence, the institutes of higher learning obtained their entire budgets from non-government sources: with the increase in the size of these institutions and the recognition of their function in the community, the financial contribution from government sources has grown until it forms the major part of the running budget. Since the percentage (though not the actual number) of students in science has fallen greatly in recent years, this is due to a shortage of facilities which are much more expensive for science students than in the arts and humanities, the government has been able to exert some influence on science development by offering financial aid to the development budget of the institutions for new or enlarged science faculties.

It will be noticed in the chart that the Treasury (or Ministry of Finance) is shown above the other ministries. This is not only because, as the holder of the national purse, it is the most important body but because, in addition to allocating funds and supervising their use, the Treasury plays a considerable part in planning. Despite the irritation which the scientific community might feel by the intervention of the Treasury, the great advantage is that the Treasury has a better overall knowledge of what is going on in other branches of the economy, in particular in the economic planning.

Chart no. 1 also shows that scientific research is carried out on three planes: the institutions of higher learning which are virtually autonomous, except in so far as they accept research funds from the government for specified projects; the research institutes of the various government departments; the industrial research associations receiving government support. Private industrial research is not shown on the chart as it is not part of any organizational scheme.

The part played by the institutions of higher learning in research is very large: the three major institutions together conduct over 50% of all research carried out in the country. The research funds come from two sources, the regular budget and special grants either from Israeli sources or from foreign foundations and contracting agencies. This research is nearly all basic.

The government institutions, which carry out about 35-40% of the total research activity, engage mostly in applied research and are almost entirely government funded.

Industrial research (entirely applied) accounts for about 7-8% of the total(1). Some 3-5% of the total is conducted in other institutions, mainly medical research.

The very small part played by industry - as compared with agriculture and the university institutions, is a direct outcome of the pre-independence history, when there was little industrial activity. Furthermore, most of the industrial undertakings are small and prefer to buy "know-how" rather than conduct their own research.

C. PRINCIPAL AIMS OF SCIENCE POLICY

(1) Planning for the development of science

The State has never had a unified policy of scientific development and in particular of industrial scientific development, possibly because of the very strong agrarian background and ideology of the country's leadership.

Yet science itself has developed, in particular basic science, which has flourished in autonomous institutions with the government reluctant to interfere. On the contrary, the government introduced the practice of making grants to these institutions, part of which goes to teaching and part to research. The State recognized the need for additional higher educational institutions and established a Public Council for Higher Education to control the academic standards of the institutions, though not their research activities.

State planning has been introduced by grants for special research programmes, and its major instrument is the NCRD. As already indicated, the NCRD cannot dictate to any of the institutions (other than those it has created itself), and relies on goodwill; this is particularly the case of the relationship of the Council to R & D

(1) Note that the basic industries - mines, chemicals, etc. - are run by government companies attached to the Ministry of Development and their research activities are included in the 35-40% of the previous paragraph.

planning by the various ministries. As indicated in the section on organization, the NCRD, which establishes policy by means of committees of specialists (mostly non-governmental personnel), will obtain overall guidance on the needs of the country from the new Ministerial Committee for Science and Technology. In the reverse direction, the NCRD will turn to the Ministerial Committee to get its recommendations implemented throughout the governmental structure.

(2) Objectives and goals

Basic science is of a high standard and well-developed, yet in many cases where basic science could help the development of the country in a longer-term view, this is not happening and one objective is to improve this situation. For example, the government has allocated funds for all aspects, however basic, of research in oceanography, having realized that this will be, in the future, a most important area for applied research. Similarly, where agricultural research is weak in basic science - for example, genetics - this is now being encouraged. (The machinery here is a joint council of the NCRD and the Agricultural Research Centre to plan basic agricultural research).

In the area of natural resources, the present position is satisfactory in that science has done much to locate such resources and establish their usefulness.

In the area of industrial research, the position is far from satisfactory and for this reason the NCRD and the Ministerial Committee will pay special attention to this aspect. Science policy has to be related to the forecast of Israeli industry in 5-10 years time.

One problem here is the need for a scientific and technological infrastructure to bring the results of research to ultimate industrial realization.

To achieve this objective, a number of activities and agencies have been introduced:

(a) the "research initiation fund" of the NCRD. This fund provides support for any proposal - whether from a private individual, a scientific institution or a commercial company - which the directors of the fund consider will advance applied research and industrial development of the country. In the case of industry, the fund support is usually given on a 50-50 basis with the industry;
(b) the patents division of the NCRD. This division helps private, institutional and industrial inventors to register patents and to exploit them where the management of the division feels that this will be beneficial to the national economy. The division will also make grants from a special "patents exploitation fund" for R & D to bring promising ideas nearer to commercial realization;
(c) government institutions that can aid the technological and economic aspects of the development of ideas emerging from the institutions of higher learning(1);
(d) government aid (usually through the NCRD) for the introduction of new technological advances;
(e) government support for technological development.

Under discussion is the question of a tax on products of different branches of industry to provide a fund for promoting technological development in those branches of the economy;
(f) encouragement of venture capital. The NCRD is now encouraging entrepreneurs to create venture capital for the promotion of scientific projects showing promise. This is a part of a general policy to encourage science-based industries which would appear to be a logical development for a small country such as Israel, poor in raw materials and having a small industrial market but relatively rich in scientific potential.

This policy is aimed at creating the infrastructure that will utilize the results of scientific research where an outlet exists - for example in agriculture - and at encouraging the development of such an infrastructure in areas where practical utilization is still some way off, for example, in oceanography and in industry. In agriculture, quite a considerable infrastructure does, in fact, exist: there are extension services, courses, information services to farmers, etc., test areas and the like.

In industry, this infrastructure is virtually non-existent; with one or two notable exceptions, there is no R & D activity in industry and a good basic idea or scientific development in an institution may never reach industrialization, the industries usually preferring to buy advanced "know-how" from abroad. Two major exceptions to this general picture are the industries belonging to the Ministry of Development (mainly chemicals and mining) and those related to water prospecting and utilization. In 1952, the Israel Mining Industries Laboratory was set up and has played an important part in chemical research related to the development of natural mineral resources right up to the production stage: the research laboratories of the Chemicals and Phosphates Co. (formerly called Chemicals and Fertilizers) have played a similar rôle in the chemical and fertilizer fields, and the laboratories of the Dead Sea Works for the resources of the Dead Sea.

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(1) The three major institutions, the Hebrew University of Jerusalem, the Hebrew Institute of Technology (Technion) and the Weizmann Institute of Science also have their own associated bodies for the development and commercialization of inventions originating in the respective institutions.

Water utilization and desalination both play an important part in Israeli science policy. The research is rather fragmented but the infrastructure exists. The government and the Jewish Agency set up a research and planning organization for water resources, "Tahal - Water Resources for Israel" - which has developed new methods of water husbandry. Tahal has also commissioned research at the Technion and other institutions. The execution of water works and irrigation schemes, is, however, conducted by a separate company, Mekoroth (owned jointly by the government, the Jewish Agency and the Histadruth). Other companies manufacture water metres, some development of sprinklers has taken place, a special body is responsible for encouraging improved devices, and testing is conducted at the Standards Institution. This rather complete infrastructure in water management and development has made it possible for Israel to provide technical assistance to many other developing countries.

In desalination, apart from numerous research and study groups, the government has set up a special high-level committee to study the whole problem with particular reference to the possibility of dual-purpose power and desalination plants.

Another field of special interest to the NCRD is desert research: this has expressed itself in ever-increasing budgets to the Negev Institute for Arid Zone Research in Beersheba, set up by the Research Council in 1956.

As already indicated, the NCRD operates or has operated, either on its own or jointly with other bodies, a small number of research associations, and another goal of NCRD policy is to create additional associations of this kind where needed and where it is felt that this is the best structural form. In most cases, these associations subsequently come under the aegis of the Ministry of Trade and Industry.

The field of atomic energy research is handled by the Atomic Energy Commission which is appointed by the government.

(3) Integration of policy into the national plan

As indicated, there is no uniform structure on the governmental level, and it is not possible to say that overall decision-making exists, except for the new Ministerial Committee for Science and Technology.

But at the ministry level, the situation is better than one might expect: in some important areas, the machinery exists for decision-making and for the feed-back of information to the policy makers.

For example, in agriculture, where science and research have played a vital part, both in pre-independent times and subsequently there are about a dozen commodity committees that examine the problems related to those commodities and recommend the short-term research needed to deal with them. Long-term research is planned by a joint committee of the agricultural research authorities and the NCRD.

In addition, ad hoc visiting committees of scientists, often including foreign specialists, are organized mainly for comparing the state of the art in Israel with that in the rest of the world, for particular fields.

In some industrial fields - one example is food - special committees have been set up and have suggested what are the research needs. These suggestions come to the NCRD (or other responsible government agency) and the necessary action is taken (in the example quoted, the setting up of a new institute for food technology).

The integration of science policy planning with national planning can be seen in the structure of two ministerial committees and their executive arms: the Ministerial Committee for Science and Technology, with the NCRD as its executive arm; and the Ministerial Committee for Economic Planning, of which the executive arm is the Economic Planning Authority. Both the executive arms are parts of the Prime Minister's Office and the Prime Minister is a member of both ministerial committees. This is probably the best way, in local circumstances, of achieving a measure of overall integration of planning.

D. RESEARCH EXPENDITURE

This brief report cannot cover the statistical material now being prepared for the science policy survey: we therefore present one group of figures that indicate the sums spent on scientific research (excluding the Ministry of Defence). (1)

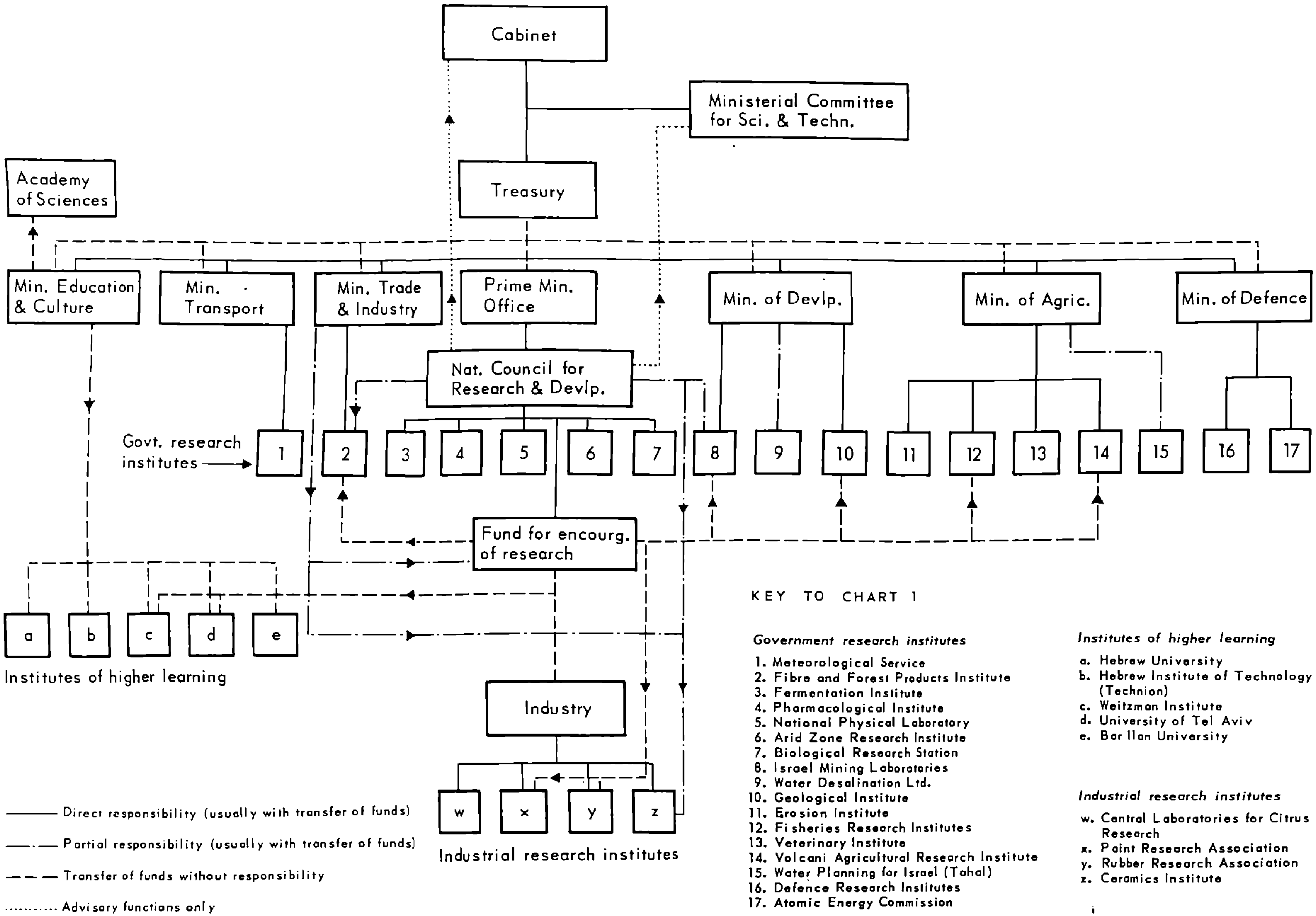
Year 1965-1966	
Expenditure, excluding buildings and heavy capital equipment;	£ 90.5 Million[2]=0.96% GNP at factor cost
Expenditure, including buildings and heavy capital equipment.	£ 122 Million=1.3% GNP at factor cost

Breakdown of sources	£ Millions
Government[3]	48.8
Institutions of higher learning	34.9
Foreign grants and contracts	23.5
Industry	6.2
Others (agricultural commodity councils, etc.)	8.6
Total	122.0

(1) These figures are approximate: more accurate figures will appear in the final report.

(2) £ 3 = 1 US dollar.

(3) This sum goes to the institutions of higher learning (approx. £ 24M) and to the government research institutes (approx. £ 24M).



KEY TO CHART 1

Government research institutes

1. Meteorological Service
2. Fibre and Forest Products Institute
3. Fermentation Institute
4. Pharmacological Institute
5. National Physical Laboratory
6. Arid Zone Research Institute
7. Biological Research Station
8. Israel Mining Laboratories
9. Water Desalination Ltd.
10. Geological Institute
11. Erosion Institute
12. Fisheries Research Institutes
13. Veterinary Institute
14. Volcani Agricultural Research Institute
15. Water Planning for Israel (Tahal)
16. Defence Research Institutes
17. Atomic Energy Commission

Institutes of higher learning

a. Hebrew University
b. Hebrew Institute of Technology (Technion)
c. Weitzman Institute
d. University of Tel Aviv
e. Bar Ilan University

Industrial research institutes

w. Central Laboratories for Citrus Research
x. Paint Research Association
y. Rubber Research Association
z. Ceramics Institute

VI. Japan

(Statement presented by Mr. T. Kuroda)

A. HISTORICAL BACKGROUND

(1) Before World War II

The history of Western science and technology in Japan began with the introduction of a gun in 1543. But about the middle of the Seventeenth century, the Tokugawa Shogunate (the title of the government of that time) closed the door to foreign countries. This situation lasted for about two and a half centuries, till the Meiji restoration (1867). During this period, Western civilization was still being imported, though only through contacts with the Netherlands; but because of the inhibiting effect of the prevailing feudal system of society, it could not be developed.

The modernization of Japan started with the Meiji restoration. The Meiji Government decided that Japan must catch up with the West, and exerted every effort to make Japan a modern State, politically, administratively, educationally and industrially. The fundamental policies adopted by the leaders were "rich country, strong arms" and "promotion of industry". To achieve those aims, the government established transport and telegraph services, built many important manufacturing plants and adopted a modern educational system even in the earliest days of the Meiji.

It is a characteristic feature of Japan that industry started under the leadership and protection of the government, and education has been placed in the hands of the government.

Tokyo (Imperial) University, the first higher educational institution for training leaders in all fields, including science and technology, was established in 1877, ten years after the restoration. To teach science and technology, many foreign instructors were recruited from the West at first. At the same time, the government sent abroad 661 students (including some in humanities), from 1875 to 1911. In the course of time, many universities were established in succession. By 1932, the number of national, public and private universities was 47. Responsibility for training in science and technology as well as for fundamental research, was taken mainly by these universities, especially the national universities.

Research institutes which played a leading rôle in developing science and technology (especially the latter) in our country down to World War II were mainly the national institutes attached to each ministry. This had its origin in the original Meiji policy for promoting industry and for making research and development in science and technology entirely dependent on the initiative of the government. These institutes, established to lead and raise industrial technology, were attached to each ministry to achieve its administrative objects, and the scope of the research was decided by each ministry. The main institutes in this class are the International Latitude Observatory, the National Research Laboratory of Metrology, the Government Chemical Industrial Research Institute, Tokyo, the Geological Survey Institute, the Electrotechnical Laboratory, the Agricultural Experiment Stations, the Central Meteorological Observatory, the Railway Technical Research Institute, the Tokyo Astronomical Observatory and the Institute of Research on Infectious Diseases (the last two attached to Tokyo University).

Of private research institutes, the most famous was the Physical and Chemical Research Institute established in 1917. This institute was very active over the next 30 years; it contributed to progress in physics, chemistry and technology, and produced a large number of distinguished scientists.

As to learned societies, the Tokyo Academy was established in 1879, modelled on the academies of European countries. It was reorganized in 1906 and the name was changed to the Imperial Academy, being considered as the highest authority in the learned world. Another leading organization was the Japan Society for the Promotion of Science, established in 1932 with the aid of the Emperor's fund. It made research grants to individuals and groups and played an important rôle in the progress of science in Japan.

In the sense of "promotion of industry" and "rich country, strong arms", attempts to harness science and technology to national objectives have existed since the earliest time of the Meiji. To achieve these aims, Western science and technology was imported rapidly into our country and we succeeded in catching up with the level of science and technology of advanced Western countries to some extent before World War II. However, this hurried introduction has resulted in a separation of science and technology and uneven progress in the various fields of science.

(2) After World War II

After World War II, changes were introduced in the science policy and the administrative structure for scientific and technological activities.

For several years after the War, research activities in Japan were virtually suspended.

In 1948, the Science Council of Japan was established as the organ representing the scientists, independent of administrative supervision and free to act on its own.

From about 1952-1953, the movement to establish an institute to administer scientific and technological affairs at the national level had developed in the Diet and in industrial circles. As a result, the Science and Technology Agency was established in 1956. In the same year, the Atomic Energy Commission was established also. Since about 1955, the importance of science and technology in the economy of the country has been widely recognized and the government and private enterprises have established new universities, faculties and research institutes. In the administrative structure, the Council for Science and Technology was established in the Prime Minister's Office in 1959 as an advisory organ to the Prime Minister, with the purpose of promoting consistent and integrated policy for science and technology by the administration.

B. ADMINISTRATIVE STRUCTURE FOR SCIENCE AND TECHNOLOGY

(1) Introduction

Japan is a constitutional monarchy with a parliamentary system of government. The government organization is grouped into the legislation, the administrative and the judiciary - three separate organs. The organ responsible for legislation is the Diet, which consists of the House of Representatives and the House of Councillors. In the administration, under the Diet Cabinet, there are one office (the Prime Minister's Office) and 13 ministries. In addition, there is a local government system. The administrative organizations responsible for scientific and technological affairs are the ministries, the agencies and the advisory organs which are attached to the Prime Minister's Office, the ministries and the agencies. The National Research Institutes are attached to the appropriate ministries. Three special public corporations - Japan National Railways, Nippon Telegraph and Telephone Public Corporation, Japanese Monopoly Corporation - also have their research institutes. In addition, there are several research institutes which have the status of special public corporations.

The policy for science and technology of Japan can be considered on two levels. The first concerns the individual ministry. Each ministry has its technical advisory organs, on whose advice it bases its science policy as necessary for its administrative work. Research necessary for its work is performed by the national research institutes attached to it. There are now about 70 such national research institutes.

The second level concerns fundamental and overall policy, and the policy for fields that cut across several ministries' boundaries or that have special national importance, such as atomic energy, space, radiation problems and marine science. These policies are developed by the advisory organs established in the Prime Minister's Office, and the advisory organs make the corresponding recommendations to the Prime Minister.

In the development of fundamental and overall policy, the important organizations are the Council for Science and Technology and the Science and Technology Agency.

(2) The Council for Science and Technology

The Council for Science and Technology, the advisory body at the highest level of policy making, consists of a Chairman (the Prime Minister) and ten members (Ministers of Finance and Education, Directors-General of the Economic Planning Agency and the Science and Technology Agency, all four of whom are Cabinet Members, together with the Chairman of the Science Council of Japan and the other persons of "learning and experience" appointed by the Prime Minister and approved by the Diet). The Council, as and when requested by the Prime Minister, considers and drafts the fundamental measures to promote science and technology with the assistance of the Science and Technology Agency, principally for long-range planning and for related policy measures.

The Council, by virtue of its composition and sub-committees, profits by the advice of those interested in research, such as the national research institutes, universities and private organizations. For advice on basic research, it is particularly indebted to the Science Council of Japan.

The Council now has five sub-committees. The first of these deals mainly with fundamental laws and long-range promotion programmes; the second with long-range research objectives and steering policies for particularly important research; the third with policy for training personnel and improving conditions for research workers; the fourth sub-committee deliberates on exchange of information, international co-operation and dissemination of scientific knowledge. The fifth is the liaison sub-committee with the Science Council of Japan.

Administrative support for the Council is provided by the Planning Bureau of the Science and Technology Agency. The Council has made two important recommendations on science policy to the Prime Minister; these are discussed below.

(3) The Science Council of Japan

The Science Council of Japan (SCJ) is a representative organization of Japanese scientists in all fields, i.e. natural sciences, technology, social sciences and humanities. It comes under the aegis of the Prime Minister, and provides the main channel to the government for academic ideas and advice.

The SCJ deliberates on important proposals relating to science, assists their realization, maintains liaison among researchers in various fields and promotes efficiency in research activities.

Specifically, it is empowered by law to make recommendations to the government on policies for: (a) the encouragement of science and the development of technology; (b) the utilization of research results; (c) the training of research workers; (d) scientific administration and (e) the permeation of science into industry and national life. The government is empowered to make inquiries regarding the distribution of budgetary funds for government research and research administration organs, and the utilization of specialists for expert advice.

The SCJ comprises seven subject sections, each section including 30 of the Council's 210 members. The members are elected from among scientists having appropriate qualifications. The Council has standing committees, ad hoc committees, and 60 liaison committees. It sends representatives to academic conferences abroad, holds international conferences and symposia, and issues publications.

This Council has no research funds of its own.

(4) The Science and Technology Agency (STA)

This Agency is an administrative organization attached to the Prime Minister's Office. It co-ordinates scientific and technological activities and provides a communication network linking the administrations concerned in each ministry; it also provides the secretariat for all top-level science advisory organs to the Prime Minister (except the Science Council of Japan).

The main functions of the Agency are planning, co-ordination and operation of several laboratories.

In line with the recommendations and plans made by the Council for Science and Technology and other top-level advisory organs such as the Atomic Energy Commission, the Agency plans the government's science and technology policy, except that of the universities. As to the universities, the Ministry of Education is responsible for their scientific administration.

The function of co-ordination is exercised through three measures, namely:

(a) co-ordination of the activities and research budgets of the ministries;
(b) allocation to the ministries of funds provided to the Agency for research of national importance involving more than one ministry;
(c) operation of laboratories in subject fields that cut across the boundaries of several ministries or that serve as common facilities to more than one ministry.

The Agency is headed by a Director-General who is a Minister of State, and is structurally composed of the Director-General's Secretariat and five bureaus whose duties are as follows:

(a) the Planning Bureau drafts plans in furtherance of the fundamental policy in close collaboration with the STC, investigates and analyses the trend of science and technological activities and compiles statistics;
(b) the Research Co-ordination Bureau is concerned with budgetary liaison among ministries, applying measures to ensure efficiency in important interdisciplinary research, utilizing the special research promotion and co-ordination fund, allocating subsidies, awarding contracts and furthering space research utilization;
(c) the Promotion Bureau is concerned with STA publicity, measures to encourage invention and to promote new technology, matters concerning consultant engineers, relations with international organizations, supervising the laboratories attached to the STA and the special public corporations under the control of STA;
(d) the Atomic Energy Bureau steers the fundamental policies concerning the application of atomic energy, manages the affairs of the Atomic Energy Commission, co-ordinates the budget concerning atomic energy in the government, regulates matters concerning nuclear reactors and fuels and prevention of hazards, and supervises the special public corporation under its control;
(e) the Resources Bureau acts as the secretariat for the Resources Council, which is responsible for general policy on the utilization of resources, investigation and analysis of utilization of resources, and compilation of statistics on resources.

The STA has five advisory organs and administers five multidisciplinary research laboratories and six special public corporations.

(5) Other research organizations

As mentioned above, each ministry and agency includes some research within its jurisdiction. Three ministries together account for a large percentage of the government budget concerning science and technology; these are the Ministry of International Trade and Industry (MITI), the Ministry of Agriculture and Forestry, and the Ministry of Education.

The MITI has the Agency of Industrial Science and Technology, the Patent Agency and the Industrial Rationalizational Council. The Agency of Industrial Science and Technology is responsible for research, analysis, appraisal, certification, technical surveys and technical information in industrial technology; the geological survey, the establishment of industrial standards; aid to research on industrialization. It has 13 research institutes and three advisory organs on its work. Research in the Ministry of Agriculture and Forestry is co-ordinated by the Agriculture, Forestry and Fisheries Research Council. There are some 30 national research institutes on agriculture, forestry and fisheries.

The responsibilities of the Ministry of Education in science at the higher educational level include the approval for, planning of and assistance to universities, maintenance of educational standards, preparation of the budgets of the national universities and related matters.

C. RESEARCH

(1) Research expenditure and personnel

Research expenditure and the numbers of research personnel are given in the "Statistical Survey of Research" published annually by the Bureau of Statistics of the Prime Minister's Office since 1953. In 1953, the total research expenditure was only 47 billion yens ($130 million), but by 1964 it had reached 382 billion yens ($1.06 billion). The trend of research expenditure during the five years up to 1964 is shown in the following table:

	1960	1961	1962	1963	1964
Private companies	345	455	499	576	678
Research institutes	82	111	132	142	168
Colleges and universities	85	115	150	174	215
Total					
Amount	512	681	781	892	1061
As % of national income	1.60	1.74	1.78	1.77	1.86

Unit: US $ million.

Some characteristic features of research expenditure of Japan are as follows:

(i) Research expenditure for defence is low compared with other countries. In 1963, it was only 3 billion yens ($8 million), or 1% of the total research expenditure.

(ii) Expenditure on research by private companies amounted to about 73% of the total research expenditure and 96% of this was provided by the private companies themselves. This proportion is roughly constant throughout these years. This fact shows that the amount of subsidies or contracts from the government to private companies is very small.

(iii) Japan spends a comparatively high proportion of the national income on research, taking account of the national per capital income, which was $512 in 1963.

The total number of workers involved in research activities at 1 April 1964 was about 290,000. The statistical survey groups them into four categories, namely: fully-qualified research workers (115,000); assistant research workers (72,000); technical assistants (57,000); clerical and other auxiliaries (45,000). The variation of the number of fully-qualified research workers is shown in the following table:

	1960	1961	1962	1963	1964
Private companies	42,938	43,608	46,110	54,073	60,009
Research institutes	14,290	14,831	16,520	18,257	18,400
Colleges and universities	24,921	28,255	28,337	33,451	36,430
Total	82,149	86,694	90,967	105,781	114,839

(2) Higher education and research

After the war, the educational system of Japan was reformed, and the "6-3-3-4" system was adopted; this implies six years at primary school followed by three at junior high school, three at senior high school, and four at university. The first nine years, covering primary and junior high schools, are compulsory. After 12 years of primary and secondary schooling, the standard form of higher education is four years at university, but an alternative form comprises two or three years at junior college. For those students who do not proceed to senior high school, there is the possibility of five years at technical college.

At present, the number of universities is 317, including 73 national, 35 public and 209 private. The research institutes and facilities attached to these universities, particularly the national universities, are the leading organizations for scientific research.

The number of such institutes is at present 108 (of which 67 are attached to national universities), including 74 for research in science, engineering, medical sciences and agriculture (of which 57 are attached to national universities).

Ten of the institutes attached to national universities established after the war are for joint research, e.g. on cosmic rays, nuclear studies and so on. These institutes are intended for research workers throughout the country, including those at other universities, to enable them to engage in joint research.

(3) Research institutes

Research institutes in Japan are grouped broadly under the headings: national, public, private, special public corporation, those attached to universities and those attached to private companies. Here, we confine our attention to the national institutes.

The national research institutes are attached to various ministries or agencies and undertake experiments, analyses, surveys and research as required by eac administration, as mentioned above.

These institutes are playing a leading part in the promotion of science and technology in the progress of Japan's industrial economy. In line with the recent surprising advances of science and technology and the reorganization and expansion of research systems in private enterprise, the nature of the requirements for the national research institutes has changed. For this reason, in 1962, the Council for Science and Technology, in response to the request of the Prime Minister, indicated the rôle of the national research institutes as follows:

(a) Research on pure science, and fundamental research intended as the basis of development of science and technology. So far as the fields of atomic energy and space are concerned, basic and applied research and development are included.
(b) Research for the public welfare, e.g. on public sanitation and prevention of disasters.
(c) Research on general technology, intended as the basis of industry.
(d) Research on the atmosphere, in geology and in oceanography.
(e) Research on international co-operation for the common benefit of mankind.

D. THE PROMOTION OF SCIENCE AND TECHNOLOGY IN THE NEXT TEN YEARS

In 1960, the Council for Science and Technology made a report on "The Promotion of Science and Technology in the Next Ten Years". This was the first attempt to construct a national science policy and summarize the various trends in the thinking of academic, business and administrative circles.

The five principal topics of this report are as follows:

(1) objectives of research to be achieved in the next ten years;
(2) scientific training and manpower problems;
(3) expansion, reshaping and co-ordination of research;
(4) exchange of scientists and information;
(5) improvement of the administrative system for science and technology.

With the passage of time, the need was felt to determine what progress had been made toward these objectives. In 1965, the Council decided to check up the results of the recommendations and to amend the report, which seemed to be inadequate in the present situation. We are now engaged in revising the report. This time we have outlined more specific measures to attain the desired goals, and have made the plan more concrete. For instance, we have roughly estimated the research expenditure necessary to realize the objectives.

In making such a plan the most controversial points involve decisions as to which fields should be stressed and how funds are to be managed, that is, the problem of finance.

There is a feeling in the academic community that the plan outlined in 1960 by the government tended to favour industrial circles. Therefore, in fixing the objectives of science and technology in the revised plan, the members of the Science Council of Japan are taking part in the Committees of the Council for Science and Technology, and the long-range plan for science made by the Science Council of Japan has been taken into consideration.

Next, as the plan becomes more concrete, the problems of financing become more important. This is a problem we are confronting now.

VII. Norway

(Statement presented by Mr. H. Dahl)

A. HISTORICAL INTRODUCTION(1)

In earlier years, scientific activities developed along traditional lines, through learned societies and universities.

In 1940 in Norway there were:

One university(2);
Six colleges at university level(2);
Three learned societies;
A number of museums with qualified staff;
A number of public institutions attached to business and industry with research as part of their programme (geology, fishery, agriculture, meterology, statistics, etc.);
A few special institutes attached to private business firms;
Modern research activity within a few major industrial firms;
A number of independent research institutes, some financed by public, some by private funds (research in comparative studies, lexicography, humanities, sociology, natural science, etc.).

In 1940, the total grants from public funds for research and teaching at university level amounted to about N.kr.11.5 million ($2.8 million) or about 0.20% of the gross national product.

Private contributions amounted to a much smaller sum than the public grants.

During the 1940-1945 war, Norwegian research came to a complete standstill. Scientific equipment was not renewed, and recruitment was very reduced.

(1) Basic information
Area: 320,000 square kilometres.
Population (1964): 3.7 million.
Gross national product: (1964) N.kr.49,000 million ($7,000 million).

(2) All these institutions will be referred to below as universities.

On the cessation of hostilities work began on a big scale to restore and extend scientific activity directed by the public authorities, universities, learned societies, representatives of business and public administration.

In 1946, the Norwegian Council for Scientific and Industrial Research was founded, followed in 1949 by the Norwegian Research Council for Science and Humanities, the Agricultural Research Council of Norway, and the Joint Committee of the Norwegian Research Councils. In the same year, Norway's second university was founded in Bergen.

Many new research institutes of different types have been established during the post-war years. These are:

- Public institutes attached to branches of industry;
- Private institutes of the same nature;
- Institutes attached to public administration;
- Independent institutes with specialized activities and independent institutes which carry out more general research of an academic nature.

Only recently steps have been taken to establish a general research policy for the country.

B. THE PRESENT POSITION

According to an investigation undertaken jointly by the three research councils on the basis of material collected in 1963, the total disbursements to research in Norway in this year were about N.kr.350 million ($50 million). This amount refers only to the research side of the institutes' activities. In the case of the universities, for example, only 45% of the total disbursements is counted. The remaining 55%, which covers teaching and other activities, is not included.

If grants for teaching and other work connected with research are taken into account, the sum reaches N.kr.550 million ($78 million). The investigation gives comparatively complete information. A few surveys are given in the following tables:

TABLE I

Total disbursement to research allocated to:

	Million $	%
Humanities	2.8	5.5
Social Sciences	2.2	4.6
Sciences, mathematics	5.1	10.2
Medicine	4.5	8.9
Veterinary medicine	0.8	1.5
Agricultural technology	3.6	7.3
Technological science	31.0	62.0
	50.0	100.0

Distribution of financial resources among different categories of institutions:

TABLE II

Financial resources	Universities Mill. $	Research institutes Government Mill. $	Research institutes Private Mill. $	Industry Mill. $	Total Mill. $
Government	12.6	13.2	2.2	0.1	28.1
Industry	0.1	1.3	1.3	13.7	16.4
From abroad	0.2	3.1	0.3	-	3.6
Others	0.5	0.1	0.1	-	0.7
TOTAL	13.4	17.7	3.9	13.8	48.8

TABLE III

The distribution to basic research, applied research and development at different categories of institutions:

Place of research	Basic research Mill.$	Basic research %	Applied research Mill.$	Applied research %	Development Mill.$	Development %	Total Mill.$	Total %
Universities	9.7	71.3	3.1	22.9	0.8	5.8	13.6	100
Research institutes:								
governmental	3.1	17.6	8.2	46.0	6.4	36.4	17.7	100
private	1.8	36.6	2.1	43.9	0.9	19.5	4.8	100
Industry	0.2	1.4	2.8	20.1	10.9	78.5	13.9	100
TOTAL	14.8		16.2		19.0		50.0	

C. THE ORGANIZATIONAL SET-UP

The institutions where research goes on can be divided into the following groups:

Universities;
Other public institutes;
Private institutes;
Industrial research institutions.

In addition to these active research institutions there are bodies whose task is to plan and direct the developments of research from a more general point of view than the separate institutions or groups of institutions:

The Government Research Committee;
The Central Committee for Norwegian Research;
Various government ministries;
Administrative planning departments;
Learned societies;
Private organizations and funds.

D. THE TASKS OF THE VARIOUS INSTITUTIONS AND THEIR PLACE IN THE SYSTEM

(1) The universities

The universities are public institutions which receive the main part of their funds through a grant from the annual State budget. At the request of the authorities, they have prepared several long-term programmes (four years), but they have not been able to get definite assurance with regard to the development of the grants for a longer period.

The tasks, the rights, and the obligations of the universities are formulated by statute and regulations in every case. The two duties imposed on them are:

(1) to provide instruction with a view to educating people in professional work,
(2) to carry out research.

The first duty, teaching, is subject to regulations laid down by the authorities, i.e., the recommendations of the universities must be approved by the authorities. This applies to questions regarding the number of teaching hours, the scope of subjects to be read, examination arrangements, possible limitation of the number of students, etc.

To the other duty, research, no such regulations apply. It is assumed that the person concerned will carry out research in conjunction with his teaching, and choice of research projects is left entirely to the individual.

Funds for this research are granted through the ordinary budget, and each researcher must present his request to his institute, then his faculty, thence to assessment by the universities' highest authority. These proposals must be tabled about 18 months before the relevant budget period begins.

The research budgets of the Norwegian universities have always been meagre. This is an obstacle to any transfer of funds between the various branches and institutes from one year to the next.

The last ten years have seen the development of a puzzling position arising in consequence of the enormous increase in the influx of students. This has caused the need for teaching premises and teachers to be given marked priority by the authorities that allot grants, at the expense of research. The result is that the funds available for research through the universities' ordinary budgets provide little opportunity for expansion of research in any direction, and that the funds per capita of teaching staff that can be devoted to research, are reduced rather than increased.

The research which the universities have been able to undertake with the funds distributed through their ordinary budgets has, for the reasons given above, generally been restricted to traditional spheres and projects. There has been no opportunity for an institute or a group of researchers to establish themselves on a new level.

At the same time, the universities are exposed to increasing pressure from two sides:

First, there is the need to carry out research of a more applied nature than that which has normally been traditional at the universities. Second, there is an increasing need for recruits for this applied research, outside the universities, where developments in certain spheres have proceeded very rapidly, but where the recruitment of scientists has mainly taken place at the universities.

This is the position which the authorities are facing, even if there has been no success in persuading them to draw the economic conclusions regarding the substantial increases in grants the universities must be given if they are to solve their problems satisfactorily.

One solution which seems obvious, and which to some extent has been accepted, especially through the action of the research councils, is that the institutes of the universities, groups of researchers, and single researchers obtain money from other sources than the current university budgets for special tasks and for an expansion beyond that generally approved of in a university budget.

Another solution is that the activity which is suitable for a university, may be organized in special research institutes outside the university, and that the recruitment should also to some extent take place in these institutes.

One of the questions which is at present under lively debate in Norway, is the division of work and the forms of co-operation between the universities and other scientific institutions.

The technical groups have made strong demands that the universities should adapt their education more closely to the need of industry.

This might well involve some rearrangement of research at the universities.

The conclusion drawn by the universities has hitherto been that with the restricted research grants there is no reason for changes in the traditional patterns, which in their opinion characterize the minimum basic freedom in scientific activity which an institution of such nature must have.

(2) Research institutes attached to the research councils and other public research institutes outside the universities

The Norwegian Council for Scientific and Industrial Research has established and administers a number of research institutes. These institutes have the duty of undertaking specified tasks in applied research. The aim of these institutes can vary widely, and not all are exclusively research institutes. As examples of the Research Council's institutes can be mentioned the Institute of Atomic Energy, which is the biggest, the Central Institute for Industrial Research and the Building Research Institute.

Of the other public institutes which are exclusively research institutes, can be mentioned as examples the Institute for Work Physiology, the Institute for Social Alcoholism Research, the Institute for Cosmic Physics, the Polar Institute, the Institute for Foreign Policy, the Fisheries Research Institute. Institutes partly engaged in research include the Central Bureau of Statistics, the meteorologic institutions and geologic research institutions. The Norwegian Defence Research Establishment was founded in 1946 and is one of the larger institutes.

In Norway, there are at present more than a hundred such public institutes with research as their sole task or as part of their activities.

These institutes have in common that they are established to carry out research in a certain field according to programmes set up by the authorities or by interested groups in society. They can all be regarded as the result of research planning, but they are not an expression of a joint policy. On the contrary, the picture is fairly heterogeneous, apart, perhaps, from the institutes which have been established by the Research Councils. These are results of deliberations in the research councils and have been established where the need was estimated to be greatest and where the possibilities for successful operation existed. The further development and the scope of the work of the individual institutes has depended upon their performance.

As for institutes not established by the research councils, the development has been dependent solely on the initiative of each institute. Several of these institutes have been financed in part by funds from research councils, and have thus been submitted to comparative assessment.

(3) Private institutes

There are also a number of private research institutes which have been established through donations, special collections, etc. These institutes have been set up in fields where individuals or groups of individuals, social groups and the like, have felt that there is a strong need to begin or to increase research activity. Some of these institutes have later received public support, even though they have maintained their independent status.

Among the institutes which have been established through donations can be mentioned the Chr. Michelsens Institute in Bergen, which has a department for natural science and one for humanities and social science. In Oslo, the Institute for Social Research was established through a donation, but its activity, as time has gone on, has received considerable public financial support through the research councils. Both these institutes receive a large part of their incomes through grants for research assignments.

Another institute, established through special collections, is the Institute for Cancer Research; likewise the Gerontologic Institute and the Council for Heart and Cardiovascular Diseases. In this group is also found a number of museums, which to a certain extent carry out research.

(4) Industrial laboratories

Norwegian industry consists largely of small businesses with little ability to finance and administer any extensive research within the firm itself. However, as the above tables have shown, there is considerable research activity in industry, both in the private industrial firms and the public, such as Norwegian Railways, Catchment Boards, the Electricity Board, and the Posts and Telegraphs, etc. Some of the institutes mentioned above also receive support from industry, especially in the form of sponsored research projects.

E. ORGANIZATIONAL BODIES

(1) The Government Research Committee

The institution which has the most decisive influence on research policy in Norway is the government, which - through its budget recommendation to Parliament - lays down the guiding lines for the development in this field.

The universities come under the Ministry of Church and Education, except for the two colleges in the agricultural sector, which come under the Ministry of Agriculture.

A large part of the public research institutes outside the universities, some under the Ministry of Industry, also have research as part of their activity both as special institutes and as planning departments.

The government has felt the need to survey all this research activity within a single line of vision, and has therefore established a special Government Committee for Research. The committee consists of the Prime Minister as Chairman, the Minister of Finance, the Minister of Church and Education, the Minister of Industry and the Minister of Agriculture. The Government Committee shares a secretariat with the Central Committee for Norwegian Research (see below), and the Chairman of the Central Committee is present at the meetings of the Government Committee. The secretariats are attached to the Prime Minister's Office. The Committee has only recently come into being and it is too early to estimate the effects of its activity.

Decisive influences in development also come from the various ministries. As has been mentioned, a great part of university research is governed by the Ministry of Church and Education, and it is the duty of this Ministry to harmonize the activity of the individual institutions, the various branches of science, and research as opposed to other work, especially teaching - both university and elementary education. There is no formal link between each university and the ministry. The universities carry out internal deliberations, especially in the form of meetings of rectors. But these deliberations are also informal and not binding for the various institutions. To some extent, the research councils are referred to as advisory bodies to the departments, not to the ministries, in matters concerning the assessment of support for research. This applies especially to the Ministry of Industry. Under the aegis of this ministry is the Norwegian Council for Scientific and Industrial Research (NTNF) (see below) which to a high degree is both advisory, co-ordinating, and executive in matters concerning the ministries' research projects.

Several of the ministries have established their own planning departments whose job is to draw up long-term plans for the ministries' projects. These planning departments are primarily prognostic institutes, which undertake investigations and estimations both alone and with the aid of other institutions. The planning departments have much influence in the shaping of policy, because their work forms a background for the authorities when they are searching for an overall estimation of how much support research can receive - for example, as a percentage of the national product.

(2) The Research Councils

Since the war, no organizations have had more influence in the drawing up of guidance lines for Norwegian research policy than the research councils. There are three research councils in Norway:

(a) the Norwegian Council for Scientific and Industrial Research (NTNF), established in 1946;
(b) the Norwegian Research Council for Science and the Humanities (NAVF), established in 1949;
(c) the Agricultural Research Council of Norway (NLVF), established in 1949.

Each of the three research councils is attached to its own ministry - the Ministry of Industry, the Ministry of Church and Education and the Ministry of Agriculture, respectively.

They are composed of representatives (about 30 in each council) from the universities and other scientific institutions, from several of the government departments, and from industry (in the case of two of the councils).

The research councils have two tasks:

(1) to allot and administer means voted for research purposes,
(2) to act as advisory bodies to the ministries in matters of research.

It is clearly expressed in the regulations that the research councils shall work actively to promote research in the spheres in which they are concerned. This means that the councils must evaluate the respective tasks in the different scientific branches, and give priorities accordingly. Estimation of this nature demands a considerable amount of analytical survey, and the councils have built up special groups for this purpose. NAVF, for example, have a department in which six to eight university graduates are employed full time, with the necessary technical apparatus. These analytical survey groups play an important rôle in the research council's advisory tasks in relation to the ministries and other public authorities.

The research councils have no right of determination or formal co-ordination duties vis-à-vis the universities or other public institutions. Their significance as policy-shaping bodies is partly that with their own funds they can expand research activity in such spheres as they find desirable, partly that they advise the authorities on the allotment of funds.

The research councils obtain a part of their incomes from the output of the State Football Pool. For NAVF and NLVF this has been the greater part of their means.

(3) The Central Committee for Norwegian Research

This Committee was established in the autumn of 1965 and has just commenced its function. The task of the Central Committee is to advise the government on long-term research policy, covering all branches. It also handles separate cases at the request of the government.

(4) Parliament

In Parliament a desire has been expressed for the establishment of a link body between Parliament and the scientific organizations and institutions. The matter has been discussed between representatives of the parties, who agreed to attempt to put up a committee with a few representatives from each side. The question has not hitherto been brought to a conclusion.

(5) Learned societies

There are four learned societies in Norway. Three of them (Oslo, Trondheim, Bergen) are general and divided into classes, while the fourth (Trondheim) is a technical academy.

The societies are members of international organizations, and in that capacity appoint representatives to these organizations. They select editorial boards for Norwegian and international scientific journals and appoint boards for the funds which the societies administer.

The societies have only small funds at their disposal, and their rôle as organs of research policy is very limited. They arrange conferences and publish books.

(6) Private organizations

Many private organizations operate to support research. Of considerable importance are a number of industrial research associations, further associations for aid to medical research, and others.

F. SCIENCE POLICY

A co-ordinated policy for science has not yet been developed. The different sectors of research have through their own organizations planned the work within their own fields, and hence the infrastructure of an organization for research is established.

With the steadily growing volume of research activity, a need for better co-ordination and planning is felt. Many committees have been set up for the purpose, and comprehensive statistical data on expenses, personnel, growth-rates, etc. has been collected. In addition to statistical surveys, economic studies have also been undertaken to assess the contribution of better methods and techniques - i.e. the results of research - to the growth rate.

The most important result of the many deliberations is the forming of the Central Committee for Research, whose main purpose will be to evolve a science policy for the country.

Some of the main problems will be:

To work out a system for priorities. This is of particular importance in a small country where resources are limited, and where difficult choices must be made.

To base decisions on prognostic studies, where the highly dynamic character of research and the element of risk make forecasts difficult.

To achieve co-ordination without creating rigidity and stifling innovation.

To balance the state effort against private enterprise and initiative.

To counter-balance applied research and basic research, and still retain the traditional freedom of academic research.

To clarify the position of the university in the future research community.

To evaluate scientific research in relation to socio-economic research and other cultural activities, and their interrelations.

There is no easy solution to any of these problems. They will in due course be taken up for further specification and study. This will represent the first steps towards the formulation of a science policy.

G. SYNOPSIS

Norwegian research institutions comprise:
universities,
other public institutions,
private institutions outside industry,
industrial research institutions.

These institutions spend annually a total (1963) of about N.kr. 350 million ($50 million) on research. On activity related to research (education, development work, etc.) about N.kr. 200 million ($28 million) is spent.

The gross national product for 1963 is about N.kr. 45,000 million ($6,400 million).

Percentage of the GNP spent on research	0.78
Percentage of the GNP spent on research including related activities	1.22

Each Norwegian university comes under the direction of the ministry without any co-ordinating link.

The universities are undergoing broad expansion, with a rapid increase in the number of students. This creates difficult conditions for research. Special attention is being devoted to recruitment, which is weak in many fields.

Research institutes, public and private, have been established for a number of purposes, especially in the technical and industrial fields. Recruitment to these institutions also takes place through the universities, a fact which has evoked a demand that the education at the universities should be better adapted to facilitate this recruitment.

Public research institutes come under the direction of one of the government ministries.

There are three research councils which administer grants and act in an advisory capacity. Together they cover the whole field of research.

There has recently been established a government committee for research and a central committee for research with a joint secretariat, attached to the Prime Minister's Office.

VIII. Poland

(Statement presented by Professor A. Tuszko)

A. GENERAL FEATURES OF THE ORGANIZATION OF SCIENTIFIC RESEARCH

It is very difficult in a short report to explain precisely the very varied questions concerning the development of science in recent years and the closely linked problem of technological progress, even within the limits of one country. That is why in my speech, I shall describe only the basic aspects of these problems in Poland, paying special attention to the dynamics of the development of organization, planification and co-ordination of scientific research in our country. However, in order to do so, it is necessary to turn our thoughts back to the past, to the year 1945. After the war, the country was completely in ruins, towns had been destroyed, industry annihilated, agriculture was at its last gasp. During the occupation, more than 40% of Polish scientists and the majority of the intelligentsia had perished. All the higher education institutions were closed.

During the first years, the first stage of work, the tendency was to succeed, at all costs, in replacing the specialists, teachers and scientists. Already in 1946 there were 46 higher education institutions, whereas now there are 74. Today, about 60,000 students enter higher education institutions each year as against 15,000 in pre-war years. Every year, approximately 20,000 students finish their studies in comparison with 6,500 before the war.

A great impulse to develop industry and agriculture springs up and large numbers of people fill the constructed towns.

Alongside the development of national economy, a network of departmental research institutes grows up. Before the war, there were only a few, now there are more than one hundred. Besides this, large industrial factories possess their own research laboratories. On the whole, applied research is carried out in departmental institutes.

But public demands to science become more and more varied. Science has not only to offer a solution to actual, existing problems, but also provide the possibility of satisfying future needs.

In 1951, the Polish Academy of Sciences was founded. It is the highest establishment in the country for questions of science and as such is a permanent consultative body to the government. The Academy has the task of determining the actual state of science in the country, of comparing it with scientific achievements abroad, of giving the most appropriate direction to research and the development of science and of setting up institutes for scientific research, which is on the whole of a fundamental character.

Apart from this, at the request of the government, the Polish Academy of Sciences was obliged, at the start of its activities, to prepare "important expert surveys" regarding such complex problems as the development of hydrography throughout the whole land, electrification of the country with indications as to the importance of requirements and of resources of energy, the reform of higher education, etc.

Foremost scientists enter the Academy. There are 95 permanent members, 124 correspondent members and 63 foreign scientists. They are selected by the General Assembly.

The General Assembly - the highest body in the Academy - elects every three years a Presidium, that is a President and three Vice-Presidents. A Scientific Secretary is nominated by the State Council, following a proposal of the Council of Ministers. He is in charge of the general management of the Academy's activities. He works in collaboration with his assistants and with the secretaries of the scientific departments of the Academy.

There are six scientific departments in the Academy: (1) the social sciences department; (2) the biology department; (3) the department for mathematics, physics, chemistry, astronomy, geography and geology; (4) the technology department; (5) the forestry and agriculture department; (6) the department of medicine.

To deal with the tasks laid before it, the Polish Academy of Sciences has organized a network of scientific institutes and appropriate scientific committees. Today, the Polish Academy of Sciences has 80 scientific research establishments, 21 of which are important scientific research institutes. There are more than 70 scientific committees.

Scientific research is also carried out under the direction of professors holding a chair and in the institutes of higher education establishments. In 1965, there were 74 higher education institutions with 1,800 professorships and 34 research institutes.

It should be emphasized that it was only recently that the importance of scientific research was realized and considered to be a necessary and very significant element in the activities of higher education institutions, and that the link between the work of scientific creation in higher education institutions and the accomplishment of teaching duties was no longer doubted.

Today, in accordance with legislation in force in the Polish People's Republic, higher education institutions are called upon at the same time to train specialists in national economy and culture, to carry out scientific research, to develop and watch over national culture and to co-operate in the development of technical progress. The significance and position of scientific research within the system of higher education in Poland are also manifest in the duties imposed on the scientific teaching staff of Polish higher education institutions. Apart from their teaching and training duties, senior and junior professors, state lecturers, assistant lecturers, senior assistants and assistants are obliged to:

these plans become an essential part of the State Plan.

Different elements of the State Plan concern the establishment of the means for carrying out research, that is to say: (a) the number of workers, (b) the financial means, (c) the setting up of a fund for technical advancement.

Besides the plans described above, there are also R Plans (Research) comprising scientific research work not included in the State Plan and which are brought into effect, according to their particular needs, by different departments of national economy as also the Ministry of Higher Education, the Ministry of Agriculture, the Ministry of Health and Social Insurance and others.

The NT Plan comprises scientific research work of an experimental character and engineering work directed towards preparing new productions or greatly raising the quality of existing industrial machinery, equipment and products, and also to preparing new methods of producing them. This plan takes into consideration the entire research cycle including work in project, the preparation of prototypes, carrying out tests and experiments in sufficient number so as to verify results.

The S Plan, as already mentioned, is prepared by the Polish Academy of Sciences. The principal place among the goals set for scientific research in the S Plan for 1966-1967 is taken up by a claim for the development of fundamental scientific research permitting practical application in national economy, technology and the life of the people, which all require rapid expansion in Poland. In the field of social sciences, fundamental research is concerned for the most part with interpreting current problems or is work which gives a Marxist synthesis of the achievements of the whole sphere of science. In biology, agriculture and medicine, experimental research is fundamental when the results are applicable in agricultural production and public health; in the exact sciences, the latest experimental research in physics and chemistry is fundamental, as also theoretical research in mathematics which brings the perspective of practical application, and earth sciences which provide the basis for complex planning for developing the country; in technical sciences, theoretical and experimental research concerning the main problems of modern technology in a wide sense is fundamental.

As well as the development of fundamental research, the plan includes certain categories of applied research. The first among these categories is research in important scientific fields formerly not dealt with in Poland, for example, electronics, automation, the construction and exploitation of calculators, the techniques of supersonics, etc.; the second is complex research important to national economy, not included in the general framework not only of different branches of economy but also of different disciplines.

The S Plan includes problems regarding the physics of solids, nuclear physics, physics of all forms of energy and of elementary particles, and also the problems of nuclear chemistry. This plan to a large degree takes into consideration problems of technical cybernetics. In the field of biological sciences, the plan deals with the problems, among others, of biosynthesis and nucleic acids.

Agrarian science is represented by complex problems in three domains: soil investigation, research into the particularities of cultivated crops, and forestry research.

As for the social sciences included in the S Plan, they are centred on economics, law and sociology.

The problems and themes of scientific research work not closely linked to the set direction indicated by the Council of Ministers and the Polish Academy of Sciences, and in consequence, not being part of the NT and S Plans, are undertaken in higher education establishments in accordance with the so-called R Plan.

This section of the plan includes to a great extent themes of the present studies for a doctor's degree and also dissertations and problems of research which belong to disciplines of a fundamental and theoretical nature.

D. PLANNING OF RESEARCH IN UNIVERSITIES AND OTHER HIGHER EDUCATION INSTITUTIONS

The co-ordination of problems entering into the NT Plan takes place at the level of the Main Commission of the Science and Technology Committee and of the foremost research establishments. The establishments in charge are concerned with the realization as a whole of all work touching on the problems in hand and co-ordinate the execution of the different elements comprising these problems. All participants in these realizations share in bringing these themes into being. These organizations also share at this stage in putting into practice the results obtained by research.

For the co-ordination of research on particular problems, groups may be formed which serve as consultative bodies to the organizations in charge. The task of such consultative groups is to establish a programme of work and also to evaluate and examine, from a scientific point of view, while giving their opinion, questions which merit attention regarding the realization of tasks within the limits of the problems in question. A group is composed principally of specialists from the staff of the participating organizations. The co-ordination of the problems entering into the S Plan are dealt with at the level of scientific committees and departments of the Polish Academy of Sciences and also at the level of the research organizations in charge. Co-ordination in the setting up of plans in the higher education institutions belonging to the Ministry of Higher Education has certain specific features.

Higher education institutions, bearing in mind the potential in scientific personnel at their disposal and the interests of science, participate in the realizations of almost all branches included in the plan. A particularly large part of the staff of higher education institutions is observed in the field of physics, electronics, chemical catalysis, chemistry and physical chemistry of polymers, agrarian science and economics.

Chairs in higher education institutions, on the basis of the general direction taken by the development of science and by different scientific workers interested in scientific research, taking into account moreover material possibilities (particularly the provision of scientific research apparatus), establish their preliminary research programmes and include them in the project for the plan.

The preliminary plan project for professorships is then discussed at a special scientific meeting, after which the titular professor transmits the plan to the Dean of the faculty, informing him at the same time of the financial requirements in this connexion.

The plan projects of all chairs in a given faculty are examined at a meeting of the faculty council where discussion is pursued along the lines of the practicability of the aims set out and the possibilities of obtaining the necessary material means.

Before transmitting the research plans of each teaching establishment to the Ministry of Higher Education Institutions, the plan is discussed by the Senate which expresses its opinion.

The appropriate organizational departments of the Ministry of Higher Education Institutions, after receiving all the plans, prepare a preliminary, amalgamated project for the plan for the department, following the system in operation, in agreement with the scientific disciplines and specializations which at this stage base their conclusions on the data given by the appropriate groups and the different professorships.

The next stage of work in preparing the plan and its co-ordination takes place at the general meetings and discussions of representatives of professorships in so-called homonymous disciplines. These meetings are organized by delegates of the minister to the scientific committees of the Polish Academy of Sciences corresponding to the disciplines they represent. They also represent the interests of the ministry.

During these meetings, the propositions presented in the different plans of the professorships are discussed in detail, the limits of the proposed research are examined and methods are established for collaboration between professors holding chairs in closely-related disciplines. This is also the occasion for selecting the proposed subjects of research, the elimination of proposals the utility of which has not been clearly proved rational or which, for lack of personnel or material means, it seems impossible to put into effect and also particularly when there is likelihood of overlapping.

As a result of this group work, an amalgamated departmental plan for scientific research work is prepared for the different disciplines and specializations.

On the basis of these plans, the Ministry of Higher Education Institutions presents the departmental general R Plan which takes into account all disciplines and specializations.

These plans are then discussed in the appropriate sections of the Main Council and are adopted by the Ministry of Higher Education Institutions. The general departmental R Plan, once adopted by the ministry, is published and distributed to all interested professorships and also, for information, to certain economic establishments and departments.

In the course of the plan's execution, further co-ordination occurs by way of discussion at meetings organized periodically between chairs of the same discipline, interested in the given problems.

The NT, S and R Plans compose a single amalgamated plan for the scientific research of the Ministry of Higher Education.

E. THE FINANCING OF SCIENTIFIC RESEARCH

The importance of science in the country and its achievements are accorded an honoured position in the activities of the government.

In the absolute figures for 1960, expenditure on scientific research amounted to 3.6 billion zlotys, in 1964 to 5.6 billion; in 1965, already more than 6 billion zlotys were allotted and the plan for 1970 provides for about 10 billion zlotys, that is to say that there is an increase rate of 11% per year for the last five-year plan and about 14% for the coming five-year plan. In the sharing out of the national income, expenditure on scientific research represents 1.2% and an increase to 1.5% is planned for 1970. The figures for the increase of expenditure on scientific research are considerably higher than for the increase in industrial production and the national income; thus, during the years 1960-1964 alone, the increase rate of national income shows a rise of 26.1%, the increase rate of the cost of industrial production is 37.8%, the increase rate of expenditure on scientific research rose to 54.5%, whereas the growth rate of per capita expenditure rose to 46.1%. During this period, the number of employees in scientific establishments rose by 23% and that of independent scientific workers by 33%.

In Poland, scientific research work is financed either directly from the budget or from a fund for technical progress or from the working capital of state enterprise.

The budget finances the Polish Academy of Sciences and its institutions and scientific establishments, non-industrial institutes, scientific libraries, grants to scientific societies, grants for research in higher education institutions, etc. Industrial institutes and laboratories are financed for the most part from the fund for technical and economic advancement following contract agreements for research and also from working capital of state enterprises.

It should be remembered that scientific research is also conducted in the so-called auxiliary exploitations attached to higher education institutions and certain institutes of the Polish Academy of Sciences. These groups are formed temporarily or on a permanent basis, in so far as teaching establishments or scientific institutions of the Polish Academy of Sciences have at their disposal a free unemployed scientific potential. With a view to closer links between science and the economic life of the country, higher education institutions and establishments of the Academy may take contracts for scientific research, and these services which are profitable to industry are paid for by the contracting department, according to an agreement.

F. CONCLUSIONS

In industrialized countries, between 1 to 4% of the national income is devoted to research, the most valuable human scientific potential. In view of this, research has been placed under the control of the government and society, who expect scientific establishments to act in such a way that the results of their work be effective and are possible to estimate. This is a very complex affair. A new scientific discipline has appeared on the scene - science management (the study of science) or the science of science, which studies and analyses everything affecting the development of science and the efficiency of its activities, and consequently the methods employed in scientific work, methods determining the orientation of research, analysing also scientific potential, cadres, establishments, bases, etc., and the dynamics of their development. It is a discipline which, in consequence of factors influencing the development of science, must propose directives with a view to assisting those occupied in and directing science whose activities are ever more successful and efficient. To undertake such work in the Polish Academy of Sciences, a Commission for the Study of Science has been organized under the Presidium, whereas in the Institute of the History of Technology and Science, a department has been set up. Between 1964 and 1966, two symposia were organized in Poland on the problems of the efficiency of research and the way to evaluate it, the first being a national symposium, the second international, in the framework of countries of the socialist camp. The Commission for the Study of Science publishes a specialized revue on these problems called "Problems of the Study of Science".

Science and its achievements know no frontiers and therefore, in order to make evaluations and comparisons, it is necessary to find a common ground of comparison, a general direction and a common language comprehensible in all countries in the sphere of scientific policy. There must be an exchange of experiments, achievements and doubts.

All these needs have been brilliantly expressed in his speech, by the representative of the Director-General of Unesco, Professor Matveyev, when speaking of the programme of the meeting. Therefore, in concluding my report, may I express gratitude to Unesco for having taken an initiative in this field so valuable and important to science and society.

IX. Union of Soviet Socialist Republics

(Statement presented by Mr. N.I. Tyshkevich)

Mr. Chairman, ladies and gentlemen,
National science policy developed in the USSR in step with the development of the country and the building of the new society. National science policy, at every stage in its progress, has formed a vital and organic part of the State's general policies.

Constant attention has been given to working out the basic lines of this development in such a way as to ensure that the tasks facing the country are carried out with all possible success.

In determining the national policy for the development of science and technology, efforts have been primarily centred on fulfilling the following requirements:

- integrated development of the material and technological basis of science; specialization of scientific institutions;
- co-ordination of the activity of scientists, designers and works specialists;
- creation of an effective State scientific and technical information service as an essential prerequisite and absolute conditions for the successful conduct of scientific research;
- guaranteeing of priority development for science;
- determination of the priority aspects of science and technology, and rating of all potentialities with a primary view to all-round development;
- unity of planning in respect of national economic and scientific development and of the elements contributing thereto;
- democratization of the administration of science;
- provision for active participation by all nationalities living in the country in the development of science and technology;
- strengthening of scientific and experimental subdivisions in higher educational establishments.

Let us examine briefly the various aspects of this question.

The basic postulate for determining measures for economic and scientific development in our country is that priority must be given to developing planning and design in respect of production.

Hence the task of scientific research is to determine all the subsequent stages and to provide far-sighted solutions.

This is the governing principle in deciding on national science policy in our country.

We attach exceptional importance to laying down the lines of scientific development. The general task - building a new, Communist society - is our starting point in this work, and for each specific historical stage is given concrete form, in respect of science policy, through discussion at various levels in institutes, ministries, in the Academy of Sciences and at government level, with specialists taking a prominent part. The main lines of scientific and technological development are worked out with the collaboration of scientists and specialists.

The general tasks for the first period of constructing a Communist society in our country are set forth in the Party Programme and cover scientific development for a period of 15 to 20 years.

In line with the general task presented to the Soviet people, the basic trend in science is the development of theoretical research in mathematics, physics, chemistry and biology as an essential condition for progress and greater efficiency in the technological, medical, agricultural and other branches of science. The effort in this connexion will be primarily focused on such decisive fields of technical progress as the electrification of the country, the all-round mechanization and automation of production, transport and communications, extensive use of chemicals in the leading branches of the economy, and utilization of atomic energy for production.

The Supreme Party and State organs lay down these basic lines of scientific development for shorter periods of time also - five years usually. For example, the lines of development for 1966 to 1970 are defined in the directives for drawing up the five-year plan.

State planning, coupled with action by a specially appointed State Committee for Science and Technology attached to the USSR Council of Ministers, ensures that the main development tasks are successfully carried out. The Committee's structure provides for collaboration between scientists, specialists and State administrative staff concerned with science development questions by:

1. Large-scale involvement of scientists in the work of the Committee (the Committee has 45 members, 30 of whom are leading scientists in various fields);
2. the establishment of a network of scientific councils, with sections and commissions, in which several thousand scientists participate on a voluntary basis;
3. direct participation by leading scientists as elements in the Committee's operational machinery. The scientific council's independence of ministries, the participation in them of scientists with special qualifications of various kinds, and the line followed in their work ensure maximum objectivity in their evaluation of the main scientific trends.

The planning arrangements are as follows:

The State Committee for Science and Technology and the Academy of Sciences, with the help of the councils, ministries and departments and on the basis of their suggestions, determine the main lines of development for science and technology; these are confirmed by the Council of Ministers on the State Committee's recommendation.

The State Planning Committee (Gosplan), in drawing up the national economic development plans, provides for measures covering these lines of development, including capital investment plans, plans for scientific research right up to the stage of mass production, plans for introducing new techniques and discarding obsolete ones, and also a plan for training key personnel.

For the period 1966-1970, the main aspects of the national scientific and technological development policy will be: fullest utilization of the achievements of research; development of social production in general; increased efficiency of social production and increased labour productivity; measures for further advances in industry and for high and stable rates of development in agriculture so as to produce a susbtantial rise in general living standards and ensure fuller satisfaction of the material and cultural requirements of the Soviet people as a whole. In accordance with the above, the basic task of scientific development in this period will be positive action to promote an increase of the rates of growth of productivity in all branches of the economy, to make work easier and to shorten working hours and to raise the standard of living of the Soviet people.

The directives of the 23rd Congress of the Communist Party of the Soviet Union on the five-year plan for the development of the economy of the USSR for 1966-1970 call for provision to be made for the following:

- development of research in theoretical and applied mathematics so as to ensure the extensive use of mathematical methods in various branches of science and technology;
- development of research in nuclear physics and solid-state physics with a view to the extensive utilization of nuclear physics methods in various branches of science and technology, further study of the problem of controlled thermonuclear synthesis, the construction of new radio-electronics and automation equipment, the creation of new construction and other materials;
- further study of outer space and utilization of the results obtained to improve radio communications, radio navigation and television and the meteorological services and to fulfil other practical aims;

further scientific work on the study of the earth's crust and of the laws governing the distribution of useful mineral deposits so that better use can be made of natural resources;

formulation and implementation of measures to increase protection of natural resources so that more efficient use can be made of the country's land, forests, reservoirs, rivers, wild life, fish and other natural riches;

development of chemical research with a view to devising new and economically advantageous chemical processes and obtaining effective substances and materials;

further study of the processes taking place in living matter, of the laws of genetics and of the selective breeding of plants and animals with a view to creating new and productive strains of livestock and prolific strains of crops; research into problems of hereditary diseases;

further development of scientific research in medicine, study of human physiology and pathology with a view to the prevention and treatment of malignant growths and cardio-vascular, virus and other diseases;

further development of the social sciences: in the field of economics, attention to be concentrated on further elaboration of the theory of planned direction of the national economy on the basis of the thorough study and application of the economic laws of socialism, and on determining ways and means for increasing the efficiency of social production and applying economic stimuli in developing production.

The plan directives also envisage measures for substantially improving the efficiency of scientific research and more rapidly applying to production research results. To that end, measures are to be devised to ensure the concentration of research workers' effort and material resources on solving the main problems of science and technology likely to yield the maximum economic effect; to improve experimental production facilities in research institutions, higher educational establishments and planning and design organizations and undertakings and provide them with the most up-to-date scientific and laboratory equipment; and to strengthen the rôle of higher educational establishments in research work. It is planned to apply more widely the system of financial autonomy for scientific institutions. This approach to planning makes it possible to concentrate substantial resources on research into the main scientific and technological problems, whether of a general nature or affecting one or more branches, and also on the most important lines of theoretical and exploratory research. The proportion of the total budget for scientific research spent on these aims increased from 56% in 1963 to 72% in 1965. The plan for 1966 provides for a figure of approximately 80% for research on the main scientific, technological and theoretical problems, including an increase of 12% for research on exploratory projects. The State Committee for Science and Technology has at its disposal a reserve fund amounting to 2% of the allocations under the plan in order to cover research, the need for which became apparent after the plan had been drawn up.

In their five-year and one-year economic development plans, the State Planning Committee, the ministries and departments and the councils of ministers of the Union Republics envisage specific measures for developing highly-efficient machinery, equipment, technological processes, new materials, integrated mechanization and automation, and employing them in the production process. In the research establishments, the research themes assigned to them are dealt with in accordance with a standard plan which covers the work to be carried out at every stage from laboratory research to incorporation in production. Thanks to this method, the work can be organized on the basis of a creative collaboration by scientists, technologists, planners, designers and factory staffs, thereby permitting a considerable reduction in the time spent on research and the more rapid general application of research results.

In order to implement the planned programme for scientific and technological development, the USSR is spending even larger sums on scientific research and capital construction (laboratories and experimental centres). For example, expenditure under this head has risen from 3,300 million roubles in 1959 to 7,700 million roubles (under the plan) in 1966, i.e. an increase of 2.3 times. These figures include an increase from 2,800 million roubles to 6,500 million roubles for research and from 500 million roubles to 1,200 million roubles for the construction of scientific installations. The average annual increase in expenditure on science over this period was about 15%. The above figures do not include research spendings by laboratories and design offices at works, factories and building sites, the cost of which is included in their production costs, nor does it include expenditure on the construction of experimental plants and workshops financed from capital investments by enterprises and building sites for developing production. The ever-growing complexity of scientific experiments has necessitated not only an absolute growth in budgetary appropriations for buying equipment, instruments and apparatus, but also an increase in their share of the total expenditure on science. The latter has increased from 5.5% in 1959 to 15.1% in 1966 (under the plan).

It should also be pointed out that the figures for expenditure for the purchase of equipment, instruments and apparatus do not include expenditure for the purchase of materials or of the equipment, instruments and apparatus used by scientific establishments to make up sets of items or parts for making experimental models or prototypes of machines, or for fitting out laboratory test benches.

Particular attention is paid to the training of scientific personnel. In 1964, there were over 611,000 scientific workers and teachers in the USSR, including over 13,000 with Doctor's degrees and about 124,000 with Candidate of Science degrees, working on problems of science and the training of personnel for the national economy. In the last 25 years, the number of scientific workers in scientific establishments (excluding higher educational establishments) increased more than thirteen-fold, from 26,000 to 356,000. There has been a considerable increase in the number of scientific establishments in the Union Republics, where Republican Academies of Sciences and independent scientific schools have been set up and science has made rapid strides during the years of Soviet rule.

An important feature of national scientific technological development policy has been the steady impact of that development on the national economy, resulting in a rise in the living standards of the population.

Thanks to the policy pursued, it has been possible to overcome economic backwardness; to transform the USSR into a developed industrial country; to make better use of the country's resources; to achieve high rates of development (3% in 1917, 26% in 1957) and to increase national prosperity (between 1913 and 1959, the country's national income increased by 16 times).

Science, and the national policy pursued for developing science and technology, have been vital factors in achieving those successes.

Such has been our experience; it may be of use to others, and we are quite ready to share it.

In conclusion, I should like to stress the great importance of the present meeting. The conclusions emerging from our deliberations here on national science policy will enable each of our countries to achieve even better results, for the benefit of all the peoples of the world.

Thank you for your attention.

X. United Arab Republic

(Statement presented by Professor A. Riad Tourky)

A. GENERAL FEATURES

In the midst of the greatest scientific revolution the world has ever seen a large number of States have achieved independence and embarked on the adventure of freedom with all the responsibilities involved in the liberation of their peoples from their social and economic ills. The process of liberation entails among other political and social activities, the proper prospection and appraisal of natural resources. For science and technology to be integrated into the economy of the country, there must be a sound planning of research programmes, which have to be dovetailed with the pressing needs of the economic and social development programmes of the country. I do not need to emphasize the importance of drawing up a programme for training and recruiting scientific and technological manpower, because unless this is done and unless there is a regular flow of personnel from universities and higher institutions, making possible the selection of an élite of scientific workers to pursue research, no research activity can take place.

Progress in research can be achieved, but it should be remembered that the process itself has become increasingly complex, necessitating the collaboration of a differentiated hierarchy much more than was the case in the past, when research workers were isolated figures. A research community collaborating in harmony can only function if a proper scientific atmosphere and a proper scientific attitude are cultivated with great care.

In our country, scientific research is financed exclusively by the government. Privately-endowed laboratories such as exist in some Western States are practically non-existent. This being so, scientific research must obtain from national leaders and government departments the appreciation it deserves.

In the UAR, this appreciation and concern was expressed in our National Charter, which was presented to the National Congress in May 1962, and which lays down the lines of national activities in all fields.

Chapter 8 of the Charter states:

"The major economic and social problems confronting our people, at present, must be resolved on a scientific basis.

The scientific research centres are required at this stage to develop in such a way that science will serve society.

Science for society, therefore, should be the motto of the cultural revolution at the present stage. Achieving the objectives of the national struggle will enable us, at a further stage of our development, to make a positive contribution to the world in the domain of science for its own sake.

Science for society does not mean that the scientist must deal only with problems of everyday life; this would be a limited interpretation of the loaf of bread which we are seeking to obtain."

Since 1952, it was deemed necessary to establish bodies at the highest level for the elaboration of our national scientific policy, the co-ordination of our scientific activities and implementation of research programmes.

Prior to this, it was thought that, in a developing country like ours, with limited financial resources, it should not be necessary to carry out research work outside the universities and departmental laboratories. In other words, the government did not feel the need for concentrated efforts for solving our national problems.

It has on several occasions been pointed out that the developing countries do not have to be in the forefront of developing new science. What they need is much more the application of existing science to their problems. This was equivalent to saying that science should be kept at a certain adolescent level as compared with that in the more advanced scientific and technical institutions. Such restriction was detrimental to the cause of science. The solution of research problems in applied fields often necessitates initiative and scientific resourcefulness. Known procedures may prove to be ineffective in application, unless intelligently modified.

The unity of science as advocated by von Humboldt more than 100 years ago requires that teaching in the universities be combined with research. In many advanced countries, research carried out in the universities stands at the centre of the country's research activities; but as is well known, the dominant feature of most scientific research carried out in the universities is the pursuit of knowledge, not necessarily with reference to practical application or utility. In other words, although science in the universities is the ultimate foundation on which all scientific efforts rest, it is difficult to direct from above and orient all research activities carried out there. Fields of research may be opened up and research projects may come forward which, although of importance to the national economy, may not appear to be of immediate interest to the universities from the standpoint of their relation to the curricula.

In a faculty of science or engineering, there can only be one or two chairs for chemical technology, in spite of the very ample domain which this subject embraces. Consequently, research problems in matters pertaining to such fields as glass, ceramics, textiles, leather, high polymers and so forth cannot all be exhaustively covered.

But even if all the research and development programmes could in theory be fitted into the university organization, the combination of the two responsibilities, teaching and research, will become too heavy a charge. In the ideal case and in very round terms, about half of the time of the academic staff and half of the expenditure should be devoted to research. In developing countries the balance between teaching and research activities can be maintained if the teaching staff capable of pursuing research activities grows in proportion to the increase in the number of the students enrolled which is mostly not usually the case. The balance is upset in the direction of increasing the teaching duties of the academic staff, which results in an atrophy of their research work. Under all circumstances partnership between universities and other research organizations was thought to be encouraged by, for example, establishing research units within, or in association with, the universities as an alternative to the creation or expansion of separate institutes. It was also considered of vital importance to the research institutes that they should benefit from the fresh young minds of members of the teaching staff who had not appropriate research facilities by giving them access to the research laboratories, thus enabling them to carry out research and train assistant research workers.

Differences in functions also exist between research carried out in government departments (ministries) and in organizations concerned solely with research. In the case of the government departments, the research policy is mainly determined by the administrative acts of the government. The main occupation of such departments is administering the law in its various forms. A Ministry of Agriculture for example, has a responsibility for enforcing laws and regulations relating to the control of diseases and pests, of inspecting the activities of farmers and advising and assisting the government in matters relating to agricultural production and development. In general, these activities are the chief responsibility of such departments, and it is for this reason that they find it difficult to be adequate research agencies as well. Their research activities are constantly interfered with by the immediate and, for the moment, more important administrative responsibilities.

In developing countries with a scientific and technical infrastructure consisting of research establishments in government departments, care should be exercised in drawing these together into the body of the new central organization as the unification of such a heterogeneous system with its different levels would only hamper the organizational mechanism and hinder the formation of a harmonious scientific community united by professional bonds.

I assume that these principles apply to many of the developing States, irrespective of the fact that the system of organization itself may vary from one State to another because they have to be adapted to the political, economic and social conditions peculiar to each. But though the systems may vary, the objectives are basically the same. At its first meeting held in Algiers in February 1964, the Scientific, Technical and Research Commission of the Organization of African Unity (OAU) adopted a resolution on this subject containing recommendations to its member states. It recommended that "each member state establish a national organization, as soon as possible, to define its science policy and to co-ordinate the country's scientific activities". The organization may take such form as a National Academy of Sciences or a National Research Council.

B. ORGANIZATION OF SCIENTIFIC AND TECHNICAL RESEARCH

In our country, outside the universities and ministerial laboratories, the pillars upon which the structure of scientific research rests are as follows:

First: Large laboratories, well staffed, equipped, financed and designed to tackle problems requiring the co-operation of various disciplines.

Second: Specialized research institutes designed to cater for the immediate practical needs of large sectors of agriculture, industry, etc.

Third: A top council whose function is to plan and co-ordinate research work carried out in the country.

Fourth: An organization for scientific and technical documentation.

(1) The first type of establishment just quoted is represented by the National Research Centre started in the autumn of 1955 as a multipurpose laboratory for oriented basic and applied research. It was designed to comprise four departments: physics and engineering physics, chemistry and chemical technology, biology and agricultural sciences and medical sciences.

These four departments consisted of 24 divisions which were in turn divided into 122 laboratory units, of which about 80 are now operating. The success of the centre during the first two years of its existence surpassed all our expectations and led, in 1964, to its reorganization. A fifth department for earth sciences was added, the number of divisions was increased to 47, and the number of units to 152.

A compact complex such as the NRC in Cairo has proved to be quite well suited to a developing country with limited financial resources. It provides a ready solution to problems requiring the combined efforts of specialists in different disciplines. The partnership between different research departments compensates for the expensiveness of certain types of devices needed by the modern research worker. Furthermore, such equipment may not be fully utilized if assigned exclusively to a single department. The very price of an expensive device would tend to orient research in one direction if it is serving a single laboratory, thus impairing flexibility in the choice of research programmes. Lastly, we scarcely need to emphasize the necessity of putting the right machine in the right place for proper maintenance and long-lasting performance. Thus, a physical device such as an emission spectrograph, although occasionally needed by a soil chemist, is better maintained by the physicist.

(2) The second of the four pillars is represented by the specialized research institutes. Each of them directly serves a main sector of production. In the UAR, the specialized institutes serving industry are: the National Physical Laboratory for Testing and Standardization, the Metallurgical Research Institute, the Petroleum Research Institute, the Textile Research Institute, the Building Research Institute, the Ceramics and Refractories Research Institute, the Electronics Research Institute, the Transportation Research Institute and the Mechanical Engineering Research Institute. Those serving agriculture are: the Crop Research Institute and the Animal Research Institute. Those serving public health are the Medical Research Institute, the Bilharziasis Institute and the Ophthalmic Institute; in addition, there are certain research institutes which, because of their specific nature, have to be autonomous. These are the observatories, the Institute of Oceanography and Fisheries and the Desert Institute. Some of these institutes are already functioning, while others are still in the embryonic stage.

In principle, the number of specialized institutes may be considerable. In making a choice we began with institutes which serve production sectors involving considerable investments and proceeded gradually to smaller sectors.

It may be expected that traditional industries, such as textiles, paper, leather and ceramics, will be slow in accepting the innovations emanating from such laboratories. This should not discourage the research worker, as in the long run his achievements will find their way into production. Other industries, such as pharmaceutics and electronics, will take readily to the innovations, since their very existence depends on their keeping up with the pace of scientific progress.

In all events, intimate links should be maintained between the research institute and the production units. The research worker should become acquainted with the difficulties confronting production as they arise. Mutatis mutandis, the producer should be constantly informed of the results arrived at by the research worker. To achieve this link, we have proposed that specialists from the production units should participate in the planning of research programmes and that research workers be represented in the committees planning production projects. In addition, representatives of the research laboratories should have access to the production units as guest research workers, and vice-versa. Courses for trainees from the production units are organized in the laboratories.

In planning for the research units, whether they belong to the Multipurpose Laboratory or the Specialized Institute, it was essential to have a clear idea of the requirements in manpower and facilities. Experience has shown that for the sake of efficiency, each research unit should have on an average three research workers of a Ph.D level who will normally cover the various specializations required. To each of these two to four graduates may be assigned as assistants and trainees. If the research units are properly selected, specialization and training of personnel can be planned for several years ahead. In many cases, young graduates are sent abroad to obtain their Ph.D. However, we found in the long run that it was best to rely on our own resources. True, it sometimes appeared necessary to send a graduate abroad for special studies, particularly in applied fields. Nevertheless, we are now convinced that it is preferable for a graduate in the first instance to take his doctorate at home in a basic science related to the field of applied science. Thereupon, he should be encouraged to pursue his studies in the applied field for one or two years abroad. This ensures that young graduates achieve a better understanding of the national needs, and since they are by then sufficiently mature, will not hesitate to return to their home countries to serve their people.

One of the first requirements for research work is suitable accommodation. If the number of units and consequently the number of staff, is clearly defined, the space required can be calculated. It has been found on an average that each research worker requires an area of about 250 square feet, half of which is actual laboratory area.

In planning for about 400 new units in the National Research Centre and the specialized institutes, it was estimated that over the next six years, an additional 1,200 research workers, of a Ph.D. level, assisted by about 3,500 assistant research workers, recruited from graduates of different faculties, would be required. An additional laboratory area of 1,200,000 square feet will also be required.

About two-thirds of the assistant research workers will be upgraded after they have obtained their Ph.D. locally, i.e. by the process of self-development.

The granting of degrees falls naturally within the competence of the universities. Experience has shown that an assistant research worker, directed to incorporate his research work, whether pure or applied, in a thesis for his M.Sc., followed by a thesis for his Ph.D., will pursue his research with zeal and enthusiasm. Presentation of the work in a compact and orderly form is a guarantee that the problem has been treated in a methodical way. Evaluation and criticism by an external authority is also likely to shape and polish the young research worker.

The other 400 research workers required will have to be trained outside the country after they have obtained their M.Sc. locally.

(3) We have so far considered the two first pillars of scientific research, namely the multipurpose laboratory and the specialized institutes. Third on the list comes the top council, whose function is to plan and co-ordinate research carried on in the country and define science policy. This task is assigned to the Supreme Council for Scientific Research which replaced the Ministry of Scientific Research. In our experience, a body which is designed to co-ordinate research work amongst a number of ministries should not itself be a ministry. The reasons are obvious.

To this Council are affiliated the National Research Centre and all the specialized research institutes referred to above. It is directly responsible to the Prime Minister. Its President has the rank of minister, and its members include a number of outstanding scientists as well as ex officio members.

These are the Under-Secretaries of State of a number of ministries, the Vice-Rectors of the universities responsible for advanced studies and research and the Director-General of the Atomic Energy Establishment.

The terms of reference of this Council may be summarized as follows:

1. Preparation of a research programme based on the national development plan to help finance this programme and follow up the results.
2. Awarding grants-in-aid to research workers outside its own research establishments.
3. Granting State Prizes to leading scientists.
4. The publication of scientific journals.
5. The organization of scientific conferences, seminars and training courses for scientists and technicians.
6. Development of scientific relations between the UAR and international agencies and other countries.

In exercising its first function, the Council, with the help of a large team of scientists from the universities and all research laboratories, has identified 15 research projects which were given priority, with the object of concentrating all efforts on these problems. For each project, a committee was formed to define its scientific content and formulate a number of research problems. The committee proposed the most suitable institutions for dealing with these problems and designated the scientists most capable of supervising the work.

It may be as well to give some information concerning one of these projects. This is concerned with the after-effects of the High Dam. The scientific content of the project was carefully analysed into its elements and subdivided into four main sections:

Section 1: is concerned with the conservancy of the big lake and includes studies on seepage from the lake, evaporation from its surface, possible growth of harmful plants and weeds, health conditions around the lake, water storage, measures for quick disposal of water under emergency conditions and the hydrobiology of the lake.

Section 2: deals with the economic future of the Nubian province lying within our frontiers and includes studies on fisheries, agriculture on the shores of the lake and navigation on the lake.

Section 3: is concerned with studies on the area north of the dam and includes degradation of the river bank, new designs for canal inlets, ground water level within the Nile valley and the delta, future drainage, erosion of coastal regions, river navigation, etc.

Section 4: deals with the effects on agriculture of the depletion of the Nile silt, the reclamation of sandy soil, the manufacture of bricks and on the chemical characteristics of the water.

Practically all laboratories in the country will participate in work on this project, each problem being allocated to the one most competent to deal with it.

(4) The fourth and last constituent of the edifice of scientific research is an efficient scientific and technical documentation service, whose responsibility it is to collect and place at the disposal of the research workers all documents required for their work, whether published at home or abroad. We have a Scientific Documentation Centre, which has its headquarters at the National Research Centre. I would like to take this opportunity of mentioning that this centre was developed with help from Unesco a number of years ago.

C. THE SCIENTIFIC MANPOWER

So far I have said little about the universities and the higher institutes at university level. In this connexion, I would like here to give a few figures. The total number of students enrolled in the UAR universities for the academic year 1965-1966 is: 123,876. The total number enrolled for postgraduate studies is: 18,870. The total number of students attending higher institutes at university level is about 60,000.

In the National Research Centre we find about 1,300 full-time research workers. In the specialized research institutes there is about the same number.

D. OTHER MINISTRIES PERFORMING SCIENTIFIC AND TECHNICAL RESEARCH

Our brief résumé of the scientific community and scientific activities in the UAR will not be complete without mention of some technical ministries, such as the Ministries of Agriculture, Public Health and Irrigation.

The bulk of the work done in these ministries is applied research of a short-term nature, aimed at finding solutions to immediate problems. The following are examples of the research activities of some ministries.

The Ministry of Agriculture is concerned with:
pest control, especially cotton pests,
the cultivation of new varieties of long fibre cotton,
the prevention of corn rust,
soil mapping,
land reclamation and combating the desert.

The Ministry of Public Health is dealing with:
the prevention and cure of endemic diseases, a number of which have completely disappeared from the country,
nutrition.

The Ministry of Irrigation's activities cover:
regulation of irrigation and drainage,
land reclamation,
extensive canalling system.

The Ministry of Industry is concerned with:
geological surveys and mapping,
prospecting for oil and mineral resources,
standardization at factory level.

In conclusion, I would like to say that most of the participants have spoken here about their Academies and their rôle in science planning. In the UAR the possibility of setting up a National Academy of Sciences is under review. It is expected, of course, that some of the functions of the Supreme Council for Scientific Research will be transferred to the Academy.

As a participant from one of the developing countries I wish to conclude by saying how grateful we are to Unesco for holding this meeting which has, for many of us, thrown light on many of the questions related to science policy.

XI. United States of America

(Statement presented by Dr. Ch. V. Kidd)

A. INTRODUCTION

It is a real privilege to present an outline of the science policies of the United States. My presentation will deal neither with statistics nor with description of our governmental structure. Instead, I will attempt to outline some of the fundamental social, cultural and political factors which influence our national policies for science and technology. This is obviously impossible to do in any detail, but our subsequent discussions may be more fruitful if I can convey some of the underlying forces which influence all of our specific actions and our machinery of government. As is true in all countries, the subject is subtle, complicated and elusive - so much so that few of my countrymen would agree in full with any analysis of the matter. Nevertheless, the effort must be made because we all know that formal descriptions of organization and statistical measures are only a part of reality. These descriptions can be misleading if the underlying factors are not understood.

The influences of national traits, customs, and general political and economic forces on science and technology are difficult to understand internally and even more difficult to explain to those from other countries. In this connexion, one aspect of the American system that deserves special mention is what is often called its "pluralistic" character. By this is meant such things as provision for funds for science from many governmental sources, from many private sources independent of government, multiple points of independent decision in government and outside of government.

B. FACTORS INFLUENCING NATIONAL POLICIES FOR SCIENCE AND TECHNOLOGY

(1) Involvement of scientists

A central element of the total set of science policies in the United States is the widespread involvement of non-governmental scientists - primarily from universities - in governmental decisions relating to science. This involvement is of two kinds. The first is the maintenance of a voice for science which is independent of government, and the second is the widespread use of non-governmental scientists as advisers to government.

Provision of an independent voice for science is based on the conviction that scientists as scientists have values and views on science which they should be able to express no matter what relation these views may have to the current policies and actions of other elements of society - including government. The reason for valuing this independence of expression on scientific matters arises in large part from a continuing tradition of basic mistrust of the power of government, and to a continuing effort to sustain counter forces and to subject government to criticism from the outside.

The National Academy of Sciences serves nationally as the most significant single voice of science at the national level. This Academy is independent of government. It selects its own members and speaks with its own voice. It operates no laboratories, but has a century of experience in advising the executive branch of government. A most significant current development is the extension of this advisory rôle to the Congress, as contrasted with the executive branch of government.

The second, and in total more significant, aspect of the involvement of scientists with science policy is widespread service on groups advisory to the agencies of government and to the President. This system had its origins in World War II, when scientists were heavily involved with service to the government. A high proportion of the nation's scientists - particularly those associated with universities - served in a variety of ways, ranging from work in laboratories to participation in policy decisions of great significance. After the war, the scientists returned to their university work, but the tradition of involvement with government survived. Now, every agency of government with a significant scientific activity depends heavily upon the advice of non-governmental scientists, and in large agencies the advisory structure is elaborate.

Scientific advisory groups serve many formal and informal functions. They make judgements on the merit of research proposals put forward by scientists, and one of the useful by-products of the project form of support has been to involve large numbers of university scientists in making about 40,000 decisions each year on the support of research projects. They also advise on basic policy issues confronting agencies. The advisory apparatus transcends the individual agencies, since the President's Science Advisory Committee advises him on any matters relating to science or technology which it considers important, or on any matter which the President requests. The informal functions of scientific advisory groups are in many respects as significant as their formal functions. For example, they are a significant means of strengthening scientific communication. Another very important informal function is provision of a bridge between universities, academic science and the government. Finally, the groups tend to be advocates of the federal programmes to which they provide advice.

This advisory system is not without its problems and defects, but on balance it is an important and constructive system. Extensive use of the part-time scientific adviser by government on both technical and policy issues is by now a settled policy in the United States.

(2) Involvement of universities

A major continuing thread of US science policy has been a deliberate effort to link basic research and graduate study, and to centre this joint effort in universities. We are convinced that graduate study in science and engineering can be of high quality only if it takes place in an environment where research of high quality is carried on with the help of modern equipment, adequate space, adequate supplies and adequate technical assistance. This is the primary reason why the United States has consistently stressed support of research in universities. Currently, about $1.4 billion is supplied by the Federal Government for research in universities.

To a greater degree than is true in many countries, university faculty members are engaged in specific research projects financed by various departments and agencies - that is ministries - of government. Indeed, this support for specific investigations of interest to the federal departments and agencies has been until recently the most important way in which national funds in the United States have flowed to universities. In contrast with many nations, the central government in the United States has provided relatively small amounts for the general operating expenses of universities. Such general funds have come primarily from State governments and from private sources.

In retrospect, it is clear that the universities had to be quite flexible and willing to accept the principle that service to government is a legitimate rôle for universities in order to make the involvement with the Federal Government acceptable and productive. In addition, the universities' system had to be composed of institutions with widely differing characteristics because the needs of federal agencies are so varied that universities with set patterns of organization and curricula could not have participated extensively in federally financed research. Fortunately, the universities did possess the needed characteristics.

A prominent characteristic of the system of governmental support is the provision of funds from the Federal Government specifically for the research of the individual professor in the university for research initiated by him. The university must formally approve the application of the individual scientist, because numerous independent requests for funds could throw difficult burdens on the institution itself. The proposals of individual scientists are judged in national competition with proposals submitted by other scientists in the same field. Groups of scientists, selected largely from universities, advise the government on the quality of proposals and the competence of scientists. No regional, State or local governmental authorities participate in this process. This is the so-called project system, and it has many advantages. It establishes a national quality reference standard, frees individuals of dependence upon local judgements, permits non-governmental scientists to participate in the processes of government, and tends to link scientific effort to the needs of government. However, the project system leaves some important needs unfilled. It tends to frustrate the efforts of university authorities to establish coherent, balanced, long-range plans for the university. It tends to shift the loyalty of faculty members to the federal agency which supplies funds and away from the university.

On balance, however, the research project is the backbone of the federal system for support of research in universities. One of the most significant and widely discussed areas of science policy in the United States is precisely how this backbone - the research project - should be complemented to form the most effective total structure for federal support of science and science education in universities. In this connexion, an important general development, which is still continuing, is the elaboration of various means of broader institutional support.

(3) Involvement of Congress as well as the executive branch

The fact that the Government of the United States is a government of divided powers has profound effects upon the definition and execution of science policy. Important decisions relating to science are made in both the executive and in the legislative branches of government.

In the executive branch, a prominent element of governmental research policy in the United States has been to decentralize support research and to put the support in the context of the missions of the various operating parts of government - the Department of Health, Education and Welfare, the Department of Defence, the Department of Agriculture, the Atomic Energy Commission, the Department of Commerce, the National Aeronautics and Space Administration, and so on. Decisions with respect to R & D have been to a large degree secondary decisions. The primary decisions have been those related to major national goals and problems - public welfare, public health, defence, resource development, and so forth. Only the National Science Foundation, which is a governmental organization, has as its major goal the support of science and science training as such.

Both the decentralized nature of the system and the linkage of research to the missions of the federal agencies are conscious policies. There is a strong continuing conviction that research and development will prosper best, and be most productive over the long run, if the effort is linked basically to social goals and if a large centralized research and development effort is avoided. We have a wary and cautious approach to central governmental planning, and prefer to disperse the power to plan and decide.

While these are the prime characteristics of the system, there are other significant elements. The decentralization requires a countervailing national objective, as contrasted with those of the individual agencies. As an example, the system is not well designed to deal with universities as a national resource. Such objectives as the strengthening of promising universities, and the establishment of stronger universities in every section of the nation, are not best achieved through a system based fundamentally on the needs of separate parts of government. In addition, some difficulties are created because each agency has its own administrative rules and procedures. Such problems as these, which represent some costs of decentralization and policy autonomy, have forced attention to means of establishing effective general policies to complement those of the separate agencies. As a consequence, since World War II there has been a steady extension of the central mechanism for co-ordination and planning. The structure of the President's Office for dealing with central problems of science policy and operations is now stronger than at any time in the past. The essential linkage of federal research to basic national goals tends to exert a pressure towards applied research, and the National Science Foundation is the major means of counteracting this tendency.

To the policy functions of the executive branch must be added those of the legislative branch. The legislative branch of the government of the United States can and does at times basically alter the proposals of the executive branch through its authority to make laws and its control over appropriation of funds. Moreover, the legislative branch often takes the initiative in proposing major lines of policy and action relating to science and technology. Even in the United States, national science policy is often equated erroneously with governmental science policy and governmental science is often equated erroneously with the policies of the executive branch.

Congressional control over elements of science policy can be quite explicit. For example, if the policy of the executive branch had prevailed, the growth of the National Science Foundation would have been more rapid. Congress must appropriate funds, and in doing so frequently states conditions which have the force of law.

One of the most important forums for debate of science policy in the United States is the Congress, and in Congress the review of the budgets of the agencies by committees of Congress is the process which generates the most extensive debate. The agencies are required by Congress to put into the public record, in the form of printed committee hearings and reports, exhaustive, detailed information on their research plans and research budgets. In addition, the committee members generally question officials from the executive branch in detail, challenge their judgements, and change their plans.

One of the most significant aspects of science policy formulation, and one of the most powerful forces sustaining a dispersed structure, is the relationships between the various executive agencies and the committees with which they deal in Congress. On the one hand, officials in many important parts of the executive branch form strong alliances with the Congressional committees which deal with legislation and appropriations affecting their agencies. Sometimes they form partnerships which are powerful enough to overrule the wishes of the President. On the other hand, the Congressional committees are sometimes antagonistic to the proposals of the President. They may refuse to pass laws and to appropriate funds at the levels requested by the President. All in all, there is probably no more formidable difficulty in securing an optimum degree of coherence in science policy than this set of executive and congressional relationships.

(4) Science policy independent of government

Many detailed and broad decisions relating to research and development are made independently of government. Private industry, private foundations and universities are free to set their own policies. For example, the level of industrial research and development and the lines of investigation are set independently by each firm in most areas of industry. However, the research and development programme of many industries are heavily influenced and in some cases determined by federal contracts. The nature of the governmental influence can be roughly assessed by the fact that of the total of \$12.7 billion spent by industry for research and development, in 1963, \$7.3 billion was provided by government. The private foundations make their own decisions as to whether they will support research, what they will support, who they will support, and the terms and conditions of support. Universities have the same freedom of choice, but on the whole they are influenced more by federal policies than are either private industry or private foundations. About 30% of all funds for research and development come from private sources - 25% from private industry and 5% from private universities and foundations[1].

The relation between what is publicly financed and controlled and what is privately financed and controlled in the United States is becoming progressively more complex. Suffice it to say that the maintenance of wide areas over which decisions can be made independently of government is a prominent aspect of science policy in the United States.

(5) Education and career choices .

So far as allocation of manpower is concernod, we rely upon the free choice of the individual both for fields of study and for field of employment. The source of this policy is fundamentally our national assumption that the basic function of education is to help the individual develop his capacities to the utmost, and that anticipated needs and demands should play a secondary rôle. Secondarily, the policy rests on the linked assumptions that the future is unknowable in detail, and that skills are transferable over a wide range if education is basic and general rather than narrow and specialized. Our efforts have therefore been centred on expanding the quality of education and the numbers educated, as contrasted with concentrating on the division by field of study. Stated in other terms, we concentrate on the supply of scientists, rather than on attempts to assess future demands. The general assumption is that we will be capable of using, in some productive capacity, all of the scientists whom we can educate.

While there have been no efforts to allocate manpower in any detailed sense, choices have been influenced in various ways. For example, guidance of students has been made more effective in recent years by a marked improvement in the availability and quality of counselling for students completing their secondary

(1) NSF Review of Data on Science Resources, Col. 1, no. 4 (NSF-65-11), May 1965, p. 5.

education. Better choices of institutions and better choices of fields of study have resulted. Various studies of anticipated demand and supply have been undertaken, but efforts to predict demand by precise occupation have been notably unsuccessful. Such studies have served as educational devices, sources of information, and broad guides rather than as the source of general governmental decisions. Finally, financial assistance has been made available on a much wider scale to those who are studying the physical and biological sciences at advanced levels than to those studying the social sciences, arts and humanities. But in the face of these inducements, which have existed at least for the past ten years, the distribution of graduate students by field has remained almost constant.

As is the case with education, career choices are free. The availability of jobs is, of course, strongly influenced by governmental action. When we inaugurated a large space research programme, we did not direct people to enter that field. We made funds available for jobs. This, plus the challenge of the scientific and technical effort, plus the glamour of space, attracted people - largely engineers - from other kinds of work. We find that our labour force is quite mobile, and we encourage this mobility. In addition to occupational mobility, people are constantly shifting from one industry to another, and to and from production to research or administration. Finally, the scientific and engineering population is geographically mobile. A recent study of holders of Ph.D. degrees by the National Academy of Sciences showed that 40% of all Ph.D.'s in the sciences were awarded in the mid-west, but only 25% work there. Only 12% of the doctorates in science were awarded in the south but 24% of them work there.

(6) Heavy investment in communication

The United States places heavy dependence upon communication among working scientists. In addition to the usual professional journals, there exist informal communication networks set up by persons in highly specialized fields. Preprints, news letters, personal correspondence and progress reports all supplement the usual channels. Finally, personal contact among scientists is encouraged, primarily through making government funds available for travel of scientists to meetings, to small symposia, or to visit colleagues engaged in similar work. This no doubt involves some waste, but we think that the net result is to expand the productivity of science.

Stress on communication extends not only to communication among scientists, but also to communication upward - or downward - from the scientific community to the decision points in the bureaucracy. We try to keep the federal agencies promptly responsive to advances in science, and the scientific advisory system plays a central rôle in this connexion. A recent example of this adaptability was a shift in emphasis in research and planning for rain making in response to a finding that cloud seeding proved to be, on the basis of statistical analysis, more effective in producing rain than had been assumed earlier. The problem of scientific communication has not been solved in the United States. An important policy of the United States Government is the establishment of stronger sets of compatible systems for the storage retrieval of scientific and technical information. We are now undertaking to develop a national network which will tie together the major private and governmental sub-systems. This is a task requiring deliberate, large-scale, governmental planning.

(7) Allocation of research resources and application of science to production

Discussions of national science policy generally place great emphasis on two broad and related questions. These are the rationale and the procedures for allocating resources to various fields of research, and means of linking research to the processes of production and distribution so that science contributes to the elevation of standards of living.

However, in the United States these two questions have not in the past been central points in discussions of science policy. The reasons for this are somewhat complex, but the most important one is that solutions have been found for both of them. The solutions are no doubt imperfect, but they have been considered - rightly or wrongly - adequate enough to move the allocation and transfer questions from the centre of the stage.

First, with respect to allocation, a fundamental point of science policy in the United States has been to place responsibility for governmentally financed research in the various agencies of the Federal Government. The agency whose mission is the support of science as such is the National Science Foundation. The research and development activities of all agencies except the National Science Foundation are essentially one of the ways in which they carry out their broad tasks.

While the functions of the federal agencies are ultimately practical, virtually every agency of government supports basic research. In fact, less than 20% of the governmental funds for academic research is supplied by the National Science Foundation. The resources which each agency has for research depends heavily, although not entirely, upon the total budget of the agency. The total budget of agencies are a general reflection of national priorities and goals, which are determined politically. Accordingly, the broad allocation of federal funds for research is also determined politically.

Under this process, there is no fixed pool of money or resources for R & D which is then allocated to various fields and goals. An important consequence of this system has been a rapid expansion of research in virtually all fields, with relatively little attention to the rationality of the division among broad fields. Within each broad field of governmental activity - health, education, resource development, defence, agriculture, space, and so forth - the actual content of research is heavily influenced by scientific opinion from below as contrasted with goals and priorities set from above. In this process, great reliance is placed upon the judgements made in the scientific market place - that is, upon the interaction of a very large number of judgements made in the context of an informal network of scientists and engineers. A prime policy question in the United States, and one that will probably never be answered in any general way, is the proper division of effort between passivity - that is, empirical response to needs and opportunities - and planning that is, a deliberate response to social and political needs and opportunities defined in scientific terms.

The national willingness to see larger investments in research and development have in fact, although not by design, made a general expansion of resources for this entire area of activity a major national policy. Indeed, the increase has been so rapid and has reached such levels that greater attention is being paid to R & D priorities and to the allocation of resources for R & D. There is now clear evidence that some areas of science have been relatively neglected - such as some fields of chemistry.

We are not completely sure why it is that innovation is a strong characteristic of some industries and a weak characteristic of others. The subject is very complicated and needs more study. However, it is clear that free enterprise competition and the opportunity to make money provide powerful built-in forces tending towards innovation. Thousands of highly intelligent, well-trained, active people have strong personal motives to search for new applications, new technologies, and new products. Continuing change in production and processing methods, and in products, is built into the system. The forces for change far outweigh the forces tending towards maintenance of the status quo over most areas of the economy.

No doubt the existence of very large scientific and developmental programmes - particularly in defence, space, and atomic energy - have provided an important technical source for new products, processes and techniques. They have also tended to generate in the private sector an active awareness of the most advanced areas of technology and sophisticated management methods. In addition, a large component of the scientific advances translatable into production technology has come from the laboratories of universities and private industry. But whatever the source of the scientific and technical advances, the translation of these potential uses into actual uses has depended on the nature of the private civilian system of management and the basic characteristics of the economic system.

However, technological innovation is not uniformly characteristic of all areas. For example, the building and transportation industries have not been characterized by rapid change. In addition, science and technology have not been brought to bear adequately until recently on some very urgent social problems centring around deterioration of man's environment. Air and water pollution, and deterioration of large urban areas are cases in point, but in the last five years, large and important steps have been taken to deal with these problems. However, they have deep roots, and the answers are not to be found through science and technology alone.

In short, the allocation question will predictably receive much greater attention in the United States, and the major unresolved problems in applying science and technology to the improvement of the condition of man in the United States lie not in the production and distribution of goods but in the improvement of man's environment for living.

C. CONCLUSION - EVOLUTION IN A PLURALISTIC SYSTEM

To conclude, the evolutionary nature of science policy changes in the United States deserves emphasis. There have been no sudden, far-reaching, dramatic changes in any essential aspect of policy although a number of significant single changes have been made. On the other hand, it is clear in retrospect that the cumulative effects of changes over two decades have produced very extensive changes. The generalizations apply to the scale of research, to substance of research, to the allocation of resources, and to organization for research.

With respect to scale, the steady expansion of virtually all kinds of research since World War II has produced a level of effort so far above levels of two decades ago that the size of the effort itself generates policy problems. This rate of growth was not anticipated, and hence not planned. Why this growth occurred is a subject in itself. In terms of organization, two developments have been particularly important. One was the adoption of a policy to support basic research through a special governmental organization - the National Science Foundation. The second has been the series of steps leading to a structure for dealing with questions of science and technology in the President's

Office. Here it should be stressed that a significant component of the science policy of the Federal Government is affected by the fact that there is a supraministerial organization for science and technology which is directly advisory to the President and, like the Bureau of the Budget and the Council of Economic Advisers, placed in the Executive Office of the President. The Special Assistant to the President for Science and Technology is the central figure in the Presidential organization for science policy. In terms of substance, the rapid expansion of research and development for space exploration have been particularly significant. In terms of objectives, the gradual adoption of the policy of expanding resources for research as well as utilizing existing human and material resources has been important. In terms of relationships, the deliberate large-scale involvement of universities in federally-financed research has been a post-World War II policy whose full consequences have not yet been worked out.

The evolutionary nature of science policy is strongly influenced by the pluralistic nature of the system. So many individuals and groups whose views do not coincide exercise some degree of power over decisions that small rather than large changes typify the system. And large changes typically follow a lengthy period of public debate.

In fact, if one theme had to be selected to typify the American process of policy formulation for science it would be pluralism. Running through virtually every aspect of the mechanisms and processes through which decisions related to science are reached is the influence of the fundamental idea that decisions are properly influenced by many independent voices. The structure of society and of government is designed to foster pluralism. Many other aspects of science policy are important, but they cannot be fully understood except in the light of the pluralistic nature of the entire system.

XII. Yugoslavia

(Statement presented by Mr. T. Martelanc)

A. GENERAL COMMENTS AND HISTORICAL BACKGROUND

The science policy and the organization of scientific research in Yugoslavia will be more fully explained and documented in a special, more comprehensive study, which is now being prepared for publication in the Unesco series "Science Policy Studies and Documents". For the present meeting of co-ordinators of science policy studies we would like to give just a brief exposé on this subject. Its aim will be to show some basic outlines of the development and the position of research in Yugoslavia, starting with some data concerning the historical development and the fundamental characteristics of the social and political system of present-day Yugoslavia. Considering the numerous outstandingly specific features of the development of Yugoslavia, such an outline of the historical and socio-political background seemed essential for a better understanding of the present-day position of scientific research and science policy in Yugoslavia.

It is not my purpose to make a summary of the Yugoslav Study as this might well be too tiring, but I should like to call your attention to some more essential and, I hope, also more interesting characteristics of research and of the development of science policy in Yugoslavia. In so far as this will provide you with a quick look at our study, we should be only too pleased if it encourages you to delve more deeply into it.

I would like to give you a rough historical outline of the development of scientific research in Yugoslavia, in the period after World War II, because such a historical presentation of this development may be of interest to the present audience, as some of you will undoubtedly find in some forms of the previous or present-day state certain well-known points of contact common to my country and yours.

In the first post-war years scientific research was almost wholly entrusted to scientific academies. The chief reason for that was the longer scientific traditions of academies and the scientific reputation of their members.

Within a few years, the academies founded a great number of scientific institutes for research in humanities and fundamental natural sciences. This kind of orientation of the institutes was a natural consequence of the tradition and of the composition of members of the scientific academies. The activities of the institutes were regulated by the republican laws (Yugoslavia as a federal state consists of six republics, and at that time it was only in three of them that academies of science existed) and financed from republican budgets. In 1948 an academic council was founded, whose purpose was to co-ordinate the activities of the academies. Its task was to help in the realization of scientific projects, but without its having any formal right to controlling the work of individual academies or their institutes.

The organization of research in institutes within individual academies was centralized. Annual financial plans of the institutes, their programmes of work and annual reports were to be approved by the presidency of the academy.

The most conspicuous achievement for that period consisted in assembling the necessary scientific staff and in improving the organization of research, mostly in the fields of the humanities and of fundamental natural sciences. No remarkable successes were achieved in the attempts to relate the institutes of the academies to more practical needs, particularly to the requirements of the development of the economy. But the need for practical applied research was becoming increasingly strong and evident. This need was dictated by the intensive industrialization of the country as well as by the transformation of an underdeveloped agriculture to a modern way of agricultural production. The orientation of the academies and of the major part of the universities did not hold out any promise of a more far-reaching adjustment for a solution of these problems; so the ministries and the "general directorates" for individual branches of economy started to found their laboratories and institutes. Almost all the institutes in the fields of farming, veterinary science, and forestry were founded during that period, as well as institutes in the fields of architectural building, hydro-economy, electro-economy, geological research and some technological research.

These institutes were at first financed from the budget. A part of their financial resources was also created through contracts with economic organizations. It soon became evident that it was more stimulating for scientific institutions to shift to financial resources coming from the economy, and gradually reducing allocations from the budget. Thus, powerful incentives were set up for the scientific institutions to relate to the main trends of economic life, weakening at the same time the stiffness of the budget plan concerning the financing of research. At the same time, this helped break the rigid links between the institutes and the individual ministries or "general directorates" and thus contributed to the onset of the first forms of self-government in scientific institutes. This was in accordance with the general process of decentralization of functions and the sharing of competency between federation and republics, particularly in economic life, a process which was given its legal form through the law of workers' self-mangement in 1950.

During this time, we can observe another significant phenomenon which also affected the development of research in Yugoslavia. The system of university studies was undergoing a great expansion. The number of universities rose from the pre-war three to seven, the number of faculties from 22 to 93, and the number of students increased tenfold as compared with the pre-war figure. This created conditions for broadening scientific work as a whole, and particularly the numerous branches of technical and natural sciences. The newly-founded laboratories enable not only the students to do practical work but also the university lecturers to do scientific research. For Yugoslav universities also follow the rule whereby the faculties are the highest pedagogic and scientific institutions in which complete unity between pedagogic and scientific work exists.

The basic characteristic of the scientific work at the universities was that this work was orientated towards fundamental research. There are several understandable reasons for this: fundamental research is most suitably adapted to the task of educating the students, it is usually cheaper than applied research and in the main it corresponds to the tradition and inclination towards individual work of university staff. Hence the results of that work were useful mostly for widening the knowledge and raising the academic level of lecturers and lectures, which is beyond doubt highly significant. In almost no way, however, was this research connected or included in wider projects that were to solve certain problems in the development of economy and of other social activities.

To fill this gap, the Federal Fund for Promoting Industrial Production and the Federal Fund for Promoting Agricultural Production were founded in 1954. The task of both of them was to finance on a contract basis certain research projects to be utilized in industry or agriculture. Industrial enterprises, of course, were investing part of the required means themselves. The funds were also financing part of the research projects at the faculties.

The foundation and the method of work of the two funds belong already to the transitional period in the realization of the new policy and methods in the development of scientific research. Science policy in Yugoslavia has thus been built gradually and has in its course changed its line of development. The basic characteristic of the first post-war decade has its quantitative as well as its qualitative aspect. On the one hand, there was a great increase in the number of professional staff and scientific institutions, and on the other, the process of direct connexion of scientific research with the development of the economy was initiated. At the same time, scientific research had by then reached a number of fields which had hitherto just been white spots on the map of scientific research as a whole.

B. RECENT ACHIEVEMENTS IN THE ORGANIZATION OF SCIENTIFIC AND TECHNICAL RESEARCH

The break-through - if we can possibly talk about a concrete date - came undoubtedly in 1957 when the law concerning the organization of scientific work was passed. The new system based on that law was further developed by the new Constitution passed in 1963 and by the new laws concerning scientific activities, the Federal Council for Coordination of Scientific Activities, the Federal Fund for Scientific Work, all passed last year. All the essential features of those legal regulations governing the system and organization of scientific work in Yugoslavia are described in detail in the study submitted. May I here be allowed to call your attention - without tiring you with detail - to just a few essential characteristics.

The new Constitution has widened the self-managing rights of the working people, which up to then had been developing in economic organizations, to other working organizations. The scientific institutions were thus freed from any administrative or other kind of intervention in their work. Scientific institutions now enter into contract terms with those who are interested in their co-operation and thus on the basis of their work obtain their own income which they can freely dispose of.

Scientific research is proclaimed by the Constitution as an activity of special social significance, and the responsibility for it is entrusted to the republics. Just as in the spheres of education and culture, so also in scientific research the federation only has the task of general orientation and co-ordination. Federal laws contain only general principles which ensure the unity of the social system in Yugoslavia.

Somebody might ask the question: Is the co-ordinating function of the federation and the responsibility of the republics in opposition to the whole independence of scientific institutions? The answer is no: for the federation and the republics play their rôles almost exclusively via the financial means. In such a way that through contracts they develop and stimulate to a greater or lesser degree a research of one kind or another and exert an influence on the orientation, on specialization, co-operation, etc. The law concerning the organization of scientific activity answers many other questions. For instance: who can found a scientific organization in Yugoslavia? The answer: any social-political community (federation, republic, commune) as well as academies of science, universities and faculties, economic organizations and their associations, social organizations and also groups of citizens.

What are the managing authorities in scientific institutions?

The answer: the council, the board, the scientific council and director. The council is the highest authority in the management of the institution. In it there can be representatives of the founder, if this is laid down in the foundation act. The director is a member of the council by virtue of position, but he cannot be chairman. The council makes decisions concerning all the most important matters of the institution; it approves the statutes of the institution, the programme of work, the financial plan, closing account, it elects the director, it elects the scientific consultants to scientific status, etc.

The council also elects the managing committee and this committee, together with the director, prepares the conclusions for the council and, when they have been approved by the council put them into effect. The director is the direct organizer of the scientific work and of the management of the institution. The programme of scientific work is according to the new law the responsibility of the scientific council. People in all the managing authorities are elected for a given period of time (generally for four years),

The federal authority competent for scientific work is not the ministry but the Federal Council for the Co-ordination of Scientific Activities. Its fundamental task is to stimulate, promote, and co-ordinate scientific research and to propose to the government measures necessary for the development of scientific research. Since the founding of the Federal Council, the Academic Council continues the work only as a free association of the academies with the task of co-ordinating their scientific activities.

The President of the Federal Council and half of the members are nominated by the Federal Assembly, the other half by various institutions: the Association of Scientific Academies, the Association of the Universities, the Chamber of Economy, the Yugoslav Peoples' Army, etc. The Federal Council has 26 commissions for various branches of research work.

Since the Federal Council has no institutes of its own, its administrative and management competencies are insignificant. The Federal Council is a social organ which studies and makes proposals for social policy in the field of scientific research and of the co-ordination of scientific activities. The Federal Council makes a programme for the development of scientific activities but this is not a detailed programme of research for the country but only a statement on the policy and the measures which are to guarantee favourable conditions for the development of scientific research in a given direction. The organization of implementation including the financing of that programme on the federal scale is the responsibility of the Federal Fund for Scientific Work. The Federal Council and the corresponding republican funds have also the task of supporting fundamental research which is long-term and of general social significance but for which the scientific institutions cannot get direct orders. The Federal Council is entitled to sign agreements with other countries for scientific co-operation and to co-ordinate the scientific co-operation of Yugoslavia at the international level. In the main, the republics have, apart from minor exceptions, a similar organization for the co-ordination of scientific work within their own territory.

This is a brief and broad outline of the present situation in the field of research and science policy in Yugoslavia.

C. PLANNED DEVELOPMENT OF SCIENCE

And what do we see as prospects for the future? These are but plans for the time being and so there is not much point in expanding too much this subject. But just for a brief illustration let me mention that in the new middle-termed plan for the period 1966-1970, we plan a comparatively high annual growth rate in the national income, from about 7.5% to 8.5% and a growth rate increasing from 9% to 10% in industrial production. According to the estimates contained in the plan, 70% of the increase in the national income will be achieved by increasing productivity and only 30% by new employed labour. These data suggest the strict orientation from the extensive development of economy to an intensive course.

The plan is for a more intensive development of research activities than has been the case so far, and above all for a wider and more effective utilization of the findings of research in industry. This is not, however, a line to subordinate the development of science to the requirements of industry. The social interest in the development of science is naturally much broader, for it contains the needs of the development of all social relations, culture, education, international co-operation, etc.

A characteristic of the plan as well as of the orientation of the Yugoslav science policy is that an increase in investment in research is planned at a faster rate than the increase in national income i.e. 14% annually. If the prospects of an increase in the national income materialize, investment in research activities will have doubled by 1970.

So much about the position of scientific research and about science policy in Yugoslavia. Allow me finally, ladies and gentlemen, to thank you for your attention and at the same time to invite you to ask any questions which my colleague, Dr. Kapetanovic and I will be glad to try to answer.

CHAPTER 5

PRINCIPAL PROBLEMS OF A NATIONAL SCIENCE POLICY. SYNTHESIZING STATEMENT

BY

DR. CHARLES V. KIDD, RAPPORTEUR OF THE MEETING

As you can all imagine, I had some difficulty in summarizing our discussions. I found the remarks of the participants, as well as the exposés, remarkably rich and fruitful. Instead of presenting an organized summary, which would presuppose some structure of facts and some organized assumptions, I decided to report what seemed to me to be some of the major questions that often rose to the surface in the course of the discussions. I thought I would present what seemed to be, from our discussions, the kinds of problems with which countries must deal. Or, stated in another way, those problems which countries may regret not dealing with if they ignore them.

(a) The question of centralization and decentralization was a recurring theme throughout these days of discussion. The question of what to decentralize or to centralize and why, was a question which we certainly did not decide but which appeared in many different forms. One may centralize, or decentralize broad decisions relating to science or technology. One may centralize or decentralize research and development facilities. One may centralize research and development planning within large industrial complexes, or one may decentralize decisions to smaller units. In the general area of planning, which is one dimension of the question of centralization, the discussions brought out the general impression that western countries are tending to undertake a greater degree of central planning while the eastern countries seem to be placing less reliance upon detailed central planning.

(b) Quite frequently through the discussions the following question arose: Is science in national life best dealt with as a primary activity or a secondary activity? That is, in principle should science be primarily linked to social functions as expressed through the structure of government, or should science be viewed as a primary activity for which one has a special structure in the State. Actually, it appears that most countries express elements of both theories in their structure for science.

(c) The question of the extent to which scientists participate in policy making was an intriguing one. At what levels and with respect to what functions do scientists have an important or primary voice? Stated in another way, what is the interaction of science and politics, at what level as one moves towards the upper reaches of governmental decisions do scientists, as scientists, participate in the making of major decisions? There was a consensus among participants that scientists are and should be participating more extensively in the general policy decisions of their governments.

It seems apparent that the significance of science in governmental affairs - and the significance of governmental decisions to science - is largely independent of political beliefs and of particular structures of government.

(d) The nature of planning for science was certainly a central point of our discussions. This obviously is an extremely complex question, and one with important political overtones. One of the central issues which I would point out for special emphasis is how the science of cybernetics is to be brought into the process of planning for science. In other words, how, given the fact that men are human beings and subject to error, are the errors caught and corrected? Cybernetics is indeed a powerful tool not only in the control of mechanical, chemical and electronic processes but in human affairs. A plan - such as a plan for science - is affected by unpredictable future events. In addition, beings are human beings, and less than perfect. Errors are made by people. Therefore, a central problem in planning is not only to establish a sound initial plan, but to ensure that the corrective feed-back process is efficient. Acceptance of the significance of the principles of cybernetics is incompatible with rigidity - that is, with the establishment of fixed, detailed goals in advance without acceptance in principle of the idea that continuing adjustment for unforeseen contingencies and for human error is needed, and that deliberate mechanisms for adaptation are necessary. Indeed, it seemed to me that some of our most interesting discussions have been on the subject of national feed-back mechanisms. It is possible that one may gain greater insight into the similarities and differences among national science policies by assessing the nature and effectiveness of feed-back mechanisms than by examining the initial planning process. From our discussions, it seems to me that studies with such a focus on an international basis would be quite productive, particularly because most investigations to date have dealt more with the formal process of planning than with the cybernetic processes through which the process of executing plans is made most effective.

(e) The relationship of science planning to the economic and social planning has been, I believe, a major theme of our conference. This problem is probably unsolvable in the general sense. On the one hand, it is clearly obvious that science policy must be linked to the aims of the State, to the aspirations of people and to more general factors. However, a number of people have noted the difficulties that are encountered when science planning is linked so tightly with economic or other types of general plans that the requirements for the development of science become overly compromised by involvement with other areas of planning. One specific area in which this becomes quite apparent is the question of how one plans for basic or fundamental research, and how one sets the criteria for investment in fundamental research.

I have detected from the comments of participants from almost every country the fact that efforts are being made to apply strictly economic criteria to these decisions. It has been most interesting to observe the strong aversion which representatives from both eastern and western nations have expressed to the application of solely economic criteria to the question of proper allocation of resources to basic research. The reason for the aversion is simple. Non-economic criteria are vitally important in this field. Incidentally, I was much interested to note that the concept "cost-benefit" is widely used among nations, but that the English term is often used.

(f) The division of research functions among national institutions has been a theme of great significance. A number of representatives have remarked upon the administration and the structure of universities in relation to the expansion of scientific effort. The division of research and teaching functions among universities, governmental research laboratories, research institutes and all of the varied mechanisms which exist for the conduct of research was a major theme. One question that appeared in a number of the exposés and discussions was the extent to which non-university research institutions, such as institutes, industrial laboratories or government laboratories of various kinds, can and should be used for the training of students at advanced levels and as places where professors may pursue advanced research. National customs differ. It seems that in most countries the situation is quite fluid, and that few, if any, nations feel that they have solved this problem satisfactorily. If I interpret our discussions correctly, it seems that those countries which have tended to keep advanced teaching (that is, at the graduate and post-graduate level) out of research institutes and industrial laboratories, are reviewing the wisdom of their policy. Similarly, those countries that have tended to view universities as teaching, rather than institutions with an important research function, are apparently having second thoughts. Finally, those nations which have deliberately encouraged major expansion of research in universities appear to be encountering some problems - such as interference with the teaching function - which are causing them to reconsider their policies. One of the most interesting aspects of this conference has been the manner in which such basically common problem areas have come spontaneously to the surface.

(g) The optimum conditions for transfer of basic research findings to production were mentioned in a number of contexts. This appears to be in large parts of the world a central problem of research policy. One important question is whether research organizations or industrial organizations should take the initiative in exploiting research. For example, should basic research people go to industry with their findings and indicate to industry what is available for industrial exploitation? That is one possible approach. Or should one take the view that science is a somewhat self-contained activity and that the responsibility for exploitation comes from the other side, i.e., from industry, if industry wishes to use the fruits of research? This is a second possible approach. These two approaches are quite different in principle. Quite often the research people because of their background training and so forth are reluctant to serve as the handmaiden of industry, and to carry abstract investigations through to conclusion. Moreover, many scientists tend to be completely aloof from practical problems and this conversely causes problems.

The preponderance of opinion in the discussions appeared to be in the direction of placing the primary obligation upon industry to seek aggressively to exploit science, rather than to place upon scientists the primary responsibility to point out to industry the relevance of their work. This is a most significant matter because it deals with a central question of science policy - how is science to be made most useful to man.

(h) I would mention the question of the criteria of choice - that is, the basis for decisions as to what one will invest in. This question faces all countries. Obviously it appears to take different forms in different countries. For example, in smaller countries the problem often appears not in terms of what the proportion of efforts should be among various fields but in terms of what cannot be done at all. These are more difficult decisions than those facing larger countries, which must decide the relative weight to be given to research in different areas.

As I see it, we did not in our discussions arrive at any clear resolution on this question of choice. But if this conference had solved that question we would all be supermen because many hundreds of intelligent people have grappled with this problem. It is not yet, I would venture to say, adequately resolved because of its enormous complexity in all countries. The criteria of choice of question takes very varied and complex forms. One of these is whether, as one of the participants mentioned, decisions should be made on the basis of the need for research in various areas or on the quality of the scientists in various fields. Clearly, the major decisions in large countries are based on need. This can be done because the base - of facilities, of scientists, of equipment and of funds - is so large and the resources are flexible enough to make possible large shifts in objectives. On the other hand, in smaller countries the choices seem to be more influenced by the capacity of individuals and groups.

It did seem to me as I listened to the discussions that in every country the future is very heavily influenced by the past. That is, what happens next year cannot be too radically different from what happened last year. There are practical limits to the rate at which people can be shifted from one field to another, to the rate of expansion of total national investments in research, and so forth. It therefore appears that in actual practice a major factor in science planning is a simple factor which is rarely given prominence. That is, the base from which one starts. One important consequence of this line of thought is that many important decisions at the centre of government deal not with all of the scientific and technological effort, but with critical strategic questions and with decisions as to increments.

(i) There was very interesting and diversified discussion of what one might alternatively call basic research, fundamental research, little science or academic science. I would not attempt to define these terms but I think that all of them convey roughly the same thing to all of us. That is, they encompass what one would call free research where the individual exercises his own initiative and imagination and generally conducts his work on a relatively small scale with a small group.

An interesting question with respect to small science or academic science is whether it is advisable to adopt special rules for protecting and encouraging this area of activity. It was quite interesting to me that a number of countries have taken specific measures to ensure that this kind of research is adequately nurtured. In Czechoslovakia, for example, I was intrigued by the average 19% of the budget of research institutes left to the director of the institute for distribution according to the director's estimate of how good the man is, how good his ideas are, and so forth. In Israel, there is a very strong tradition of protecting this free research. From the United Arab Republic we heard of the significance of basic research in developing countries. In the United States we have a strong National Science Foundation. In Yugoslavia I was interested in the means that have been adopted to nurture this sort of small science. So it does appear when one looks around the world that this kind of science is given, through one form or another, a protected status and priority. It is interesting to note that there seem to be universal values in the free research of individuals which are of such significance that governments undertake to protect them.

(j) We had as one central theme of our discussions the structure of governments for forming science policy. Perhaps we devoted too much attention to these structural questions, because every country clearly is in a sense the captive of its own cultural, political and economic system. There is only a certain degree of freedom and a certain rate at which institutions can change. However, I was interested in hearing the succession of exposés to note that there has been over the past few years a somewhat general tendency to raise to higher governmental level the points of decision for science, to make the structure for decisions relating to science more formal. These structures for science policy obviously take extremely diverse forms. Nevertheless, it appeared in this conference that all of the participating countries are now actively considering the adequacy of their governmental structures for science policy. Evolutionary change rather than fixed structures seems to be the general pattern. It seemed evident from the discussion that no country felt that it had found an ultimate and satisfactory solution.

(k) How to handle the relationships between research and development has been an important topic at the conference. Should the functions be combined in the central governmental structure in the same organization, or should the functions be separated? Different countries have arrived at different answers. It appeared from the discussion that there are no common patterns, that ideological considerations are less important than pragmatic considerations, and that the question is so inherently complex that there may be no general answer. In the U.S.A., for example, we tend to handle these questions in the same organization. Thus, we have an Office of Science and Technology in the Executive Office of the President. The United Kingdom recently, as you all know, established a Ministry of Education and Science and a separate Ministry for Technology. Czechoslovakia as I understand the discussion, has tended to separate the functions. On the other hand, in the USSR, they appear to be somewhat more tightly linked.

(l) At various times in the discussions, the question of the training of manpower was raised as a central problem. Here we find that each country apparently faces the same basic problems. There is apparently a general recognition among all nations of the value of extremely rigorous, broad, fundamental training in science and engineering in order to turn out people who are flexible and are able to cope with change. On the other hand, the general training in fundamentals sometimes leaves industry somewhat at a loss because people trained in fundamentals are not immediately able to solve industrial problems. In addition, in some smaller countries, the necessary in-service training that is necessary to translate general fundamental formal training into useful work in the plant is not possible because the necessary resources do not exist.

(m) Most if not all countries appear to be suffering from the inability of their scientists to secure the information which they need when they need it in usable form. There were a number of expressions of concern over this, and descriptions of a number of different approaches to resolutions of this problem. Again it seems that there is a general trend among countries to consider information technology and the storage and retrieval of scientific information, as being not a general abstract problem but a central problem of science policy as such. This seems to me to be a quite significant development.

(n) The discussions brought forth contrasting views of the definition of science. These can be stated in extreme terms to make the differences clear. On the one hand, science can be defined in broad terms as "learning", or in the widely used German concept of "Wissenschaft". On the other hand, science can be defined in substantially narrower terms as encompassing the physical and biological sciences. Which of these two concepts exists in a country has a great deal to do with such basic questions as the rôle of science in national life and the attitude of governments towards science. Discussants pointed out that in countries where the narrower definition of science prevails, scientists may tend to become preoccupied with their specialized concerns and not adequately engaged with the effects that science may have on important national problems. Other discussants pointed out that if science is defined to include all aspects of learning, it is in practice difficult to focus on those aspects of science which have the highest potential for advancing levels of economic well-being, national defence, and so forth. The discussions did not result in a consensus, but they did make clear the fact that some countries adopt a concept of science without realizing that other potentially useful concepts exist in other countries.

(o) I select as a final point worth mentioning the discussions relating to the kinds of people who must be available to define and to carry out national science policies. Can such persons be specifically trained to deal with these problems? Every country seems to feel the pressure of a growing scientific effort which must be administered, in the sense that we must have people capable of bridging technology and science as technics, the problems of universities and the problems of government. If I may interject a personal view at this point, I think this is a new kind of person - many of whom are around this table - and that this kind of person is in very short supply. Our discussions did not point to any definite way in which people should be trained to carry these responsibilities. The most diverse backgrounds of those at the conference testify to the fact that there has been no common core of training, in the sense that a physicist, an engineer or an economist has a common core of training. However, this may be simply because the problems are so new that we have not had time to consider what kind of formal training would be useful.

(p) In concluding, Mr. Chairman, these are some primary points as I saw them. I am sure that my presentation has not been complete nor particularly well organized. However, I hope that some of the points that I have mentioned may be useful in our future discussions.

CHAPTER 6

CLOSING SPEECH

BY

PROFESSOR VLADIMIR BAŽANT, CHAIRMAN OF THE MEETING

Ladies and gentlemen,
Our conference, which during its five-day session has dealt with problems of extraordinary importance for the further development of science, and with several questions of utilizing science in social practice, is now coming to its end. The fact that experts from different countries have participated in this conference and the actual outcome of their work as well as the recommendations on which they have agreed, provide a wide opening for developing international co-operation. This, I feel, is the main significant feature of our conference, to the preparation of which Unesco devoted much attention.

Therefore, allow me in the first place to thank the members of the Unesco Secretariat, particularly its Science Policy Division, for enabling us all, by arranging this conference, to come together to discuss the problems of science, which all countries, irrespective of the degree of their socio-economic and scientific development, are facing.

I cannot, in this short concluding address, evaluate the outcome of our conference in great detail. But from the reports of our working groups, we can obtain a good idea of their intensive activity and its result. This enables us all to estimate the degree to which our conference has succeeded in achieving its aims, and I think we may be generally satisfied with this achievement.

I therefore thank the moderators for their efforts in fulfilling their exacting tasks. I also thank all the members of the working groups whose activity enabled us to obtain the results we did. I further thank Mr. Vice-Chairman and all members of the presidium of our conference for their collaboration in the organization. I wish to express special appreciation of our Rapporteur who, with great understanding of the aims of our meeting, succeeded in formulating and summarizing the most substantial ideas expressed in the discussions of both the plenary session and the working groups.

Ladies and gentlemen, our conference enjoyed the participation of 13 nations with different languages. The interchange of opinions was made possible not only by the participants' knowledge of the subject, but also by the perfect interpretation services. I therefore move that we all express our thanks to the interpreters who helped us so much in mutual understanding and, together with the technical staff, ensured the smooth work of the meeting.

We also thank the town of Karlovy Vary and its Committee for their kind hospitality.

In closing our conference I wish to express my opinion that life in our time requires an ever-increasing utilization of scientific achievements and optimizing relations between scientific and socio-economic development, which is the question of greatest importance. This will result from studying science from many angles. Some of them we mentioned in our proceedings, others remain to be dealt with. Only a small number of scientists are as yet engaged in studying the social aspects of science research and development, really good international co-operation may multiply those scarce and dispersed forces.

In this lies the important rôle of Unesco, and this also implies an obligation on all of us. I hope we shall meet again to resume and further develop our work. The very friendly atmosphere of our meeting justifies my presumption that our future working contacts will be continued in the same spirit.

I wish you all a very pleasant time during the rest of your stay in our country, and the best of success in your own work. I also hope that one of the results of this conference may be to induce the participants to pay a further visit to our country, where they will always be welcome.

I now declare the conference closed.

Thank you and good luck to all of you.

CHAPTER 7

RESOLUTIONS AND RECOMMENDATIONS

The resolutions and recommendations were prepared by the working groups on the proposal of their members and/or the chief participants at the meeting.

They were submitted for the approval of all participants in plenary meeting. They were unanimously adopted at the closing meeting on Saturday, 11 June.

The resolutions are concerned with the rôle of science policy in the development of society, operational activities associated with science planning, the operational research network and scientific workers and technicians for research (Part A). Generally speaking, they are addressed to all scientists and government officials, administrators and research users who need to be familiar with these problems in their professional life.

The recommendations are concerned with basic studies and data in support of science policy making on the one hand (Part B), and with principles and methods of action and Unesco's programme for the international promotion of national scienee policies on the other (Part C). They are addressed to the Director-General of Unesco.

I. SCIENCE POLICY AND NATIONAL DEVELOPMENT

A. THE ROLE OF SCIENCE POLICY IN THE DEVELOPMENT OF SOCIETY

Resolution 1. The nature of national science policies

The development of science is one of the prerequisites for social, economic and cultural development. Science policy consists of the sets of general guides, actions and organizational arrangements through which countries undertake to develop science - basic and applied - in harmony with their economic, cultural and political circumstances. Both applied and basic research are important to full national development.

Resolution 2. The organization for science policy

The development of science policy should be the responsibility of an organization at the highest level of government in the country, with scientists having a decisive influence in the formulation of the science policy at all levels. This organization should co-operate closely with other government departments, but should not be a subordinate organization.

Resolution 3. Relations between science policy bodies and agencies responsible for planning national development

Bodies responsible for science policy must have close working relationships with the authorities managing and planning social and economic development, particularly to co-operate on setting up basic programmes of general development. In the course of this co-operation they should be guided not only by the main trends indicated by the authorities of state policy but also by their own analyses and concepts. To accomplish these tasks it is necessary to organize a broad participation of scientists and research institutions.

Resolution 4. Participation of scientists in the planning of national development.

Scientists have a high responsibility for contributing to national development; accordingly, they should participate in the planning of national development, at the various levels of planning.

Resolution 5. Research in universities

The national science policy organization should give special attention to the problems of research in the universities, and particularly to the reciprocal effects of scientific research and scientific education in universities(1).

Resolution 6. Organizational structure for science policy

The character and organizational structure for science policy in different countries is strongly influenced by their historical development and their current fundamental political, economic and social institutions. Hence, no generalizations relating to preferable organizational structures are possible.

Resolution 7. Functions of science policy bodies

As a consequence of the way in which their institutions have evolved and of their current needs, countries are typically organized to carry out two sets of functions in science policy planning and organization of research:

(a) the first set of functions consists in planning the development of science, in securing funds for science, and in distributing funds for the support of science;
(b) the second set of functions is the management of research laboratories which a central research agency controls directly or indirectly.

However, the nature of the organization(s) for carrying out these functions varies widely among countries and no general recommendations for their structure can be made.

Resolution 8. Management and planning of basic research

A generalization that seems valid in virtually all countries is that scientific institutions actually engaged in research should be given substantial opportunities to apply their own initiative within general guidelines. In addition, it is recognized that scientific institutions engaged in basic research need much more flexible forms of management and planning than those engaged in applied research.

Resolution 9. Infrastructure of scientific institutions

In those countries which do not have an adequate infrastructure of scientific institutions, a major effort should be made to create it in the shortest possible time.

The importance of the auxiliary services and activities for scientific and technological research is emphasized. Scientific and technological documentation, the collection of relevant data and the effective dissemination of results are particularly significant in this connexion.

Resolution 10. Science policy makers

The effective operation of science policy organizations depends heavily upon the work of a new kind of professional person - one with a broad understanding of science not only as science but as an economic, social and political force. Active research experience is a further desirable qualification for this work. Special efforts to provide appropriate training for this new kind of science administrator are needed. Experimental efforts to this end should be encouraged in many countries.

Resolution 11. Continuity in science planning and research

There is an urgent need to ensure continuity both of institutions and effort in the development of science policy and research at the national level.

Resolution 12. International aspects of national science policies

National science policies must meet national needs and obligations not only in terms of internal requirements but also in terms of international co-operation on a bilateral, regional and world-wide basis. However, national and international research programmes must be co-ordinated with great care.

Resolution 13. Economics of science

The study of the economic consequences of science and technology is important. Studies on the economic effectiveness of research and on the productivity of research are particularly significant for all countries.

Resolution 14. Implantation of science in society

Studies on the relation between science and society are significant. In countries which have not evolved a modern scientific and technological tradition, there is a special need to develop a scientific outlook and attitude in order to ensure recognition of science as a most useful means of social, economic and cultural development(2).

Resolution 15. Scientific creativity

An intellectual climate favourable to science and technology and conducive to individual creativity is a prerequisite of scientific progress. These are most complex questions; they are deeply interrelated, and the way in which they interact has a great influence on the development of science in a country.

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(1) See also, in this connexion, Recommendation 19 (g) below.

(2) See also, in this connexion, Recommendation 14 below.

Resolution 16. Sociology of the scientific community

Studies in the sociology of the scientific community and the effectiveness of science in attaining non-economic as well as economic goals are significant, and should be undertaken on a wider scale(1).

B. OPERATIONAL ACTIVITIES ASSOCIATED WITH SCIENCE PLANNING

Resolution 17. National science policy planning functions

No matter what the structure of governments may be, there are certain functions relating to science which are performed at the national level. The most significant of these functions, some of them performed entirely by government in certain countries and by governmental as well as private efforts in others, are:

(a) Determination of the allocation of governmental research and development funds to broad objectives in the light of national goals and aspirations;
(b) planning for a national balance between current and future investment in research and development, in the form of physical facilities and training of manpower;
(c) arranging for the mutual accommodation of plans for science with plans for the attainment of other national goals;
(d) determination, or guidance, of the division of effort among fields of science, special tasks and other areas of activity;
(e) co-ordination of the research activities of research organizations controlled by government;
(f) establishment of effective means of maintaining continuing review and adjustment of the relation between education and research, and of sustaining the most effective arrangements for performance of the combined teaching and research function at the university level;
(g) arranging for, or performing, the studies and analyses which provide the factual basis for policy decisions.

Resolution 18. Studies and analyses for science policy planning

In relation to the analytical function in science policy planning, data and analyses such as the following are commonly considered important:

(a) Establishment, maintenance and improvement of a system for providing data in the detail and with the degree of accuracy required for policy decisions on such matters as:
    (i) Division of research and development effort by field, discipline or other relevant sub-division;
    (ii) resources for research, including manpower and physical facilities;
    (iii) sources of funds for research, and the places where money is spent.
(b) Critical analyses of organizational arrangements and of the functioning of the system for research, and particularly of the relationship between research and higher education;
(c) study of the factors influencing the effectiveness of research workers, including such matters as the economic and psychological factors affecting creativity and innovation, the physical and organizational factors affecting scientific productivity, the influence of governmental procedures on the ability of scientists to work effectively, and the influence of communications on scientific output.

All such studies should be published to make the data most effective as a means of education, as a means of promoting wider discussion by scientists and others, and as a means of making wiser decisions.

Resolution 19. Science statistics

(a) Statistics relating to research and development are actually simplified representations of: (i) phenomena that are most complex; (ii) processes that are particularly affected by qualitative as well as quantitative factors; (iii) an activity whose actual output is most difficult to measure and to assess, and (iv) the work of people whose productivity is particularly sensitive to their environment and working conditions.
(b) Therefore, an adequate programme for science statistics - including such matters as definition of terms, scope and coverage, frequency of collection of data and interpretation of data - must be planned under conditions which give science policy makers the primary voice. Close collaboration of individuals and groups with special training and responsibility for statistics is needed. When collection of statistics in a country is the responsibility of a central statistical agency, it is of the utmost importance that science policy makers should have an important voice in all matters relating to statistics on science.
(c) Any plan for research and development statistics should be adjusted with great care to the stage of development of the nation concerned.

Resolution 20. Studies of the economics of research

Since a major justification for support of research by government is the economic return produced by research, it is rational to stimulate studies designed to provide more accurate determinations of the cost of resources devoted to research and particularly of the return on the investment in

(1) See also, in this connexion, Recommendation 14 below.

research. Such studies, often called "cost-benefit" analyses, must at this time be used with great caution in making decisions on research and development investment. Their greatest utility appears to be in relation to specific research or development efforts which have direct economic objectives. Cost-benefit analysis cannot and should not be applied to fundamental research because such research has costs and benefits not measurable in economic terms. However, the costs and the benefits (including purely scientific as well as economic) of large fundamental research programmes must be compared since choices must generally be made among them.

Resolution 21. Investigation of the criteria of choice for investment in science

The real reasons for establishment of any given level of national investment in research, or for setting relative levels of investment by field are at the present time quite obscure. The efforts of many talented people in many countries could be profitably devoted to these questions, since progress towards a satisfactory answer would be of extreme value.

Resolution 22. Inventories of natural resources

A prerequisite for a rational choice of research programmes is an adequate inventory of natural resources (minerals, water, food, etc.), and such inventories are often particularly deficient in developing countries.

C. THE OPERATIONAL RESEARCH NETWORK

Resolution 23. Minimum investment in research

Countries should recognize that an effective research programme in any field requires a certain minimum investment not only in physical facilities but also in manpower and in continuing operational expenditures. No government investment in a given field should be made unless the country is prepared to sustain this minimum effort.

Resolution 24. Scientific research in universities

The rapidly changing rôle of universities in modern society is a matter of great significance that needs serious and extensive investigations.

Teaching and research are closely associated at the university level, where both are integral functions. Research undertaken by universities should, as a general rule, be of a type which can be productively related to teaching, at both undergraduate and post-graduate levels.

However, in some circumstances, universities may be properly called upon to perform applied research of immediate national importance.

Resolution 25. Training of scientists in research institutes

When research institutes outside universities perform research, efforts should be made to use them in order to train additional scientists.

D. SCIENTIFIC WORKERS AND TECHNICIANS FOR RESEARCH

Resolution 26. The national scientific community

It is important to create a harmonious scientific community where the relations between the members reflect their common responsibility towards society.

Resolution 27. Careers for scientific workers and research technicians

There is an urgent need to secure a recognized status as well as a steady and well-paid career for scientific workers and research technicians. The necessary facilities should be made available to keep them in touch with the new developments in science and technology.

Resolution 28. Proportion of scientific workers and research technicians

An adequate proportion in the numbers of scientific workers and research technicians is emphasized as an essential prerequisite for successful teamwork in research. This problem is particularly serious in developing countries.

Resolution 29. International mobility of scientists

Scientists are the most mobile group in the world. Freedom of movement of scientists is to be encouraged as a contribution to the development of individuals, of science and of nations. However, this movement may at times deprive nations of scarce talent needed for cultural and economic development. Establishment of a proper balance leading to productive rather than disruptive movement has not yet been attained in many countries. The organizations belonging to the United Nations system (particularly Unesco) are studying this problem, and this effort is strongly encouraged.

The Unesco science policy studies are valuable in two ways:
(a) as a means for assessing the scientific and technological potential of individual countries;
(b) as a means for making possible comparative studies of national science policies.

Recommendation 1. Flexibility of the framework for national science policy studies

The institutional forms through which societies may conduct scientific and technological activities are many. So are the ways in which these activities may be organized. There are, moreover, a variety of means open to different nations for formulating the content of policies affecting these activities, for implementing policy decisions, and for long-range policy planning.

These considerations point to the wisdom of maintaining great flexibility in the mode of preparing science policy studies. It is recommended that Unesco's objectives should be to encourage the preparation of a series of studies which faithfully represent the science policies of a nation as they operate in fact, rather than to assure the production of studies which meet the terms of reference of a rigidly framed plan or outline.

Recommendation 2. Methodology of the national science policy studies

It is recommended that the Unesco sponsored national science policy studies be undertaken at the official level in the various countries by national agencies concerned with science policy. They should be carried out in each case by a multidisciplinary team of specialists.

Recommendation 3. Manual, or Guidelines, for national science policy studies

It is recommended that Unesco publish a revised "Manual" or "Guidelines" for carrying out national science policy studies, taking into account the deliberations of the Karlovy Vary meeting and the comments to be submitted subsequently by countries engaged in national science policy studies. Furthermore, Unesco should keep this manual under periodic review. This publication should be widely circulated among Member States and interested organizations concerned with science policy problems. It is furthermore recommended that an abridged and simplified version of these guidelines be prepared for countries in which an operational network of research and infrastructure of scientific institutions is as yet lacking or only poorly developed.

Recommendation 4. Review of national science policy studies

It is recommended that Unesco, in order to advance the state of the art of preparing science policy studies, adopt the practice of submitting each of the studies it publishes to analytical review by a small team of experts drawn from Member States which have either completed or are undertaking such studies under contract with Unesco. The team would consist of three members.

These reviews would take place after publication of the studies, and the findings would be made available to Unesco and to the particular countries concerned. The objective of this procedure would be to contribute to improvements in the methodological and substantive aspects of subsequent studies.

Recommendation 5. Scope of national science policy studies

The science policy studies undertaken by Unesco should be extended in scope, so that they deal with such problems as criteria for budget allocation to scientific research, organization of research in universities, etc.

Recommendation 6. Theoretical studies on science policy

It is recommended that the special studies undertaken by the Secretariat of Unesco or by consultants be critically examined by small groups of specialists in the field to develop the theoretical basis of science policy making and to ensure comparability to the greatest possible degree.

Recommendation 7. Science policy concepts and definitions

It is recommended that an international glossary of terms used in science policy making be established by Unesco as soon as possible. The glossary should be established in close consultation with the national agencies entrusted with science policy making in the various countries which have currently undertaken national science policy studies for Unesco. Furthermore, in compiling the glossary, due account should be taken of terminological studies already undertaken by international organizations including the Organization for Economic Co-operation and Development (OECD) and the Council for Mutual Economic Assistance (COMECON).

Recommendation 8. Indicators of scientific resources and activities

It is recommended that Unesco establish a provisional list of the most significant indicators of scientific and technological resources and activities, together with the relevant definitions. The participants at the Karlovy Vary meeting will suggest indicators to the Secretariat of Unesco to be considered for inclusion in the provisional list with a view to their incorporation in the revised "Manual" or "Guidelines" for carrying out science policy studies.

Recommendation 9. Standard methodologies for collecting, presenting and analysing statistics in the area of science and technology

It is recommended that Unesco continue and accelerate its methodological studies in the area of science and technology statistics in view of their vital importance to the formulation of sound science policies. Building on the work of individual Member States, and in co-operation with other international organizations, Unesco should seek to develop standard methodologies for collecting, presenting and analysing such statistics as are adapted to the needs and resources of countries at all levels of development and with differing socio-economic organizations. Particular attention should be devoted to problems of international comparability of data including, for example, that of comparing expenditures for research activities in different countries (the "research exchange rate" problem).

It is suggested moreover that the Unesco Secretariat, in order to attain these goals, also find appropriate ways for generalizing upon the experiences gained by individual countries and international organizations in coping with problems of science and technology.

III. INTERNATIONAL CO-OPERATION FOR THE PROMOTION OF NATIONAL SCIENCE POLICIES - THE PROGRAMME OF UNESCO

Recommendation 10. Guiding principles of the Unesco programme for the promotion of national science policies

The following guiding principles for promotion of national science policies by Unesco are recommended:

(a) the scientific autonomy of countries, which means that the aim of these policies is to promote endogenous, social and economic development;

(b) the duality of national science policy, i.e. (i) the advancement of science and (ii) the application of science and technology to national development;

(c) the unity of science planning, i.e. co-ordination of activities ranging from such tasks as measurement and information, processing and interpretation of data, to determination of the objectives of science policies and pursuance of the research objectives. The measurement and information function should consist mainly in assembling the essential data of scientific and technical resources and in setting up a system of national statistics in the area of science and technology;

(d) recognizing some of the difficulties arising from resource limitations and the common nature of problems, it is recommended that, without infringing the principle of scientific autonomy, Unesco should foster and encourage joint integrated multinational projects of scientific activity among developing countries of a region.

Recommendation 11. Objectives of international promotion of national science policies

Objectives of international promotion of national science policies are recognized to be:

(a) fostering information and intellectual co-operation between specialists of the different countries;

(b) technical assistance in science policy;

(c) international co-operation in science policy making.

The need is stressed to differentiate between: (a) international co-operation in defining and refining science policy, and (b) international co-operation to strengthen the appreciation and understanding of science policy.

Recommendation 12. Criteria for assessing the technical assistance needs of developing countries in the field of science policy

Countries can be usefully divided into four categories as recently adopted by the Economic and Social Council's Advisory Committee on the Application of Science and Technology to Development, for deciding technical assistance in science policy. However, it was felt that this classification only represented organizational structures and that it was not fine enough. It is therefore recommended that the Unesco Secretariat attempt to determine additional categories.

Recommendation 13. The scientific and technical potential of countries

It is recommended to extend technical assistance to Member States in assessing their scientific and technical potential, and to assist them upon request to create adequate machinery for such assessment.

Recommendation 14. Special problems in science policy pertaining to developing countries

Integration of scientific and technological activities into the national development plan involves:

(a) the formulation of a policy for the development of science and technology as such, (b) the formulation of a policy for applying science and technology to national development.

It is recognized that the problems relating to developing countries are particularly complex and that the formulation of national science policies should take note of factors such as the difficulty that a country's administration may have in appreciating science, for example in countries where modern science is a new "imported" concept; in such cases it is recommended to Unesco:

(a) that every effort be made to impress on the national leadership of these countries an understanding of the importance of science in the modern world. This should include stress on science as an important part of the curriculum of the educational system;
(b) that every possible assistance be given to the popularization of science and to the creation of a favourable atmosphere for science and technology (in particular among the youth) so that even if the present generation does not fully appreciate modern science the next generation will accept it;
(c) that any technical assistance in science and science policy strive to reduce the tendency (in some countries) to promote "fashionable" science remote from national needs;
(d) that specific studies be undertaken (either commissioned studies or small working parties of specialists) to examine the imbalance of effort put into different disciplines and as between basic and applied research, since this imbalance is a factor significantly hampering the development of some countries;
(e) that, in assisting developing countries in science policy, stress should be laid on adapting science policies to the stage of development of the countries receiving the aid (particularly in the early stages) and that such economizing devices as the use of incremental (or adaptation) research be encouraged;
(f) that the working conditions of scientific workers and research technicians be given special consideration by national authorities, since below minimal conditions no science could flourish;
(g) that, in considering any technical assistance to a given country, particular attention be paid to any other technical assistance being received, and to helping and advising the country in the co-ordination of such assistance from various sources.

Recommendation 15. National surveys of natural resources

It is recognized that national surveys of natural resources, ecology and the like, are absolute prerequisites for any intelligent science planning policy. It is therefore strongly recommended that Unesco encourage Member States, the competent United Nations agencies and the United Nations Development Programme to give high priority to the initiation of these surveys in countries where they have not yet been initiated, and to their acceleration in those cases where progress is too slow.

Recommendation 16. Case studies and meetings on national science policy

In relation to studies and meetings it is recommended that, in addition to studies referred to above, dealing primarily with developing countries, some studies on very specific problems be initiated among the developed countries particularly with a view to intercomparison and mutual exchange of findings among countries with different economies. Recommended subjects for such studies include:

(a) the relationship between the allocation of scientific resources among the various scientific disciplines, and the economic and social development of a country;
(b) utilization of computerized information and documentation services (with particular reference to the problems of linguistics) including the possibility of establishing regional information and documentation services having computerized retrieval facilities.

Recommendation 17. Technical assistance missions in national science policy

In relation to the Unesco technical assistance missions in science policy, the meeting recognized two classes of experts, in addition to counterparts:

(a) the international visiting consultant of first-class rank, and
(b) the resident expert, i.e. suitable person trained in science policy for work in the country requesting assistance.

The latter may, in fact, be the assistant to the former, in cases where a consultant is provided.

Recommendation 18. Training in science policy

(a) It is recommended that Unesco hold seminars and conduct a vigorous fellowships programme for training science policy makers and science administrators in developing countries (local counterparts).
(b) It is also recommended that the creation of a cadre of high grade consultants be an aim of Unesco and that, where possible, Unesco should encourage the developed countries to train and finance the training of such consultants as a contribution to international technical assistance.

Recommendation 19. Promotional activities of Unesco in science policy

As regards promotional activities of Unesco in the field of science policy, it is recommended that Unesco should include as far as possible:

(a) Publication of a list of institutes working on science policy. This would lead to requests, within the category of training, for foreign scholars to study in such institutes.
(b) Publication of a bibliography on science policy literature (including, of course, Unesco's own publication in this field).
(c) Publication of a glossary of terms.
(d) Establishment of a roster of inter-institutional links in science and technology, and the maintenance of a liaison service for research institutions wishing to participate in such co-operative agreements.
(e) Organization of comparative studies on specific problems (some of which have already been indicated in previous recommendations).
(f) Collection of national data relevant to science policy on standardized forms - say every two years - and publication of these data.
(g) Initiation of a joint programme undertaken by Departments of Science and Education to study the management, organization and rôle of universities in research, taking into account the context of national development in countries at different levels of development.

Recommendation 20. International and inter-regional co-operation in science policy

In the field of international and regional co-operation, the advantages of collaboration between different international political and regional groupings on matters of science policy are recognized.

All countries face common problems in developing their science policies, even though they must solve these problems differently in the light of their national political and economic structures.

Countries have much to learn from each other in science policy and one important source of information for this learning process is constituted by organized studies of science policy and data relating to science in various countries.

A number of intergovernmental organizations exist for encouraging such studies and statistical analyses. COMECON is stimulating such research on research. OECD has an active programme of science policy studies. OAS is stimulating studies of science policy, improved statistics on scientific manpower and so forth.

Unesco encourages studies of science policy and of resources for science on a world-wide scale.

The value of such studies to all countries would be increased and the burden of producing studies and statistical data would be decreased, if there were close collaboration at the technical level among the various international groups concerned with science policy.

It is therefore recommended that Unesco should offer its services as the agent through which means of recurring collaboration be made available for the exchange of information, for ensuring comparability of definitions, and so forth, in science policy studies conducted or planned by COMECON, OECD, OAS, OAU, and other regional intergovernmental organizations.

IV. FINAL RECOMMENDATION

The unique contribution of the Unesco Conference on Science Policy at Karlovy Vary has been to bring together countries with highly diverse economic, political and social systems for extended discussions of the national structures, processes and problems involved in the establishment of science policy. The participants found that these discussions contributed to better understanding not only of the systems of other countries but also of their own countries. Further meetings or symposia of this character, perhaps concentrating upon more specific areas of science policy, would be highly productive.

V. MOTION OF THANKS

The participants wish to express their deep appreciation of the warm hospitality of their Czechoslovak hosts, particularly of the Czechoslovak Academy of Sciences, and of the hard work of those who devoted themselves whole-heartedly to the success of the conference.

APPENDIX 1

AGENDA OF THE MEETING

1. Opening of the meeting by the President of the Czechoslovak Academy of Sciences or his representative

2. Address by the Director-General of Unesco or his representative

3. Election of Chairman, Vice-Chairman and Rapporteur

4. Adoption of the Agenda and organization of the proceedings of the meeting

5. Statements by participants on the principles, field of action and structural and operational aspects of the national science policy

6. Relations between the national scientific policy and the social, economic and cultural development

7. Basic data needed for elaborating the national science policy

8. International co-operation for the promotion of national science policies - the Unesco programme

9. Miscellaneous

10. Adoption of recommendations

11. Closing of the meeting

APPENDIX 2

LIST OF PARTICIPANTS

1. CHIEF PARTICIPANTS

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Dr. Henry David, Head, Office of Science Resources Planning, National Science Foundation, Washington, D.C.

YUGOSLAVIA

Mr. Tomo Martelanc, Secretary, Secretariat for Education and Culture, Slovenian Socialist Republic, Ljubljana

Dr. Kemal Kapetanović, Professor, Faculty of Metallurgy, Zenica

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Council for International Organizations of Medical Sciences

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France

Mr. Louis Gros, Conseiller technique, Délégation générale à la recherche scientifique et technique, Paris

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Dr. Jiří Nekola, Chief, Research Section, Institute for Science Planning, Czechoslovak Academy of Sciences, Prague

3. UNESCO

Representative of the Director-General

Professor Alexei Matveyev, Assistant Director-General for Science

Secretariat of the Meeting

Mr. Yvan de Hemptinne, Head, Division of Science Policy

Miss Nicole Visart de Bocarmé, Division of Science Policy

Observers

Mr. Ratchik Avakov, Office of Economic Analysis

Mr. Lawrence Alan Seymour, Office of Statistics

APPENDIX 3

LIST OF DOCUMENTS CIRCULATED AT THE MEETING

General documents

UNESCO/NS/ROU/101/PR.rev.: Agenda of the meeting
UNESCO/NS/ROU/102/PR: Purposes, scope, organization
UNESCO/NS/ROU/114/PR: List of the participants
UNESCO/NS/ROU/119/PR: General information
UNESCO/NS/ROU/122/PR: Rules of Procedure

Item 5 of the agenda

UNESCO/NS/ROU/105/PR: Considerations on the concept of science policy
UNESCO/NS/SPS/1: La politique scientifique et l'organisation de la recherche scientifique en Belgique
UNESCO/NS/SPS/2: Science policy and organization of scientific research in the Czechoslovak Socialist Republic

Item 6 of the agenda

UNESCO/NS/ROU/103/PR: Integration of scientific planning and socio-economic planning
UNESCO/NS/ROU/124/PR: Financial aspects of the integration of scientific policy with the economic, social and cultural development policy

Item 7 of the agenda

UNESCO/NS/ROU/85/PR: National science policy data
and ANNEX I: Guidelines for the elaboration of national science policy studies
UNESCO/NS/ROU/106/PR: International glossary of science policy - work plan

Item 8 of the agenda

UNESCO/NS/ROU/107/PR: Promotion of national science policies - Unesco's programme
UNESCO/NS/ROU/100: Survey of Unesco's activities and achievements with regard to science policy (1952 to 1965)
UNESCO/NS/ROU/117: The proposed science policy programme of Unesco for 1967-1968

UNESCO PUBLICATIONS: NATIONAL DISTRIBUTORS

Afghanistan	Panuzai, Press Department, Royal Afghan Ministry of Education, KABUL.
Albania	N. Sh. Botimeve Naim Frasheri, TIRANA.
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Iceland	Snaebjörn Jonsson & Co. H.F., Hafnarstraeti 9, REYKJAVIK.
India	Orient Longmans Ltd.: 17 Chittaranjan Avenue, CALCUTTA 13; Nicol Road, Ballard Estate, BOMBAY 1; 36a Mount Road, MADRAS 2; Kanson House, 1/24 Asaf Ali Road, P.O. Box 386, NEW DELHI 1. *Sub-depots:* Indian National Commission for Co-operation with Unesco, Ministry of Education, NEW DELHI 3; Oxford Book & Stationery Co.: 17 Park Street, CALCUTTA 16; *and* Scindia House, NEW DELHI.
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