No. 12

Science policy and organization of research in the Federal Republic of Germany

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PREFACE

The Unesco series " Science policy studies and documents " forms part of a programme " to collect, analyse and disseminate information concerning the organization of scientific research in Member States and the policies of Member States in this respect", authorized by resolution 2.1131 b. adopted by the General Conference of Unesco at its eleventh session in 1960, and confirmed by similar resolutions at each subsequent session.

This series aims at making available to those responsible for scientific research and development throughout the world factual information concerning the science policies of various Member States of the Organization as well as normative studies of a general character.

The *country studies* are carried out by the governmental authorities responsible for policy making in the field of science in the Member States concerned.

The selection of the countries in which studies on the national scientific policy are undertaken is made in accordance with the following criteria : the originality of the methods used in the planning and execution of the national science policy, the extent of the practical experience acquired in such fields and the level of economic and social development attained. The geographical coverage of the studies published in the series is also taken into account.

The *normative studies* cover planning of science policy, organization and administration of scientific and technological research and other questions relating to science policy.

This same series also includes *reports of international meetings* on science policy convened by Unesco.

As a general rule, the country studies are published in one language only, either English or French, whereas the normative studies and the reports of meetings are published in both languages.

The present Study on the science policy and organization of research in the Federal Republic of Germany has been prepared under a contract signed in March 1966 between Unesco and the Deutsche Forschungsgemeinschaft (German Research Association). Dr Claus Müller-Daehn, of that Association, was entrusted with the co-ordination of the various parts of the Study, which comprise the following :

Part One outlines the historical background of scientific development in the Federal Republic of Germany, and indicates the vicissitudes occasioned by political changes resulting from successive wars.

Part Two describes the existing science policy structure and the organization of scientific and technological research.

Part Three deals with the financing of scientific activities, including research.

Part Four examines questions relating to scientific manpower, from the points of view of training, supply and demand, and career conditions.

Part Five sets forth the principal aims of the country's national science policy.

Part Six provides a concise sketch of the economic background to the country's scientific activities.

Quantitative data regarding expenditure on scientific activities and details of numerous scientific organizations and projects are given in the tables and annexes. The institutional structure of the organization of science for the country as a whole and in several bodies of particular importance, is shown in organizational charts. The Study is completed by a collection of definitions of the principal concepts encountered in dealing with science policy, and a bibliography of relevant works published in the Federal Republic of Germany.

The opinions expressed in the study are the sole responsibility of the authors, and do not necessarily coincide with the views of Unesco.

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PREFATORY NOTE ON THE SCOPE OF "SCIENCE"

Any attempt at understanding the structure and functioning of scientific life in Germany and comparing it with the corresponding systems of other countries will meet with some specific difficulties involved in the interpretation of the terminology associated with the fundamental concept of "science".

Thus the very key word, "Wissenschaft", for instance, though commonly used as the translation of the English "science", is by no means identical with the usual connotation of the latter. Whereas the English word "science" normally refers to the natural sciences only, the German term covers the social sciences and the humanities as well, and thus corresponds rather to the English expression "sciences and humanities".

Furthermore, the concept of "Wissenschaft" covers not only the well-ordered store and system of human knowledge, but also a wide range of activities concerned with the acquisition, the dissemination, and sometimes even the application of such knowledge (cf. Annex 9, Concepts in the field of Science organization).

It is under the heading of "Wissenschaft und Forschung" (Science and Research) that all institutions and activities falling within this sphere appear in the Federal and "Lander" (State)[1] budgets, in the Constitution, in legislation and in common usage. Accordingly, the word "Science" in the title of the present Study, is to be interpreted in this wider sense.

1. The Federal Republic ("Bundesrepublick") of Germany is composed of a number of individual States, in German called "Länder". In the present Study, the English term will be used whenever this does not give rise to ambiguity.

Part one

THE HISTORICAL BACKGROUND OF SCIENTIFIC DEVELOPMENT IN THE FEDERAL REPUBLIC OF GERMANY

I. GENERAL

The development of science and research in Germany began in her traditional universities, of which that at Heidelberg (founded in 1386) is the oldest existing representative within the Federal Republic.

Stimulated by French ideas, but soon to take an independent course, the Brandenburg Scientific Society (Brandenburgische Societät der Wissenschaften), was founded in 1700; it later became the Prussian Academy of Science (Preussische Akademie der Wissenschaften). The Academies of Göttingen and München followed during the 18th century, and of Heidelberg and Mainz in the 20th century.

The technological and industrial progress of the 19th century opened up new possibilities for research. At the universities, the tendency to separate research from teaching increased, the traditional university institutes and departments moved towards greater independence, and new ones came into being. The increasing need of trade and industry for personnel with systematic education and professional training led to the development of separate establishments for education and research in technology. Thus the traditional universities eventually found themselves flanked by the technological universities (Technische Hochschulen). Of the nine Technological universities of the Federal Republic, seven date back to the 19th century.

Other research establishments were set up outside those institutions of higher education. The individual States and the "Reich" (German Empire) created separate public research institutes for direct service – often including the solution of practical problems – to the administration. Thus a number of State Institutes for Research and Testing ("Landesversuchsanstalten" or "Landesstellen") came into being. The great institutes set up by the national administration dealt with the humanities (e.g. the German Institute of Archaeology ("Deutsches Archäologisches Institut"), as well as the natural sciences and technology (e.g. the "Physikalisch-Technische Reichsanstalt", now the "Physikalisch-Technische Bundesanstalt" (Federal Institute for Physics and Technology).

Early in the 20th century, the practice was developed of founding separate institutes to concentrate exclusively on research. A memorandum dated November 1909 led to the creation of the "Kaiser-Wilhelm-Gesellschaft", which today is the "Max Planck Society for the Promotion of Science" (Max-Planck-Gesellschaft zur Förderung der Wissenschaft). It was formally founded in January 1911, and the years 1912 and 1913 witnessed the establishment of the first institutes; within a short period, there were 20 institutes for research in science, technology, and medicine, and another 4 in the humanities.

The first world war temporarily put an end to this promising development. In 1919, leading men from industry and commerce, science and politics realized the urgent necessity of promoting research again and helping German science to overcome the heavy losses in equipment, property and qualified manpower. Their initiative led in 1920, to the foundation of the Emergency Association of German Science (Notgemeinschaft der Deutschen Wissenschaft), which continues to exist today as the German Research Association (Deutsche Forschungsgemeinschaft). At about the same time the Donors' Association (Stifterverband) of the "Notgemeinschaft" was founded with the aim of raising private funds, particularly in industry and commerce, for the support of science. This organization, too, continues to exist today as the Donors' Association for Promoting Arts and Sciences in Germany (Stifterverband für die Deutsche Wissenschaft). The great depression of the early thirties impeded further development, and the subsequent course of German politics seriously affected the material and general working conditions of German research. After 1933, the hostility towards science that was part of the Nazi ideology made any plans for further development illusory. Numerous highly qualified scientists emigrated or were expelled. University enrolment decreased by as much as

50 per cent - from 111,600 in 1928/29 to 55,900 in 1938/39. The natural sciences and technology were affected just as much as the social sciences and the humanities. Then came wartime destruction: by 1945, about 60 per cent of all building and facilities for higher education and research were destroyed; many libraries had lost all their stock. Reconstruction could not be begun until 1949, and then the first years had to be devoted to creating anew the basic conditions for scientific work.

The "Basic Law", the 1949 Constitution of the Federal Republic of Germany, guarantees the freedom of research and teaching. In accordance with the principles of Federalism, the constitution provides for a distribution of responsibilities between the "Bund" (Federal administration) and the "Länder" (the individual States), leaving to the latter the legal responsibility for the universities and also the main share of the financial burden of their reconstruction.

The responsible public and academic authorities in Germany were facing a twofold task: they had to make up for wartime losses and destruction, and at the same time they had at least to try to cope with the enormus new demands resulting from the international development of science. It became obvious that this called not only for increased funds, but also for an appropriate organizational mechanism to lay the foundation for scientific development on a national scale. The Federation and the individual States had to co-ordinate their efforts, plans and financial programmes. Thus a set of bodies for planned development and co-ordination evolved. The first formal step was an organization for voluntary inter-State co-ordination, the Permanent Conference of the Ministers of Education and Cultural Affairs of the States of the Federal Republic of Germany (Ständige Konferenz der Kulturminister der Länder in der Bundesrepublik Deutschland). Its partners in the Federal administration were originally the Divisions for Education and Cultural Affairs in the Federal Ministry of the Interior and the Federal Ministry for Foreign Affairs. In 1955 a newly created Federal Ministry for Nuclear Energy - with limitations imposed on its competence by the Constitution - assumed the responsibility for co-ordination in this particularly important new field of science. In 1962, this Ministry was given a wider remit and took over some responsibilities from the Ministry of the Interior, at the same time being renamed as the "Federal Ministry for Scientific Research".

Already in 1957, the Federal and States administrations together had, by an Administrative Agreement, set up the Science Council (Wissenschaftsrat) as a major agency for co-ordination. This body has since, by a series of recommendations, exercised a decisive influence on the development of research and teaching, and has become an efficient instrument of co-ordination between the Federal administrations, the States, and the scientific community. In the meantime, other agreements between the Federal administration and the States have been concluded or are being negotiated.

The Federal Government further created a Cabinet Committee for Scientific Research, Education and Training, which may be taken as an indication of the special importance attached to these issues by the political authorities. In 1965, the Government published its first comprehensive report on the national policy for science, with a forecast for the years 1966 - 68. The second report was published in July 1967.

Besides the publicly administered institutions and bodies, there are a number of administratively autonomous bodies that are of special importance and have contributed essentially towards the national scientific development. The most important of these is the German Research Association.

A major share of research activity is carried on by the private sector. The bigger individual firms operate large laboratories of their own, medium-sized firms have joined together to maintain common research institutes or give research contracts to university and Max Planck institutes. In addition to financing their own research, industry and commerce donate considerable amounts to the Donors' Association for the Promotion of Arts and Sciences in Germany.

II. INSTITUTIONS OF UNIVERSITY RANK AND COMMON ACADEMIC ORGANIZATION (Wissenschaftliche Hochschulen)

1. *General*

In 1967 there were 23 Universities (Universitäten), nine Technological Universities (Technische Hochschulen) and four other institutions of university rank within the Federal Republic of Germany. The detailed list of these institutions is given in Annex 2; Three new Universities - at Bielefeld, Bremen and Dortmund - are to be established in the near future.

These Institutions of university rank - universities, technical universities, and a few other higher education institutions for teaching and research in limited areas of science - are identified in common by: the close integration of free research and teaching; a constitution providing for academic autonomy with a "Rektor" at the head, and appointment to the faculty through co-option; the right to award the doctorate and the "Habilitation" (post-doctorate degree implying qualification for appointment to professorship).

The highest authority of the university is the Senat; its members elect the Chancellor (Rektor) and the Vice-Chancellor (Prorektor). Each individual Faculty is headed by a Dean (Dekan), who is also elected by his peers.

Though all institutions of university rank are public institutions, they enjoy constitutional guarantees to ensure the freedom of research, teaching and learning.

2. The *Universities*. The traditional universities are, in the main, the oldest of the institutions of university rank. They have their origin in a common European movement of the Middle Ages. Following the foundations in Prague and Vienna, the first German universities were founded in Heidelberg (1386), Köln (1388), Erfurt[1] (1392) and Leipzig [1] (1409). These first foundations resulted largely from the secession of teachers and students from Prague and Paris.

Additional foundations followed in the course of the 15th century, bringing the total number of universities within the then territory of Germany to about 15. The conflict between scholastic tradition and Humanism, the struggle between Reformation and Counter-reformation, led to a large number of further foundations, some of a denominational character and founded by territorial princes. Unlike the oldest universities in Italy and France, the German ones were set up by the public authorities - mostly princes, some municipalities - and were thus to a greater degree subject to the supervision and general influence of these authorities. After a period of torpidity and unimaginative rote-learning in the 17th century, the Age of Enlightenment and the rise of mathematics and the natural sciences brought a new stimulus. Instead of simply handing down traditional knowledge, the universities now turned to the quest for truth. This tendency implied a struggle for freedom of research and teaching and for independence from princely or ecclesiastical influence. This is where the Universities of Göttingen and Berlin gained special importance; while the foundation of Göttingen bears special witness to the development of mathematics, the rise of the natural sciences and the practical interests of the 18th century, the Berlin foundation grew out of the partly conflicting concepts of the 19th century philosophers Fichte, Schelling, Schleiermacher and Humboldt, and was to exercise a marked influence on the development of science all through the 19th century. Up to that time, university science had mainly aimed at absorbing and passing on traditional knowledge, adapting it to suit didactic interests, systematizing it or offering a new synthesis; from the late 18th century onward, however, there was a growing spirit of penetrating into the unknown, of subjecting old doctrine to critical examination and searching for new knowledge. Exact research in mathematics and the natural sciences became more and more important.

In contradistinction to the situation in some other countries - where the emphasis remained on the transmission of established knowledge, supplemented by a system of general education developed through long experience, but leaving research rather to a set of separate institutes and academies - research in Germany remained to a large extent within the sphere of the university and became an important instrument in academic teaching and training. It was Humboldt's firm belief that sharing in actual scientific work would not only provide the student with the best possible academic training in his field, but would also develop in him the faculty of independent thinking, recognized as the essential prerequisite for professional activity. In consequence of this belief, the German university appears less concerned about the general education of its students than its counterparts in other countries, but is at the same time very serious and exacting in its endeavour to educate through scientific work itself.

This basic concept accounts for some characteristic features of the German university: the great systematic lectures ; the seminars, in which staff and students discuss special problems of their discipline; the principle of the freedom of learning, implying the student's personal responsibility for his studies, and his right to choose and change his university.

From the confrontation of this concept of the university on the one hand, and the concrete and practical demands for professional training which State and society are entitled to make on the universities on the other hand, there results a tension which makes itself as keenly felt today as ever, and may be considered fruitful and stimulating as long as the State acknowledges and appreciates the necessity for the freedom of science, and the world of science reciprocates by acknowledging its obligation towards society.

The German university as conceived by Humboldt and his contemporaries 150 years ago has, of course, been profoundly affected by the political, economic and social upheavals that have occurred since. The demands of modern science call for changes in the university structure to adapt it to the increasing requirements of research and teaching for manpower and facilities. Debate on these issues has gone on for decades and has grown in intensity since the second world war, as witnessed by the large number of memoranda, expert analyses and proposals that have appeared.

Of special interest in this connection are the newly founded universities and similar establishments which are still in the first stages of development; while keeping, in principle, to the Humboldt concept of the unity of research and teaching, they are searching for new forms and

1. Now in East Germany.

structures of university organization, and in some cases are even abandoning the traditional subdivision into faculties and disciplines. Time will show whether these new universities will in the long run also influence the adaptation process at the traditional ones.

3. *The Technological Universities*

The practical interest of the State in obtaining from the institutions of higher learning the qualified professional manpower needed for social and economic development led to the establishment of separate *institutions for technological training* in the early past of the 19th century. They quickly increased in numbers to satisfy the growing demand of industry for engineers and technicians. The universities justifiably considered them as being mainly establishments for professional or advanced vocational training of the type of specialists urgently needed by industry; this applied even to such institutions as the *Academy of Construction Engineering* (Bauacademie) and the *Academy of Trade* (Gewerbeakademie) in Berlin, though these had by 1870 adapted their teaching methods to those of the universities. The professional education of men for leading positions the universities still considered their own responsibility. Thus they established, in addition to the already existing chairs for financial studies and technology, new ones for the purely technical disciplines, such as mechanical engineering and hydraulics. This development came to a halt, however, when the polytechnics developed so rapidly and achieved such importance for industry and the economy that soon the idea of developing them into separate institutions of university rank prevailed. In Berlin, the " Gewerbeakademie " - which was training mainly mechanical and electrical engineers - and the even older " Bauakademie " - which dated back to the days of Schinkel[1] and served mainly for training civil engineers and architects - were merged in 1879 to form the *Technical University of Berlin-Charlottenburg* (Technische Hochschule Charlottenburg), with full university status. The polytechnics in other German States underwent a similar development. Thus technological training remained outside the traditional universities, but on the other hand the technological universities have to this day adhered to the same principles of training and education.

4. *Other institutions of university rank*

In addition to the universities and the technical universities, there are a number of *institutions of university rank* for teaching and research in special fields of science, to train qualified manpower for specific professions. Some of these establishments have after a relatively short period of independent existence been integrated into a university. The *College of Economics and Social Sciences* (Hochschule für Wirtschafts- und Sozialwissenschaften) at Nürnberg, for instance, was founded in 1949 and in 1961 became the sixth Faculty of the University of Erlangen-Nürnberg. The Wilhelmshaven *College of Social Sciences* (Hochschule für Sozialwissenschaften) founded in 1949, was absorbed by the University of Göttingen's new Faculty of Economics and Social Sciences in 1962. The former *College of Mining Engineering* (Bergakademie) at Clausthal, on the other hand, has been expanded into a full technological university, and the *Academy of Medicine* (Medizinische Academie) at Düsseldorf into a full university. Some institutions of this group still remain, and some new ones have been added (see Annex 2), especially in medicine and the natural sciences.

5. *West German Conference of University Rectors*

In 1949, the universities and other institutions of university rank in the Federal Republic of Germany combined to form the *West German Conference of University Rectors* (Westdeutsche Rektorenkonferenz). The Conference is based on the agreement between the academic authorities of its member institutions, and holds regular meetings with a view to arriving at a common policy on matters of common interest. Each university is represented in the Conference by its Rector.

6. *The Association of Universities Teachers*

Members of the university teaching staffs in the Federal Republic are organized in the *Association of University Teachers* (Hochschulverband), founded in 1950 as successor to the " Verband Deutscher Hochschulen " which was dissolved in 1934. Membership is voluntary. The purpose of the Association is to discuss and comment on all questions related to the function of its members in research and teaching, as well as on social, economic and professional questions having a bearing on the interest of the members.

7. The *Association of German University Students*, (Verband Deutscher Studentenschaften) founded in 1949, is the federal body representing university students in the Federal Republic. The delegates of the local student bodies of all member institutions meet at an annual general assembly to discuss student problems.

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1. A famous German classical architect of the 19th century.

III. THE MAX PLANCK SOCIETY FOR THE PROMOTION OF SCIENCE

This Socisty is the legal successor to the Kaiser Wilhelm Society for the Promotion of Sciences (Kaiser Wilhelm-Gesellschaft zur Förderung der Wissenschaft) which was founded in Berlin in 1911. Its aim was to establish and maintain special institutes for research, particularly in the natural sciences, where outstanding scientists could concentrate on research work without any teaching obligations.

In order to insure its complete independence, the Society was initially financed exclusively from private funds. A group of well-known men succeeded in winning about 200 persons of means and influence as donors. The initial amount thus made available was about 15 million reichsmark. The Society was completely free to decide on its scientific aims and projects. This freedom it still enjoys today, though in the course of time an increasing fraction of its finance has come to be provided from public funds.

Within the first year of the Society's existence, its first institute was established; this was the Institute for Chemistry, where Otto Hahn was later to make his discoveries in nuclear fission. The Society survived the two world wars, the great depression and the political events of the nineteen-thirties, although many of its directors and scientific members were driven into emigration.

Early in 1946 the Kaiser Wilhelm Society for the Promotion of Science was dissolved, and in February 1948, the Max Planck Society for the Promotion of Sciences was founded as its successor.

The core of the organization was formed by the old institutes. Others, such as the Kerckhoff Institute in Bad Nauheim and the Gmelin Institute in Frankfurt, were added. Then new institutes were established, and the older ones modernized and enlarged. Today, in 1967, the Society has again about fifty institutes with 1,200 scientists and a total staff of 5,500. The essential feature of the Society's work is that it will provide a highly qualified scientist with accommodation and equipment to enable him to carry on his research in complete independence and free from any teaching obligations. As a consequence of these specially advantageous conditions, scientific success has been great from the very beginning, Of the total of over thirty German Nobel prize winners within the last fifty years, more than half belonged to institutes of the Max Planck (or formerly the Kaiser Wilhelm) Society.

Many directors of Max Planck institutes also hold posts at universities, thus forming personal links between these two important sectors of scientific life in the Federal Republic.

One of the most important functions of the Society in the sphere of the national science policy lies in the promotion of new fields of research going beyond the borderlines of the established disciplines or requiring an interdisciplinary approach. Not having the teaching and training obligations which limit the operational freedom of the university institutes, and with a much higher degree of financial independence than the universities, the Max Planck institutes have the flexibility necessary for this task.

IV. THE ACADEMIES OF SCIENCES

1. *General*

Except for a forerunner - the German Academy of Naturalists (Deutsche Akademie der Naturforscher) - founded at Schweinfurt in 1652 and later developing into the "Leopoldina" at Halle - the first Academies of Science within the German-speaking territories were established in the 18th century: Berlin 1700; Göttingen 1751; München 1759. Almost a century later, there followed the foundations at Leipzig (1846) and Vienna (1847); the Heidelberg Academy was established in 1909, the one at Mainz not until 1949.

The founders of the early Academies were territorial princes, but the initiative of individual scientists - e.g. Leibniz in Berlin - made a considerable contribution. Unlike other scientific societies, the Academies have always had their existence guaranteed by the State. Their assignment was the promotion of science and knowledge in general, except as regards teaching, which remained the special task of the universities. Thus the State in those days, considering the universities mainly as training centres for its qualified personnel, assigned research to the Academies, and in their early days the older Academies established laboratories and institutes for scientific research which the universities did not have at that time.

In the 19th and 20th centuries, the Academies made contributions of special importance through planning, financing and directing large-scale scientific projects, such as the publication of dictionaries and important works. They took up many large projects which went beyond the capacity of an individual scholar. At a time when periodical scientific publications were little developed, the compilation and publication of research results by the Academies was of great importance; a similar purpose was served by the exchange of experience and opinion at the regular meetings of the members.

In the course of development, the Academies organized themselves into two classes or divisions, one orientated towards history, philosophy and philology, the other towards mathematics and the sciences.

These principles of organization and operation, which date back to the 18th century and were fully developed in the 19th, have essentially been maintained to this day. At the same time, however, the role of the Academies in 20th century scientific life has changed considerably. As the universities increasingly assumed responsibility for research as well as teaching, and as scientific research split up into more and more disciplines and an increasing number of separate institutes, the Academies could no longer claim to be the sole agents and legitimate centres of such research. The foundation of the Kaiser Wilhelm Society in 1911 marked an important turn in the history of the Academies, which after that date almost completely gave up their former practice of founding and operating their own institutes and limited themselves to setting up working groups for special projects. Institutions such as the *German Research Association* (Deutsche Forschungsgemeinschaft) took over from the Academies the chief responsibility for the general promotion of research.

Political developments, especially after the Second World War, affected the Academies severely. The Prussian Academy of Sciences (Preussische Akademie der Wissenschaften), which stands first by age, size, and scientific reputation, has undergone great changes since the division of Germany and Berlin; it continues to participate in certain common projects, but only on a limited scale. Of the six Academies within German-speaking territory that joined in 1893 to form the so-called " Kartell ", only those of Göttingen, Heidelberg and München are located in the Federal Republic. Mainz is a new foundation, and differs from the others in structure, since it appoints its members from anywhere in the Federal Republic and since it includes a special division for literature. These four Academies have established some organizational ties to form an association.

Their present position is that of scientific bodies with limited membership and a certain defined range of functions. Their scientific importance lies mainly in the projects which they initiate and sponsor. Their international scientific contacts are numerous and manifold.

2. *The Göttingen Academy of Sciences* (Akademie der Wissenschaften zu Göttingen) was founded in 1751 and has been since 1893 a public corporation (independent of the university). It has two divisions, one for philology and history and the other for mathematics and physics, with a maximum of 35 regular and 80 corresponding members in each, and twenty-six committees and special offices. Research results of members are published in the various series of Academy publications.

3. The *Bavarian Academy of Sciences* (Bayerische Akademie der Wissenschaften) was founded in 1759, with the status of a public corporation. It has two divisions, one for philosophy and history, the other for mathematics and sciences, with a maximum of 35 regular and 80 corresponding members in each; also thirty subject committees. The Academy partly finances some research establishments of its own, and their staff; it supports research projects of its members; and publishes proceedings, committee reports, special lectures and a yearbook.

4. The *Heidelberg Academy of Sciences* (Heidelberger Akademie der Wissenschaften) was founded in 1909, with the status of a public corporation. It has two divisions, one for philosophy and history, the other for mathematics and sciences, with a maximum of 35 regular and 50 corresponding members in each. The Academy supports the research work of its members and publishes its proceedings.

5. The *Mainz Academy of Sciences and Literature* (Akademie der Wissenschaften und Literatur zu Mainz) was founded in 1949, with the status of a public corporation. It has three divisions, one for mathematics and sciences, one for humanities and social sciences, and one for literature; maximum membership in each class 25 regular and 50 associate members. There are 28 subject committees. The Academy operates some research establishments with its own staff. Publications: literary and scientific reports; yearbook. The 4 Academies mentioned above form a separate association, i.e. the " Working Group of West German Academies " (Arbeitsgemeinschaft der Westdeutschen Akademien).

V. SCIENTIFIC SOCIETIES

Within the Federal Republic there are more than 500 societies within the fields of science, the humanities, and technology. They have sprung up within the last hundred years; many of them are small groups of highly specialized scientists, others cover wide subject fields and have hundreds of members. Many of these societies have members in other German-speaking countries, and many are still active in both parts of Germany, thus constituting important links between scientists in East and West.

Most of these societies have their regular meetings and publications, represent the interests of their fields in relations with public and academic institutions and organizations, and serve as national branches and correspondents in the respective international societies and associations.

The two largest societies are in the field of technology, namely, the *German Federation of Technological and Scientific Societies* (Deutsche Verband Technisch-Wissenschaftlicher Vereine), with more than 70 member organizations and about 160,000 members; and the *Association of German Engineers* (Verein Deutscher Ingenieure), dating back as far as 1856, with more than 44,000 members.

Though smaller in size, some other societies are still of great importance: these include: the *Association for Time and Motion Studies* (Verband für Arbeitsstudien REFA), with over 20,000 members: the *Association of German Electrical Engineers* (Verband Deutscher Elektrotechniker), with over 15,000 members; the *German Chemical Society* (Gesellschaft Deutscher Chemiker) with over 11,000 members; the *Association of German Ferrous Metallurgists* (Verein Deutscher Eisenhüttenleute), with over 9,000 members; the *German Society for Welding Technology* (Deutscher Verband für Schweisstechnik), with about 8,500 members; the *Association of German Architects and Engineers,* (Deutscher Architekten- und Ingenieurverband) with about 5,500 members; the *Society of German Naturalists and Medical Scientists* (Gesellschaft Deutscher Naturforscher und Arzte), with about 5,000 members; the *German Surveying Association* (Deutscher Verein für Vermessungswesen), with about 3,300 members; the *Association of German Physical Societies* (Verband Deutscher Physikalischer Gesellschaften), with over 3,200 members; the *German Society for Chemical Apparatus* (DECHEMA - Deutsche Gesellschaft für Chemisches Apparatewesen), with about 3,000 members; the *Senckenberg Naturalists Society* (Senckenbergische Naturforschende Gesellschaft), with over 3,000 members. In addition to these large societies, there are smaller associations, some of which can look back on almost a century of tradition, such as: the *German Association of Mathematicians* (Deutsche Mathematiker-Vereinigung), founded in 1891; the *Astronomical Society* (Astronomische Gesellschaft), founded in 1863; the *German Meteorological Society* (Deutsche Meteorologische Gesellschaft), 1883; the *German Botanical Society* (Deutsche Botanische Gesellschaft), 1882; the *German Zoological Society* (Deutsche Zoologische Gesellschaft), 1890; the *Anatomical Society* (Anatomische Gesellschaft), 1886; the *German Ophthalmological Society* (Deutsche Ophthalmologische Gesellschaft), 1863; etc.

VI. STATE INSTITUTES

A large group of research institutes outside the universities and the Max Planck Society are financed entirely by the Federal or individual States administrations and have a regular position in the respective State budget. They cover a wide range as regards discipline and organizational structure. Some of them date back to the 19th century; the *Imperial Office for Public Health* (Kaiserliche Gesundheitsamt), founded in 1876, and the *Imperial Institute of Physics and Technology* (Physikalisch-Technische Reichsanstalt), which was founded in 1887, on the initiative of Werner von Siemens, are examples. The latter foundation resulted from the realization that the rapid development of industry called for the creation of special institutions for research in science and technology where the staff would be free from teaching obligations. The Imperial Institute soon became a model for similar establishments in other countries (e.g. in the United Kingdom in 1900, in the United States in 1901). In Germany itself, several further institutes on this pattern were founded before the end of the century, especially for research in agriculture.

During the last fifty years, the number of such institutes has greatly increased; within the Federal Republic, there are now about 100 State institutes; while many of them are directly affiliated with a Government department and serve by their research the administrative purposes of that department, there are others whose research is independent of the sponsoring department's work and serves general scientific interests only. Some of these are the *German Archaeological Institute* (Deutsche Archäologische Institut) in Berlin; the *German Historical Institute* (Deutsche Historische Institut) in Rome; the Hahn-Meitner Institute for Nuclear Research in Berlin, and the Land Observatory on the Königstuhl near Heidelberg. The fact that administratively they are State institutes can only be explained from the historical development.

VII. INSTITUTES OF THE INTER-STATES KONIGSTEIN AGREEMENT (Königsteiner Staatsabkommen)

Among the research institutes financed by the Government, those covered by the Königstein Agreement form a special group. In the years following 1945, each of the States constituting the Federal Republic first concentrated on the task of reconstructing the universities and scientific establishments on its territory. There were, however, a number of institutions and establishments of national importance distributed over several States, varying in size and financial needs. In order to equalize the burden, the States in the U.S. occupation zone in 1947 made an agreement on the joint financing of these institutions, to which Berlin acceded. Then in March 1949, all the States of the Federal Republic became parties to the Königstein Agreement, which assured the joint financing of these institutions by

the Federal administration and the individual States for a period of five years ; this agreement has since been renewed several times and is still in force.

VIII. "BIG SCIENCES" ESTABLISHMENTS

For several years now, the Federal administration has sponsored projects in the big sciences and has - sometimes jointly with the individual States - provided the necessary institutional facilities under varying organizational and private legal forms. These institutions conduct research and development projects which are normally beyond the scope of university research, lying mainly within the fields of nuclear, space and aviation research.

The establishments of this kind which exist at present are : the *Nuclear Corporation* at Karlsruhe (Gesellschaft für Kernforschung) ; the *Nuclear Research Centre* at Jülich (Kernforschungsanlage) ; the *Corporation for the Use of Nuclear Energy in Marine Engineering and Ship Propulsion* (Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt) at Hamburg ; *The German Electron-Synchrotron (DESY)* (Deutsches Electronen-Synchrotron) at Hamburg ; The *Institute for Plasma Physics* (Institut für Plasmaphysik), München ; the *Hahn-Meitner Institute for Nuclear Research,* Berlin the *Radiation Research Corporation* (Gesellschaft für Strahlenforschung), München.

IX. THE GERMAN RESEARCH ASSOCIATION (Deutsche Forschungsgemeinschaft)

In 1919, shortly after the end of the First World War, a group of leading intellectuals in the Weimar Republic came to the conclusion that a special institution was required to assist in the endeavour to put scientific research in Germany on a firm foundation again. At a meeting of the Technological Association and the Association of Electrical Engineers in the summer of 1920, the proposal was brought before the public. On 30th October 1920, after a period of careful preparation, the *Emergency Association of German Science* (Notgemeinschaft der Deutschen Wissenschaft) was founded. The founders were the 40 universities and all the Academies of the Republic, the "Kaiser Wilhelm Society", the German Federation of Technological and Scientific Societies (Deutsche Verband Technisch-Wissenschaftlicher Vereine) and the Society of German Naturalists and Medical Scientists (Gesellschaft Deutscher Naturforscher und Arzte). In 1920, the national Parliament unanimously voted public support to the amount of 21 million marks. After the period of inflation and stabilization, public support was incorporated in the annual national budgets.

The foundation of the "Notgemeinschaft" was soon followed by that of the *Donors' Association for the Emergy Association* (Stifterverband der Notgemeinschaft In response to the initiative of a group of leading men in politics, business and science, sponsors from industrial organizations and individual firms were brought together by the realization that support for science was not the responsibility of the State alone, but that trade and industry ought to testify to their interest by financial support as well. In the last years of the nineteen-twenties, the immediate aim of the Emergency Association seemed to be achieved. It became clear, however, that a central organization for research, based on the principles of scientific autonomy, had become essential. The tasks that remained were co-ordination of research by the scientific community itself, representation of its interests at national and international levels, and financial support for individual research projects. Thus the scientifically autonomous organization prevailed. In 1930, it changed its name to the *German Research Association* (Deutsche Forschungsgemeinschaft). The far-reaching political changes of the nineteen-thirties soon destroyed the basis for scientific autonomy ; State influence increased. Though the organization was spared dissolution by the occupation authorities after the Second World War, it was not in a position to fulfil its proper assigment and was therefore liquidated by a members'assembly.

At a joint conference of all university "Rektors" and Ministers of Education of individual States within the British and U.S. occupation zones in 1948, it was unanimously agreed to re-establish an Emergency Association for German Science. The formal foundation meeting was held on 11 January 1949, at Köln University. In constitution and aims, it corresponded largely with its predecessor. As main source of public funds, however, the "Reich" had been replaced by the community of the States within the three Western occupation zones. Their delegates sat on two bodies which made the financial decisions - the *Main Committees* (Hauptausschuss) and the *Board of Trustees* (Kuratorium). On 1 March 1949, the Bad Godesberg office of the Emergency Association was opened. Almost simultaneously, on 9 March, the three West German Academies of Göttingen, Heidelberg and München and the Max Planck Society met at Stuttgart and founded the *German Research Council* (Deutsche Forschungsrat). On 15 August 1961, the Emergency Association and the Research Council combined to form one organization which took the name of "Deutsche Forschungsgemeinschaft" (German Research Association), like its predecessor of the nineteen-thirties.

X. FOUNDATIONS

1. *General*

There are a large number of scientific foundations in the Federal Republic, but as regards financial or scientific importance none of them can be compared to the very large foundations in other countries, notably in the U.S.A. Most of these rather small foundations specialize on fairly narrowly defined projects or aims.

Only three of them are of considerable importance. They are: the *Donors' Association for Promoting Arts and Sciences in Germany* (Stifterverband für die Deutsche Wissenschaft), though this is not strictly speaking, a true foundation; the *Volkswagen Foundation* (Stiftung Volkswagenwerk); and the *Thyssen Foundation* (Thyssen-Stiftung).

2. The present *Donors' Association* for promoting Arts and Sciences in Germany was founded in 1949, at about the same time as the Emergency Association described above; its predecessor was the Donors' Association of the years 1921 to 1945.

The basic idea, then as now, is that the responsibility for science promotion should not be left to the State alone, that trade and industry should be made aware of the importance of science and should be reminded of the close relation between economic and industrial development and scientific research, and that their obligation to support science and research beyond the immediate interests of the individual branch or firm should be made clear.

In the Donors' Association, about 4,800 associations, firms, and individuals from craft, trade, commerce and industry join to support science. The Association passes their contributions on to science, either as " free " money or ear-marked for a particular scientist, institute, or project. Regular contributions from the members, calculated according to definite criteria, constitute the basis of the funds; in addition, there are special donations.

The bulk of the Association's funds goes in lump-sum grants to central science organizations, which include them in their regular budgets. Individual support is given only in special cases.

As well as giving financial support, the Association has in the past fifteen years become a meeting place for science and industry which is of great value to both sectors.

In several series of periodicals and in individual publications, the Association furthers and serves the interests of science and research with the general public. A special statistical service for science compiles annual data on public and private expenditure for research.

In 1957, the Donors' Association, the *Federal Association of German Industry* (Bundesverband der Deutschen Industrie), and the *German Board of Industry and Trade* (Deutsche Industrie- und Handelstag), jointly set up the *Discussion Circle for Science and Industry* (Gesprächskreis Wissenschaft und Wirtschaft), where more than 150 personalities from teaching and research, business and the professions meet together with representatives of the public authorities to discuss problems affecting the scientific life of the country.

3. *The Volkswagen Foundation* (Stiftung Volkswagenwerk) originated in connection with the transformation of the Volkswagen automobile works into a private joint stock company. In November 1959 the Federal Government and the State of Lower Saxony, in which the works are located, concluded a treaty on the legal structure of the « Volkswagen G.m.b.H. » (i.e.Volkswagen Ltd.) and the establishment of a Volkswagen Foundation. By this treaty, the Volkswagen organization was transformed into a joint stock company, with Federal Government and State of Lower Saxony each holding 20 per cent of the capital. The remaining 60 per cent of the shares were to be offered to the public in small parcels, The annual profit on the 40 per cent held by the two. Government partners and the proceeds from the sale of the remainder were turned over to the Volkswagen Foundation, which was set up in May 1961. The purpose of the Foundation, which has a capital of over DM one billion[1] and an annual income of about DM 110 - 120 million, is to support research and teaching in science and technology. The Foundation covers the whole range of science, i.e. the natural sciences, the humanities, social sciences, and technology, but not technological development and testing. It does not itself engage in research nor does it support research establishments permanently; it limits itself to giving special grants to establishments for research and teaching, and to stimulating special projects where new and promising developments may be expected. Such support may be given to the universities and their seminaries, institutes and establishments belonging to scientific societies, and also to private non-profit-making research establishments.

4. *The Fritz Thyssen Foundation* (Fritz Thyssen Stiftung) was set up in 1960 as a private foundation. Its purpose is to support science at universities and research establishments, especially in Germany, with special emphasis on the training of promising young scientists. The Foundation gives financial support for limited periods to teaching and research establishments for certain well-defined projects and the publication of their results; and for other measures in line with its aims. The Foundation capital

1. Here and throughout this Study, " billion " signifies a thousand million, in accordance with U.S. usage.

consists of about DM 100 million's worth of shares of the " August Thyssen Hütte ".

XI. INDUSTRIAL AND APPLIED RESEARCH

1. *Intramural research*

After the Second World War, industrial research had to be rebuilt from practically nothing. The main problems were caused by war-time destruction, dismantling, lack of material and equipment, restrictions on research and loss of patents. In consequence of war losses and and post-war emigration, qualified personnel were scarce.

Research in the direct interests of industry in the Federal Republic is now conducted on several levels : in the larger *firms' own research* establishments ; in the various industrial research associations ; and on a contract basis in a wide range of research institutes throughout the country.

Industrial research by the individual firms is conducted mainly in the large plants of the main branches of industry, the scope and investment varying from branch to branch. In the larger firms, research and development are usually organized into a special division, whose head is in many cases a member of the board of directors. Thus the research division enjoys a considerable degree of independence within the firm, and the special issues and questions related to research can be brought directly before the board.

In addition to scientific and technological research and the development of new processes and products, industrial research usually also includes research on the application and economics of production methods.

2. *Co-operative research*

The beginnings of *co-operative research* in industry date back to the 19th century, but planned, systematic development of this type of research did not begin until after 1945.

Following recommendations and discussions initiated by the OEEC[1] and the Federal Ministry of Economic Affairs, a number of already existing industrial research associations combined in 1954 to form a *Federation of Industrial Research Associations* (AIF) (Arbeitsgemeinschaft industrieller Forschungsvereinigungen).

The aims of this organization are to facilitate the exchange of experience between its members, to co-ordinate research projects, to stimulate the concentration of research effort on fields of special importance, new or old, to advise on the establishment of new research associations in industry and trade, to advise and support its member associations' efforts to obtain public funds, to represent the members' general interests, and to act as a link between them and the public administration.

In addition to its regular members, the AIF has a number of associate members, i.e. organizations which support and foster its activities.

The member associations differ greatly in size and structure. Some possess a research institute in common (common institutes of a particular branch of industry ; research institutes at - not of - a technical university, founded and maintained by industry ; research institutes founded jointly by several industrial groups etc.) ; others sponsor research work in the interests of the particular industry by various means (industrial research societies ; scientific-technological societies for the general promotion of research in the public interest, etc.). The majority of member associations, however, have their own research institutes. The others have their research done on a contract basis by the institutes of their fellow-members, or by institutes of the individual or Federal States, the universities, the Max Planck Society, or other private institutes.

The funds of the AIF come from the Federal Ministry of Economic Affairs and from members' contributions as well as fees charged for the organization and execution of certain projects. A basic condition for support to member associations is that the latter also must carry an appropriate share of the total cost.

The member associations in turn obtain their funds from contributions of their member firms, from the Ministries for Economic Affairs of the individual States and from payments for contract research.

It may be assumed that the AIF includes about 80 per cent of those levels and branches of industry for which co-operative research is a practical proposition.

In addition to research by individual firms and co-operative research, there are a large number of other institutes, societies and working groups which deal with research in the interests of industry. They range from small private laboratories to institutes and working groups maintained by national organizations for trade and industry, by business associations, labour unions, and other interested groups. They vary greatly as regards structure, legal status, and programme.

Two public non-profit institutions, of widely different origin and importance, stand out from the general pattern, namely : *the Fraunhofer Society for the Promotion of Applied Research* (Fraunhofer Gesellschaft zur Förderung der angewandten Forschung) and the Battelle Institute.

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1. The Organization of European Economic Co-operation, now the Organization for Economic Co-operation and Development (OECD).

3. *The Fraunhofer Society* was founded in 1949. Its aim is to promote and facilitate scientific and technological research for the benefit of industry; to identify research problems whose solution would be of economic importance; to advise on and sponsor industrial research projects; to operate institutes for applied research. The Society also negotiates and distributes "free" and ear-marked funds for research, acts as clearing-house for administering public and other funds for research, and assists scientists in legal matters concerning the protection and exploitation of research results and inventions.

The Society has a number of institutes of its own, where both "free" research – mostly financed from public funds – and contract research are conducted.

The Society's "Patent Office for German Science" advises and supports scientists and inventors on all questions related to the legal protection of research results.

4. The *Battelle Institute* was founded in 1952; its purpose is to develop new scientific knowledge for industry through contract research. In 1966, it had a total staff of 901 in its several scientific departments.

XII. SCIENTIFIC LIBRARIES, DOCUMENTATION CENTRES AND PUBLICATIONS

1. *General*

Most of the *scientific libraries* in the Federal Republic can look back on a tradition of centuries. In many cases, the original intentions of the founders – ecclesiastical or princely, municipal or private – have left their mark to this day.

Not until the 19th century did it become generally accepted that systematic development and acquisition, regular administration, and availability of stock to a broad public were necessary prerequisites for the functioning of a library.

The losses which the German scientific libraries suffered during the Second World War are being made good where possible. With the support of a special programme of the German Research Association, replacement and modernization of stock are nearing completion. Present measures are mainly aimed at rationalization and technical improvement of facilities and service.

After the Second World War, the Deutsche Bibliothek (German Library) in Frankfurt was founded to maintain a complete collection of all publications in the German language, In doing so, it fulfils one of the functions of a national library for the Federal Republic.

2. In the big *university libraries,* special collections are built up in accordance with a plan devised and supported by the German Research Association, so that at least one copy of the scientific literature published on special subjects may be accessible in the libraries of the Federal Republic.

Specialized libraries covering practically every scientific subject are established at different points in the Federal Republic. Their structure varies. Some of them have been developed into central libraries for the respective branches of science, e.g. the Technische Informationsbibliothek in Hannover (Technology, Engineering), the Bibliothek des Instituts für Weltwirtschaft in Kiel (Economics), the the Zentralbibliothek für Landbauwissenschaft in Bonn (Agriculture).

The *Technology Library* in Hannover works in close touch with the European Translations Centre at Delft and keeps a record of the translations of Russian Scientific Publications available in the Federal Republic. It includes a special service for the exploitation of scientific and technical literature in East European, Chinese and Japanese languages.

3. *Scientific journals*, of which about 1600 are published in the Federal Republic, are the principal and most comprehensive source of information on research findings. German scientific journals are systematically listed in the *Verzeichnis deutscher wissenchaftlicher Zeitschriften,* and there is a separate union catalogue for foreign journals and serial publications, namely the *Gesamtverzeichnis ausländischer Zeitschriften und Serien,* which lists all the foreign journals available in the libraries of the Federal Republic and indicates where they can be found. Since 1962, a general catalogue covering all the Russian journals available in West German libraries, both old and new, has been issued under the title *Gesamtverzeichnis russischer und sowjetischer Periodika und Serienwerke.*

Many research organizations and institutions regularly publish the titles of research projects financed by them. For instance, in its annual reports the German Research Association publishes a summary of all the projects which it has sponsored during the year; the Max Planck Society includes in its yearbook a table listing the publications of the Society's institutes; and other organizations do likewise.

Finally, many institutes and societies publish reports of their own scientific activities.

4. Some idea of the *documentary material* available in many departments is given in the *Documentation Centres Index* (Verzeichnis von Schrifttum-Auskunftstellen) which is published jointly by the *German Standardization Committee* (Deutsche Normenausschuss) and the *Rationalization Research Institute* (Forschungsinstitut für Rationalisierung) attached to the Technical University of Aachen.

In 1961, the increasing importance of scientific documentation was recognized by the foundation of

the Max Planck Institute for Documentation in Frankfurt. Its task is not to engage in documentation services itself, but to serve as a centre and clearing-house for planning, co-ordinating, and promoting scientific documentation both nationally and in international co-operation.

As regards the international exchange of publications, the Libraries Division of the German Research Association acts as a clearing-house for the Federal Republic, and in this capacity works in close touch with Unesco.

Part two

THE ORGANIZATION OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH : INSTITUTIONAL STRUCTURES AND OPERATIONAL LINKS

I. GENERAL

The organizational pattern for the promotion of research in the Federal Republic of Germany is determined by : the federal structure of the country ; the autonomy of the institutions of higher education and of the large scientific organizations : the important role of the institutions of higher learning not only in the teaching of science, but also in research ; the promotion of so-called " big science " from public funds through the Federal Government ; the fact that all institutions of higher education are public institutions maintained by the Federated States .

The following eleven States constitute the Federal Republic : Baden-Württemberg ; Bayern (Bavaria) ; Berlin (West) ; Bremen ; Hamburg ; Hessen ; Niedersachsen (Lower Saxony) ; Nordrhein-Westfalen (North-Rhine-Westphalia) ; Rheinland-Pfalz (Rhineland-Palatinate) ; Saarland ; Schleswig-Holstein.

The Basic Law, i.e. the Constitution adopted by the Constitutional Assembly (Parlamentarischer Rat) in 1949, defines certain State functions as coming under the responsibility of the Fedral Government ; any functions not so ascribed remain with the individual States. Under this Constitution. legislation in respect of the promotion of scientific research falls within the competence of the Federal authorities (Article 74, Number 13) ; the Federal Parliament may may pass legislation in this field in the following cases :

When a given issue cannot be dealt with satisfactorily by legislation of the individual States ;

When legislation by an individual State might be detrimental to the interests of other States or to those of the Federation ;

When Federal legislation is called for in the interests of maintaining uniformity of legal status, of the economic system, and in particular of living conditions throughout the various States (Article 42).

In practice, science promotion by the public authorities has developed within the existing framework without special legislative measures.

II. THE ORGANIZATION FOR THE PROMOTION OF SCIENTIFIC RESEARCH

1. *The Federal Administration*

(a) *Organization.* Though the Federal administration has not so far used the competence for legislation in this field which it has been given by the Constitution, it has within the past decade taken an increasing share in the promotion of scientific research This has been mainly due to the fact that the development of certain fields of science and the extension of universities called for financial support and organizational measures that went beyond the means of the individual States. Furthermore, international scientific co-operation - as for instance in Unesco, OECD, EURATOM, ESRO, ELDO, and ESO - has created new functions and tasks in which the Federation has had to assume its share.

This development has been reflected in organizational changes.

(i) In 1962, the Federal Ministry for Nuclear Energy was transformed into the *Federal Ministry for Scientific Research*, which was given the responsibility for all Federal Government activities concerning the promotion of science not directly within the sphere of responsibility of other Government Departments. In addition, this Ministry is responsible for the co-ordination of all activities related to scientific research among the various Federal Government Departments. In the discharge of its responsibilities, it is advised by the German Atomic Energy Commission (Deutsche Atom-Kommission), the German Commission for Space Research (Deutsche Kommission

fuer Weltraumforschung), and the Advisory Committee on Data Processing (Fachbeirat für Datenverarbeitung).

(ii) A *Cabinet Committee for Scientific Research, Education and Training* was formed in 1965 to co-ordinate scientific research, to consult on all questions relating to the promotion of science which do not come before a full Cabinet meeting, and to prepare the discussion of pertinent topics in full Cabinet. Its members are 10 (of the total 20) Federal Ministers, with the Minister for Scientific Research in the Chair as permanent proxy for the Chancellor.

(iii) There is also an *Interministerial Committee for Science and Research* on which almost all Federal Ministries are represented by senior civil servants; this Committee provides guidance to the Federal representatives on the Science Council.

(iv) Within *Parliament*, the *Committee for Science, Cultural Affairs and Information Media* is especially concerned with all matters related to the promotion of science.

(v) Within the *"Bundesrat"* - the second legislative body of the Federal Republic, formed by representatives of the individual States - the States Ministers responsible for cultural affairs constitute a *Committee for Cultural Affairs.*

Aside from departmental research and similar projects closely related to the activities of the individual Ministries, the *Federal Government Programmes* for the promotion of science are concentrated on the following five areas: General promotion of science; Nuclear research and development; Space research; Defence research; General student scholarship programmes.

In addition, a programme for the promotion of Computer Research and Development has been initiated very recently.

Of these, the programmes for general science, nuclear, space, and computer reserach come under the responsibility of the Federal Ministry for Scientific Research.

(b) *Programmes.*

(i) Under the *general science promotion programme*, the Federal Government gives financial support to:

- the expansion of the existing universities and the construction of new medical academies; it is intended to include also the construction of other new institutions of higher education (universities, technical universities) in this programme of Federal Government support;
- the German Research Association;
- the Max Planck Society;
- the development of scientific documentation;
- certain research institutes of national importance;
- the Academy of Sciences.

The participation of the Federal Government in the financing of university expansion began in 1957, when rapidly increasing student numbers and the general development of science resulted in startling increases in the needs of institutions of higher learning and for scientific research in all disciplines. In 1964, it was given a firm basis in an administrative agreement between the Federal Government and the individual States, in which the former bound itself to contribute at least DM 250 million every year to the cost of university expansion. Actually, this sum has been considerably exceeded in recent years: in 1967 it was DM 530 million.

The funds are allocated to the individual States in accordance with recommendations of the Science Council[1] (see below), which each year lists those construction projects recommended for Federal support.

The 1964 administrative agreement expired in 1966. While negotiations on a new agreement are in progress, Federal support to university expansion continues, though at present not based on a formal agrrement.

The 1964 agreement further stipulated that Federal Government and individual States should each provide 50 per cent of the public funds needed by the German Research Association and the Max Planck Society. For implementing this part of the agreement, an Administrative Committe of senior civil servants has been set up consisting of six Federal representatives (from different Ministries) and one representative of each of the eleven States (either from Ministries for Cultural Affairs or from Finance Ministries). This Committee examines the financial demands submitted by the two research organizations - particularly where based on plans for new projects or the establishment of new institutes - and then fixes the amount of public support to be given. The 50 per cent of the total to be provided by the eleven States is levied according to a certain code laid down in the Königstein inter-State Agreement (see Part One/VII).

German research institutes abroad (Historical Institutes in Rome and Paris; Archaeological Institutes) are maintained entirely from Federal

1. In the body of this Study, the names of institutions mentioned frequently are given only in English. To permit unambiguous identification, the corresponding English and German names are listed together in Annexes 1 to 6.

funds. Some research institutes of national importance within the country are financed in part by the Federal Government under its programme for the general promotion of science, with the remainder of the necessary public funds usually covered by the individual States. The Federal Government also gives financial support to the Academies of Science.

(ii) The Federal programme for the *promotion of nuclear research* is intended to serve the development of nuclear science and technology for peaceful uses. Whereas in the programme for the general promotion of science outlined above the major share of the funds is placed at the disposal of competent institutions for their general purposes and not tied to specific projects, funds under the nuclear research programme are given to university and other research institutes (e.g. those of the Max Planck Society) for specific projects, as well as in general support of competent research institutions. Federal funds may also be used to finance investments (construction or equipment); where the recipients of such support are research institutes normally financed by an individual State, the Federal support will – as in the case of the universities – normally be 50 per cent.

Federal support in the field of nuclear research covers activities ranging from basic research through applied research and technological development to the construction of demonstration nuclear power plants. It thus represents an instance of the close interrelationship between science and economic policy which is a typical feature of modern "big science". The Federal Government also supports the training of qualified manpower for nuclear science and shares the responsibility for the country's participation in the work of international organizations (for details, see Part Five below).

Federal activities in this field are based on a national "Nuclear Programme" ("Atomprogramm"), which was formulated by the German Atomic Energy Commission to cover the years 1963-1967. The Commission continues to serve the Federal Government in an advisory capacity.

(iii) In the promotion of *space research*, as in nuclear research, Federal activity is not limited to the allocation of funds to specialized institutions for use as determined by them, but includes support to university and other research institutes for specific projects. Activities cover the range from basic research to satellite technology. For the execution of projects in this area that are to be carried out through special development contracts and in close co-operation with private industry, the Federal Government has set up, and operates through, a special agency with private company status, Space Research Ltd. (Gesellschaft für Weltraumforschung GmbH).

To advise the Federal Government in all matters related to space research, the German Commission for Space Research has been formed. It has provided the Government with guide-lines for its activities in the shape of a detailed memorandum on the status of space research and plans for its development in the period from 1966 to 1970 (for details, see Part Five).

The Ministry for Scientific Research has quite recently developed a medium-term plan for space research which has been approved by the Government; it shows the individual measures planned and the development steps envisaged up to 1971. In the field of space research, international co-operation is of particular importance.

(iv) Unlike many other countries, the Federal Republic has not developed a special organization for *defence research*. Responsibility for defence research rests with the Federal Ministry of Defence, which allocates its funds for this purpose to various research institutes. Projects of importance for national defence fall mainly within the scientific and technological disciplines. Private industry, too, carries out a large number of defence research projects on a contract basis.

For advanced development and testing purposes, a centre with testing facilities for common use has been established; it is operated by the Industrial Facilities Corporation (Industrieanlagenbetriebsgesellschaft), which was founded for that purpose.

(v) The development of qualified scientific manpower is considered part of the overall programme for the promotion of science and research. Within the legal framework provided by the so-called "Honnef[1] Modell", the Federal Administration (through the Ministry of the Interior) and the individual States provide funds for a *general scholarship programme for students* at institutions of university rank.

The Federal Administration also finances various other scholarship programmes, such as international student exchange, academic training for the special requirements of certain Government Departments (e.g. Transport, Communications, Defence), assistance to persons especially affected by the War or post-war events, special programmes designed to counteract the consequences of the partition of Germany, and

1. Honnef is the name of the town where this arrangement was concluded.

the National Student Scholarship Foundation (Studienstiftung des deutschen Volkes) which grants scholarships to particularly gifted students.

(vi) Several Departments of the Federal Government operate research institutes to carry out research projects directly related to their legislative or administrative functions. This *departmental research*, or administration-related research, though quite important, takes only a small share of the total Federal funds for research and of the qualified manpower engaged in research. The Departments mainly concerned are: Economic affairs; Food, agriculture and forestry; Post and telecommunications; Transportation; Social Welfare and health; Law and administration; Libraries and documentation; Foreign policy and Development aid policy.

2. *The individual States*

(a) The policy of the individual States in the field of science promotion comes under the competence of the *Ministers responsible for education and cultural affairs.* Their exact designation varies from State to State: in the City States of Berlin, Bremen and Hamburg, the heads of departments are called 'Senators' rather than "Ministers". Moreover Government responsibilities for education and cultural affairs, which are centered in one department in most States, are divided in Berlin (with one Senator for science and arts, and one for education) and in Hamburg (one Senator for education together with science and one for cultural affairs).

(b) Nordrhein-Westfalen has, in addition to the Ministry for Cultural Affairs, a "Landesamt für Forschung" (*Office* for the promotion of scientific research) which is under the direct authority of the Prime Minister.

(c) The primary objective of the States' policy for the promotion of science is the maintenance of "wissenschaftliche Hochschulen". This term comprises all *institutions of higher education* which have the right to administrative autonomy, to have a Rektor (Vice-Chancellor) as constitutional head, and to grant academic degrees and "Habilitation" (post-doctoral degree indicating qualification for appointment to professorship). At these institutions of university rank, scientific research is conducted in altogether about 3 000 institutes.

Whereas the running costs of these institutions are borne by the States alone, the Federal Government contributes up to 50 per cent of the cost of construction under the expansion programme for existing universities. As mentioned above, this is done on the basis of administrative agreement between Federal and State Governments. A similar agreement for co-financing the construction of new universities is being negotiated. In the meantime, the States have agreed among themselves to finance jointly the construction of the universities of Bochum, Bremen, Dortmund, Konstanz and Regensburg, while the Federal administration – without prejudice to commitments to be entered into by later formal agreement – is contributing to the construction costs of the Medical Academies in Hannover and Lübeck.

(d) Besides the universities and similar institutions, a great variety of *independent research institutes* receive finance from the States, either as their sole source of funds or in a co-financing scheme with the Federal administrations; the States also support other institutes through grants-in-aid or for specific projects. They have further established a number of Government research institutes to serve the needs of certain branches of the administration.

(e) In the *Königstein Agreement* of 1949, i.e. even prior to the foundation of the Federal Republic, the States already agreed among themselves on the joint financing of certain research institutes of national importance. Under this scheme, the States provide, for instance, 50 per cent of the public funds going to the German Research Association and the Max Planck Society, the other half coming from the Federal administration. A joint conference of all States Ministers responsible for science and for finance, and an administrative inter-States committee of senior civil servants supervise the execution of the Königstein Agreement.

(f) *Communities and municipalities* participate only on a small scale and in a very limited number of cases in the public promotion of research. They have not established any special offices or organizations for this purpose.

3. *Non-Government Agencies and Institutions*

(a) The *German Research Association* is the largest and most important independent organization for the promotion of research in the Federal Republic. It is an autonomous organization of the scientific community, i.e. an organization in which all decisions are made by scientists or by bodies with scientists in the majority. Its legal status is that of a private registered society. Its members are:

- the universities and similar institutions of university rank;
- the Max Planck Society for the Promotion of Science;

- the Academies of Sciences;
- the Society of German Naturalists and Medical Scientists;
- the German Federation of Professional Science and Technology Associations;
- the Federal Institute of Physics and Technology;
- the Fraunhofer Society for the Promotion of Applied Research.

The Association has the following policy bodies:

- the General Assembly of Members;
- the Executive Board, consisting of a full-time President and four honorary Vice-Presidents as full members, together with the Chairman of the Donors' Association for Promoting Arts and Sciences in Germany and the Secretary General of the Research Association in an advisory capacity;
- the Senate, consisting of 30 scientists, elected by the Members' Assembly, the Presidents of the: West German Conference of University Rectors and the Max Planck Society, and the Chairman of the Working Group of West German Academies;
- the Board of Trustees (Kuratorium), consisting of the Senate members plus six representatives of the Federal Government, one representative of each of the eleven States Ministries responsible for science, and five representatives of the Donors' Association for Promoting Arts and Sciences in Germany;
- the Main Committee, comprising 15 scientists appointed by the Senate, six representatives from the Federal and six from the States Governments, and two representatives of the Donors' Asssociation for Promoting Arts and Sciences in Germany.

The basic policy decisions are made by the Senate. The Main Committee decides on the allocation of research funds. Incoming applications are judged on their scientific soundness and promise by scientific experts in a total of 26 special consultant committees. The scientists serving on these committees, about 300 in all, are appointed by their qualified colleagues in the relevant societies, in secret elections.

Science policy issues and problems of general importance are discussed in a number of Senate commissions.

A special committe for applied research maintains the link with industry.

The scope of the Association's activity is indicated by the following main programmes:

- Support to research projects of individual scientists in all fields of scientific endeavour through full or partial payment of the expenses for personnel, material and equipment (Normal Procedure Grants, mainly in response to application);
- Planned development, through financial support, of special areas of research defined by the Senate (Priority Procedure Grants, projects often started on the Association's initiative (see Annex 7 Priority Programme);
- The procurement of costly facilities, e.g. computers for universities and other institutes of university rank;
- Support of interdisciplinary co-operation through the establishment and financing of interdepartmental research groups;
- Development of qualified scientific manpower through the award of "Habilitation" fellowships to promising candidates for academic careers;
- Support of research projects involving international travel, though travel grants;
- Support to scientific libraries and documentation programmes.

The Research Association also maintains certain scientific service installations which are at the disposal of all scientists, and performs numerous functions in the field of international co-operation among non-government organizations.

The major share of the Association's funds comes from public sources, the Federal administration and the States as a group each providing one half. Additional funds come from other sources, notably the Donors' Association for Promoting Arts and Sciences. The total budget for 1967 was DM 174 million, of which DM 152 million were provided by Federal and State administrations (see Table 1).

(b) In 1961, the Volkswagen organization was transformed into a limited company. Concurrently, the Federal Government and the State of Lower Saxony established a private foundation called the *Volkswagen Foundation.* The purpose of this body is to promote teaching and research in science and technology by making grants to a wide range of research institutions and projects.

Policy and allocation decisions are made by a Board to which the Federal Government and the State of Lower Saxony each appoint seven members from various spheres of science and public life.

(c) The *Fritz Thyssen Foundation* has been set up as a private foundation, the capital consisting of industrial shares having a nominal value of DM 100 million, yielding an annual income of DM 10-12 million. Its purpose is to support the education and training of qualified manpower; its organs comprise a Board of Directors, a Board of Trustees, and a Scientific Advisory Council.

(d) The *Donors' Association for Promoting Arts and Sciences in Germany* (see Part One/X/2) was founded on a new basis in 1949 for the purpose of raising private funds, in particular

TABLE 1: THE FINANCIAL DEVELOPMENT OF THE GERMAN RESEARCH ASSOCIATION, 1949-1967, SHOWING SOURCES OF FUNDS

Year	States	Federal Government	Trade and Industry	Miscellaneous	Total
1949	1,989,000			684,765	2,673,765
1950	3,567,000	1,500,000	754,500	4,113,774	9,935,274
1951	5.000,000	1,920,040	636,200	1,509,073	9,065,313
1952	6,000,000	2,400,000	1,024,170	2,203,666	11,627,836
1953	6,000,000	9,750,000	1,348,060	1,751,043	18,849,103
1954	6,500,000	13,580,000	1,960,788	124,063	22,164,851
1955	6,500,000	14,900,000	2,246,300	1,021,627	24,667,927
1956	8,000,000	38,600,000	3,645,000	1,891,973	52,136,973
1957	8,000,000	55,283,578	5,210,859	2,109,424	70,603,861
1958	8,500,000	63,576,102	5,660,000	2,288,432	80,024,534
1959	9,000,000	56,309,094	7,790,000	2,217,265	75,316,352
1960 [1]	7,500,000	32,000,000	10,418,935	1,983,470	51,902,405
1961	12,000,000	42,521,190	10,400,000	2,850,500	67,771,690
1962	17,000,000	64,800,000	14,822,915	2,107,099	98,730,014
1963	24,000,000	72,358,500	22,245,500	2,262,055	120,866,055
1964	33,167,004	70,065,000	14,455,000	2,346,650	120,033,694
1965	58,000,000	59,285,000	19,489,090	4,375,391	141,149,836
1966	67,511,500	70,135,000	21,257,248	4,560,949	163,464,697
1967	74,250,000	78,000,000	17,820,000	3,600,100	173,670,100

1. Fiscal Year of 9 months.

in industry, for the support of scientific research. Unlike the foundations, the Donors' Association has no capital of its own, but is dependent on annual membership fees and donations. The latter are solicited separately for general purposes, to be used at the discretion of the Association, and for special projects and purposes. Of the general purpose funds (about DM 22 million in 1966), the major share is given to the DFG.

(e) Besides these private organizations described above, a large number of *smaller foundations, scientific associations and societies* are active in the field of science promotion. The activities of these organizations are, however, directed towards increasing scientific knowledge and a general understanding of science or towards the discussion of broad problems of science policy, rather than towards direct financial support of research.

(f) Corresponding to the increasing importance of research for economic development and productivity, research expenditure in *private industry* has risen steeply. Important firms, particularly those in the chemical and electrical industries, operate large research establishments of their own. Smaller firms have formed associations, for making research facilities available to all members. These associations again have joined in the Federation of Industrial Research Associations – Otto von Guericke Society (Arbeitsgemeinschaft industrieller Forschungsvereinigungen, Otto von Guericke Gesellschaft) which, in addition to membership fees, receives an annual grant from the Federal Ministry of Economic Affairs. Industrial organizations also place contracts for research work with university institutes.

III. CENTRAL BODIES FOR PLANNING, CO-ORDINATION AND ADVICE

1. *General*

By developing medium-term programmes and identifying and recommending points of emphasis for the promotion of scientific research, some of the above mentioned agencies – in particular the Science Council (described in detail below), the national Committees for nuclear and space research and the German Research Association – also fulfil certain functions of policy planning, co-ordination and advice (see Chart 1).

In addition, there is a unit responsible specially for research policy planning in the Federal Ministry for Scientific Research. At present, moreover, a special planning division is being set up in the office of the Federal Chancellor, which will also be concerned with science, research and technology.

Every two years, the Federal Government publishes a comprehensive report[1] on its activities in the promotion of science and research, wich includes a survey of the underlying policy principles and aims for the future.

2. *Co-ordination between Federal and States Governments*

(a) *General.* Since under the Federal Constitution a large part of the responsibility in the field of science policy is assigned to the individual States, the issue of co-ordination acquires special importance. In certain cases, such as the promotion of nuclear and space research in university establishments, co-ordination is achieved by the Federal Government. In addition, Federal and States Governments have established several bodies with the assignment of ensuring continuous and comprehensive co-ordination of policy, as follows:

(b) The *Science Council* is the most important body for national co-ordination and advice in the field of science and research. It was established on 5 September 1957, by an administrative agreement between Federal and States Governments. Its members conprise:

- six representatives of the Federal Government (Deputy Secretaries of State) who jointly possess eleven votes;
- one representative of each of the eleven States (Ministers);
- sixteen scientists, appointed for three years by the President of the Federal Republic on the joint proposal of the Max Planck Society, the German Research Association and the West German Conference of University Rectors;
- six leading figures from public life, three proposed by the Federal Government and three by the States Governments, and appointed by the President of the Federal Republic.

The terms of reference as laid down in the administrative agreement are:

- on the basis of the individual plans prepared by the Federal and States Governments in accordance with their spheres of responsibility, to develop an overall co-ordinated plan for the promotion of science, and to establish points of special importance and a scale of priorities;
- to establish an annual priority programme;
- to make recommendations on the allocation of the funds provided in the Federal and States budgets for the promotion of science.

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1. The most recent in this series is "Bundesbericht Forschung II", published by the Federal Minister for Scientific Research, 1967.

The representatives of the two Government levels constitute the Council's Administrative Committe, those from science and public life the Science Committee.

In pursuance of its assignment, the Science Council has submitted a series of comprehensive recommendations which have greatly influenced and improved the development of policy and facilities within the universities as well as in non-university research. The series so far comprises the following:

' Empfehlungen zum Ausbau der wissenschaftlichen Einrichtungen ' (Recommendations for the Development and Expansion of Scientific Institutions):

- Part I: Wissenschaftliche Hochschulen (Universities and Institutions of University Rank) (1960);
- Part II: Wissenschaftliche Bibliotheken (Scientific Libraries) (1964);
- Part III: Forschungseinrichtungen ausserhalb der Hochschulen, Akademien der Wissenschaften, Museen und wissenschaftliche Sammlungen (Non-university Research Establishments, Academies of Science, Science Museums and Collections) (1965);

' Empfehlungen zur Neugliederung des Lehrkörpers an den wissenschaftlichen Hochschulen ' (Recommendations on the Re-organization of University Faculty and Teaching Staff) (1965);
' Empfehlungen zur Neuordnung des Studiums an den wissenschaftlichen Hochschulen ' (Recommendations on the Reform of University Study and Curricula) (1966).

The Science Council annually advises on the allocation of the funds that the Federal Government makes available for university expansion. These recommendations list each construction project and the amount of Federal support considered necessary. Quite recently, in July 1967, the Council adopted a further set of comprehensive recommendations on the development of universities and institutes of university rank until 1970, ' Empfehlungen des Wissenschaftsrates zum Ausbau der wissenschaftlichen Hochschulen bis 1970.' These do not limit themselves to quantitative aspects, but also deal with such qualitative issues as university structure and study reform.

Though the recommendations are not legally binding on either the Federal or States administrations, they are the fruit of close co-operation between scientists and high-ranking representatives from the competent departments of both those administrations. Thus they carry considerable weight and have in the past to a large extent been accepted by the administrations, notably as regards the expansion of research facilities in general and those for university teaching and research in particular.

In fact, the financial expenditure and its results have in some sectors exceeded the scope of the recommendations. On the other hand, there has not yet been sufficient time to put into full effect those recommendations concerned with structural reform of the university, study programmes and faculties.

In the preparation of its recommendations, the Science Council is assisted by a number of committees whose members – scientists as well as representatives of the two Government levels – need not be members of the Council proper. Thus a large number of scientists are contributing to the work of the Council.

It has become a frequent practice to consult the Science Council on the establishment of new research institutes. At present the Council is preparing a set of recommendations on the identification and selection of special areas of research and the means to ensure their effective development through a concentration of facilities, manpower and funds.

(c) By an administrative agreement dated 4 June 1964, a *special administrative committee* was established to decide on the annual amount of public support *for the Max Planck Society and the German Research Association*, of which Federal and States Governments each provide one half. The Committee is composed of six Federal representatives and one from each of the eleven States.

3. *The Federal level*

(a) At the Federal Administration level, there are a number of bodies for planning and co-ordination in various important sectors of science and science policy. The most important of these are affiliated with the Ministry for Scientific Research.

(b) The establishment of the *German Atomic Energy Commission* was decided by the Federal Government in 1955; its terms of reference are to advise the Federal Minister for Scientific Research on all questions related to nuclear research and technology for peaceful purposes. The Minister appoints the members of the Commission and himself acts as Chairman. There are five special committees, namely:

- Law and Administration; Nuclear Research; Nuclear Technology; Radiation and Safety Problems; Economic, Financial and Social Questions. Some of the committees have in turn established working parties on special issues.

Membership in these committees and working parties is not limited to members of the Commission itself.

In its Nuclear Science Programme the Commission draws up medium-term plans for the promotion of nuclear research which serve as guidelines for the national programme.

(c) The *German Commission for Space Research* was created in 1962 by the Federal Minister for Scientific Research to advise him in all matters relating to the promotion of space research and technology. There are between 15 and 30 members, appointed by the Minister, who himself acts as Chairman.

The Commission has set up four special committees, namely: Space Science and Research; Satellite Science and Technology; Electronics and Communications Technology; Co-ordination, Planning, General matters. These Committees have in turn established working parties on special issues. In 1965, the Commission presented a memorandum on the situation and prospects of space research which serves as a guide-line for Federal policy on the promotion of space research.

(d) In view of its special importance for society, science and the economy, the Federal Ministry for scientific Research has worked out a special programme for the promotion of computer science and technology over several years. The Minister in 1967 appointed a committee of experts, the *Advisory Committee for Data Processing* (Fachbeirat für Datenverarbeitung), to advise him in all relevant matters.

(e) Most of the Ministries within the Federal Government are advised in the execution of their functions by *special committees of outside experts*, whose field is restricted to scientific questions related to the regular activities of particular branches of the administration, such as those responsible for economic policy, social policy, the public health programme, or road construction.

4. *The States level*

(a) Even before the Federal Republic itself came into being the individual States had institutionalized co-operation and co-ordination in the field of general cultural policy, education and science policy by setting up the *Permanent Conference of the Ministers for Education and Cultural Affairs of the States of the Federal Republic of Germany* (Ständige Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland). Within the framework of this Conference, Committees meet several times a year to discuss, decide and co-ordinate policy; the Committee on Higher Education Policy, for example, meets about ten times a year. These committees include senior civil servants in the relevant States Ministries.

According to the Constitution, no individual State can be compelled by a majority of the other States to pass a law to adopt measures against the will of its own parliament and Government, in those fields where political sovereignty is left to the States; thus, all policy decisions of the Permanent Conference must be unanimous. These unanimous decisions are then implemented through decrees of the individual States administrations. Any decisions that require new legislation can only be put into effect after having been discussed and approved by the States Parliaments.

The Federal Minister for Scientific Research has the right to participate in the meetings of the Permanent Conference whenever matters that also fall within his area of responsibility are under discussion.

(b) A further instrument of co-ordination, the *Joint Conference of States Ministers for the implementation of the Königstein Agreement,* has already been mentioned. Unlike the Permanent Conference just described, however, it does not deal primarily with policy questions in the fields of science, education and cultural affairs, but is concemed with the joint financing of certain research establishments of national importance and decides which institutions are to be included under this scheme.

(c) Besides these joint bodies set up for co-ordination purposes, some States have appointed *scientific advisory committees* to advise and assist the Government in matters of science and science policy, including the development of research in special fields. Among these, the Working Group for Research Problems in Nordrhein-Westfalen and the advisory Committee for Research problems in Hessen are of outstanding interest.

5. *Non-governmental Organizations and Institutions*

(a) In addition to those bodies that have been set up by public administrations, there are a number of autonomous national science organizations through which the scientific community, on its own responsibility, fulfils certain functions of co-ordination and planning as well as carrying out scientific work.

(b) The most important of these is the *German Research Association*, whose structure and mode of operation have already been described (see Part Two/II/3(a)). Whereas the Science Council in its co-ordinating and advisory function is

mainly concerned with the institutional side of scientific education and research, the Research Association concentrates on the questions of science itself. In its priority project programmes and through the work of about twenty special scientific commissions (see Annexes 7 A and 7B) it fulfils an important national function for the scientific community, the State and the public. It has, for instance, advised the Federal Government on legislation for food control, and it has on various occasions called the attention of the competent public authorities to special problems or danger points on the national research scene. Its activities include publications, based on comprehensive surveys, such as a 1964 report on «Stand und Rückstand in den Naturwissenschaften und Ingenieurwissenschaften» (Status and Deficiencies in the Natural and Engineering Sciences in Germany). Beside these special reports, it regularly monitors developments in the various disciplines and lists its findings as well as its proposals for future policy and development in detailed reports (e.g. on astronomy, physics, chemistry, biology, Oriental studies, and some areas of applied research).

The universities and other institutions of university rank have established the *West German Conference of University Rectors* as a co-ordinating agency. Its members are the individual institutions ("Hochschulen"), represented by their heads, the "Rektor". At their plenary sessions, which are held twice a year, a wide range of questions related to university policy may be dealt with, e.g. university and faculty structure, training and recruitment of academic staff, student aid, the relationship between the university and the State, curricula and examinations, international relations, and the recommendations of the Science Council and their implications.

Other bodies besides the plenary assembly include:

- the States Committee, consisting of the Presidents of the Rectors' Conferences of the individual States;
- the President's Committee ("Präsidialausschuss"), comprising the Vice-President and five members elected by the plenary assembly;
- special committees on international university relations, legal questions concerning the university, and pre-university education;
- a joint committee of the Rectors' Conference and the Permanent Conference of Ministers for Cultural Affairs, for the study of curricula and university examination requirements.

IV. RESEARCH ESTABLISHMENTS

1. *General*

Research in the Federal Republic is carried out in the following types of individual establishments:

- universities and other institutions of equivalent rank;
- institutes belonging to the national research organizations (Max Planck Society, Fraunhofer Society, etc.);
- Government (Federal or States) research institutes;
- "big science" research establishments;
- industrial research institutes;
- Academies of Science;
- other research establishments

Most of the research institutes are part of a university or an institution of equivalent rank. Thus according to a Science Council survey there were, in 1964, a total of 2,916 institutes at institutions of university rank, as against 362 non-university research institutes. Their distribution according to disciplines is shown in Annex 8.

2. Though the above survey gives a ratio of about 8: 1 between the numbers of university and non-university research establishments, the ratio for the numbers of qualified manpower employed is very different. Whereas the number of scientific personnel working in university institutes in 1964 was about 25,000, there were about 8,150 in non-university research establishments, the ratio thus being about 3: 1. It must further be borne in mind that there is a strong concentration of non-university research in a limited number of disciplines, and also that university scientists will generally not be full-time researchers, but will devote a considerable part of their time to teaching.

On the whole, however, and disregarding marked differences between disciplines, it is quite clear that the major share of research in the Federal Republic of Germany is carried out in university institutes.

Many of the non-university research establishments belong to or are maintained by, one or other of the major national research organizations.

3. The *Max Planck Society for the Promotion of Science*, which was founded in 1948 as successor to the former Kaiser Wilhelm Society, is the largest research organization in the country. It is registered as a private society.

The membership of the society includes individuals as supporting members, the scientific staffs of the individual institutes of the society as scientific members, and a number of honorary and *ex-officio* members.

The Society functions through:

- the President;
- the Senate, consisting of 12 to 36 persons, mostly scientists, elected by the members; the three heads of sections of the Scientific Council and the Secretary-General as members *ex-officio*; two Ministers or Under-Secretaries of State appointed by the Federal Government; three representatives of the individual States Governments nominated jointly by the States Ministers of Education and of Finance;
- the Administrative Council (Verwaltungsrat), consisting of the President, at least two Vice-Presidents, the Treasurer and two to four further members elected by the Senate;
- the General Assembly (Hauptversammlung), including all members;
- the Scientific Council (Wissenschaftlicher Rat), consisting of all scientific members; this Council comprises three sections dealing respectively with biology and medicine, chemistry and physics, and humanities and social sciences.

The Society maintains about 50 institutes for research in the natural sciences, medicine, and social sciences; a detailed list of these institutes is given in Annex 3. Of the total staff of 5,500, about 1,200 are highly qualified scientists. The major part of the budget is provided by the Federal and States Governments; in 1967 their contribution amounted to 220 million out of a total budget of DM 292 million.

4. The *Fraunhofer Society for the Promotion of Applied Research* was founded in 1949 as a private registered society. Its main interest lies in the field of applied research, conducted as contract research in its own establishments. At present it operates 14 institutes and research stations, which are financed partly from the contract payments, partly from public grants for specific projects, partly from public funds or private donations given in support of their general purpose. A list of these institutes is given in Annex 6.

The Society also gives administrative assistance to outside investigators and institutes.

5. The *German Society for Aviation Research* (Deutsche Gesellschaft für Flugwissenschaften) is essentially an "umbrella" administrative-type organization embracing a number of aviation groups as members. It receives funds from the Federal Government and to a lesser extent from certain States. It allocates these funds to its member bodies, the most important of which are the Institute for Aerodynamic Testing (Aerodynamische Versuchsanstalt) in Göttingen, the German Aviation and Space Research Institute (Deutsche Forschungsanstalt für Luft - und Raumfahrt) in Brunswick and the German Aviation and Space Testing Institute (Deutsche Versuchsanstalt für Luft - und Raumfahrt) in Köln-Wahn. The distribution is made through a board of trustees which includes representatives of the Federal and State Governments. The actual research is carried out at members' institutes. Altogether, some 40 research institutes and independent sections are included within this complex, with almost 2,000 employees, and the great bulk of aviation research performed in the Federal Republic is conducted in these laboratories.

6. There are about 40 *Federal Government research establishments,* operating under the direct authority of various Government Departments; a complete list of them is given in Annex 5.

7. Altogether there are 59 *departmental research institutes* maintained by the individual *States.*

8. Under the *Königstein Agreement* the States not only provide part of the public funds for the Max Planck Society institutes, but also finance jointly about another 40 *research establishments* of national importance. A detailed list of these is given in Annex 4.

9. *"Big Science"* is in the Federal Republic understood to cover nuclear, aviation and space research. The *research establishments* for "big science" occupy a special position within the organizational pattern of non-university research. They are characterized by the need for particularly costly equipment and facilities and a large number of scientific staff in a variety of disciplines, and by the special nature of the projects. Several establishments of this kind under a variety of statutory forms, have been set up by the Federal Government and in the case of some nuclear research establishments also by the States, either jointly or separately. Some of the most important of these ate listed below:

- The Nuclear Research Society (Gesellschaft für Kernforschung) in Kalrsuhe, established jointly by the Federal Government and the State of Baden-Württemberg; it has a staff of over 3,000, and its 1967 budget was DM 125 million.
- The Jülich Nuclear Research Centre in Nordrhein Westfalen (Kernforschungsanlage Jülich des Landes Nordrhein-Westfalen), with a staff of about 3,050.
- The Society for Nuclear Technology in Naval Engineering and Ship Propulsion (Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt) in Hamburg; established jointly by the Federal Government and the four sea-coast States, with a staff of 440 and a 1967 budget of DM 13 million.
- The German Electro-Synchroton (DESY) in Hamburg, established jointly by the Federal

Government and the State of Hamburg. The facilities are available to all research institutes in the Federal Republic. It has a permanent staff of about 400, and its budget in 1967 was over DM 40 million.

- The Institute for Plasma Physics Ltd (Institut für Plasmaphysik GmbH) in München, with a staff of over 800, and a 1967 budget of DM 28 million.
- The Hahn-Meitner-Institute for Nuclear Research (Hahn-Meitner-Institut für Kernforschung) in Berlin, established by the Berlin State, with the Federal Government providing one half of the running cost. It has a staff of about 300, and its 1967 budget was about DM 9 million.
- The Society for Radiation Research (Gesellschaft für Strahlenforschung) in München, established by the Federal Government, with a staff of about 500 and a 1967 budget of DM 1.5 million.

10. By far the greatest amount *of industrial research* is carried out in the laboratories of the individual firms. The extent of this activity can only be estimated. No precise data are available regarding the number of persons working in this field or the number and the size of these laboratories.

To ensure their future existence, many of the smaller industrial concerns have combined to form co-operative research associations. In 1954, these in turn combined to form the Federation of Industrial Research Associations (Arbeitsgemeinschaft industrieller Forschungsvereinigungen). The associations belonging to the Federation together operate 47 research institutes. Members are listed in the "Handbuch der industriellen Gemeinschaftsforschung" (Handbook of Co-operative Industrial Research), 1959.

In 1952 the Battelle Institute at Frankfurt was established. The aim of this institute is to provide new scientific data for industry by undertaking research on a contract basis.

11. Within the wide range of non-university research institutes, the *Academies of Sciences* hold a special place. Whereas the Academies of Sciences of Göttingen, Heidelberg and München may look back upon a long tradition, the Mainz Academy was founded only in 1949. The members, who are co-opted, and include representatives from a variety of disciplines, are usually grouped in a number of sections for the planning, discussion and execution of research projects.

12. Besides the categories mentioned above there are a number of *special research institutes and central auxiliary research institutions.* They are distinguished by their structure or their special legal status, and are affiliated or associated under various arrangements with the universities or technological universities. There are no common criteria for their functions, and their financial support comes from many sources.

Several special institutes have central auxiliary or supporting functions for scientific research in the whole country. Usually these institutes have very expensive apparatus which it would not be economical to instal at a university, since their capacity could not be fully exploited there. Instead they are placed at the disposal of several universities or even all the scientific institutions of the country. Examples include the research vessel "Meteor", the "Central Laboratory for the Geochemistry of Isotopes" in Göttingen, the "Central Institute for the Breeding of Animals to be used in Scientific Research" in Hannover, and the German Computer Centre in Darmstadt.

Part three

THE FINANCING OF SCIENCE

I. THE FINANCING STRUCTURE

Science in the Federal Republic is financed mainly from public funds (Federal and State Governments and communities) and by private industry. The contribution from other private sources is very small. Even research institutions or organizations having private status receive their main funds from the State or from industry. Table 2 shows the structure of science financing and its trends since 1961.

TABLE 2: TOTAL EXPENDITURE FOR SCIENCE IN THE FEDERAL REPUBLIC OF GERMANY 1961-1966 (DM million)

	1961	1962	1963	1964	1965	1966
I. *Public Sector*						
Federal administration	1,064	1,431	1,706	2,042	2,221	2,693
European Relief Programme Special Funds	-	12	22	7	3	4
Individual States	1,645	1,989	2,431	3,069	3,788	4,099
Communities	66	69	71	75	80	82
Total I	2,775	3,501	4,230	5,193	6,092	6,878
Increase per cent	-	+ 26.2	+ 20.8	+ 22.8	+ 17.3	+ 12.9
II. *Private Sector*						
Private Industry	1,873	2,150	2,670	3,279	3,750	-
Foundations and Donations	78	93	102	119	127	-
Total II	1,951	2,243	2,772	3,398	3,877	4,500
Increase per cent	-	+ 15.7	+ 23.2	+ 23.9	+ 14.1	+ 16.1
Total (I and II)						
a) absolute	4,726	5,744	7,002	8,591	9,969	11,378
b) increase per cent	-	+ 21.8	+ 21.8	+ 23.2	+ 15.9	+ 14.1
c) as per cent of GNP	1.5	1.6	1.9	2.1	2.2	2.4

Source: Federal Report on Research II, Annex Table 23.

Of the 1966 total of about DM 11.4 billion, about DM 6.9 billion came from public funds, about DM 4.5 billion from the private sector (mainly industry). These figures represent an increase over 1961 of 148 per cent for public, 131 per cent for private funds; in other words, expenditure on science in both sectors has far more than doubled since 1961. As a percentage of GNP, the increase is from 1.5 per cent in 1961 to 2.4 per cent in 1966: the 1966 GNP was DM477.9 billion, and the public budgets

in that year amounted to DM 147.7 billion (Federal, States and communities). Table 3 shows the relationship between GNP, total public expenditure and public expenditure on science:

TABLE 3: GROSS NATIONAL PRODUCT (GNP), TOTAL PUBLIC EXPENDITURE AND TOTAL PUBLIC EXPENDITURE FOR SCIENCE, 1961-1966

Year	GNP at current prices		GNP at 1954 prices		Total Public Expenditure			Total Public Expenditure for Science	
	DM billion	increase %	DM billion	increase %	DM billion	increase %	per cent of GNP	DM billion	increase %
1961	326.2	+ 9.9	268.6	+ 5.4	95.5	-	29.3	2.8	-
1962	354.5	+ 8.7	279.6	+ 4.1	107.0	+ 12.1	30.2	3.5	+ 26.2
1963	377.6	+ 6.5	289.3	+ 3.5	116.3	+ 8.7	30.8	4.2	+ 20.8
1964	413.8	+ 9.6	308.5	+ 6.6	127.2	+ 9.4	30.7	5.2	+ 22.8
1965	449.6	+ 8.7	323.2	+ 4.8	139.7	+ 9.8	31.1	6.1	+ 17.3
1966	477.9	+ 6.3	331.5	+ 2.6	147.7	+ 5.7	30.9	6.9	+ 12.9

Source: "Federal Report on Research II", Annex Table 19. (Annex Tables 1 and 2 of the same Report give the amounts for scientific research and development alone.)

II. FEDERAL ADMINISTRATION EXPENDITURE ON SCIENCE

The Federal Government's expenditure on science increased from DM 1,431.2 million in 1962 to DM 2,693.4 million in 1966. (These figures include DM 410.3 million for 1962 and DM 761.2 million for 1966 from the budget of the Federal Ministry of Defence.) Its contribution to total national expenditure for science is about 25 per cent. The following list shows the Government departments mainly involved and the amounts made available through their budgets in 1966:

	DM millions
Scientific Research:	1,246.9
Defence	761.2
Interior	177.0
Economic Affairs	110.2
Food, Agriculture and Forestry	83.9
Transport	73.2
Health	27.0
Housing and Town Planning	24.9
Family and Youth Affairs	15.4

The distribution of these funds over the different sectors of scientific activity was as follows:

	DM millions
Federal research promotion programmes including:	2,326.8
General science promotion	647.7
Nuclear research and nuclear technology	590.6
Space research	173.2
Defence research	756.0
General student scholarship programme	159.4
Departmental Research[1]: including research for the following sectors of administration:	366.6
Economic Affairs	108.8
Food, Agriculture, Forestry	84.4
Transport	73.5
Social questions, health	54.3
Law and administration	13.0
Archives, libraries, contemporary history	16.9
Foreign policy, development aid policy, political science	15.5

Including defence research, science received 4 per cent of the Federal budget in 1966; excluding defence research, the share was 2.9 per cent. (Source: "Federal Report on Research II, Annex Table 1.)

III. STATES EXPENDITURE ON SCIENCE

Of the total national expenditure on science in 1966, the States provided DM 4,099 million, i.e. about 36 per cent. The major share of that sum - DM 3,565.8 million, about 88 per cent, went to the institutions of higher education (including university hospitals and student scholarships). The remainder went to

1. This term includes not only research conducted in Departmental research institutes but also all research directly related to the requirements of the Federal Administration (i.e., in German, "Verwaltungsbezogene Forschung").

TABLE 4: EXPENDITURE OF THE INDIVIDUAL STATES ON SCIENCE, 1964

	Institutions of Higher Education and University Hospitals	Departmental Research Institutes of the States	Other Establishments for Science	Student Aid	Total	
	DM million					%
Baden-Württemberg	513.2	6.9	61.3	23.8	605.2	19.7
Bayern	348.0	12.2	49.7	24.3	434.2	14.1
Berlin	154.8	6.4	25.2	14.8	201.2	6.6
Bremen	25.7	1.6	5.7	0.3	33.3	1.1
Hamburg	107.7	6.1	27.0	9.8	150.6	4.9
Hessen	283.4	12.3	20.0	13.1	328.8	10.7
Niedersachsen	222.6	8.8	45.2	11.0	287.6	9.4
Nordrhein-Westfalen	506.2	11.2	209.9	25.7	753.0	24.5
Rheinland-Pfalz	104.7	1.1	11.5	4.7	122.0	4.0
Saarland	64.9	0.2	2.6	3.3	71.0	2.3
Schleswig-Holstein	67.2	9.0	4.2	1.9	82.3	2.7
Total	2 398.5	75.7	462.3	132.6	3 069.1	100.0
as per cent of total	78.1	2.5	15.1	4.3	100.0	

Source: "Federal Report on Research II", Annex Table 13

certain research institutes maintained wholly or partly by the States. Table 4 shows the distribution of the expenditure of the individual States according to these different purposes in 1964.

IV. JOINT FEDERAL/STATES EXPENDITURE ON SCIENCE

The Administrative Agreement between Federation and States of 4 June 1964, referred to above, provided for the joint financing of the expansion programme for existing universities, of the German Research Association, the Max Planck Society and the general student scholarship programme. These funds have been included in the sums given in the preceding sections.

Federation and States together provided DM 4.3 billion for the institutions of higher education (including student scholarships) in 1966. (For details, see Part Four/II below.) The funds jointly provided for the German Research Association in the same year amounted to DM 135 million, those for the Max Planck Society to about DM 175 million.

V. PRIVATE INDUSTRY EXPENDITURE ON SCIENCE

In 1965, private industry provided DM 3,750 million for science and research; 1966 expenditure is estimated at DM 4,300 million. By far the major part of these funds was spent on industry's own research. According to a survey for 1964, with a total industrial research expenditure of about DM 3.6 billion, chemical industry held the lead with about DM 1.1 billion (30.6 per cent), followed by the electrical industry with about DM 900 million (25.5 per cent) and the steel industry (including machine-tool and vehicle construction) with about DM 660 million (18.4 per cent). Of all research carried out for industry - either in industry's own establishments or on a contract basis - 95.4 per cent was financed from industry's own funds. [1] An analysis of the research effort according to size of firms showed 3.3 per cent provided by firms with less than 500 employees, 9.3 per cent by those with 500 - 1,999 employees, and 87.4 per cent by firms with over 2,000 employees.

1. *Source*: "Federal Report on Research II", Annex Table 20.

TABLE 5: EXPENDITURE ON ALL SCIENCE ACTIVITIES AND RESEARCH AND DEVELOPMENT IN THE FEDERAL REPUBLIC OF GERMANY 1964: BREAKDOWN BY SOURCE AND DESTINATION OF FUNDS

	Expenditure on all Science Activities		Expenditure on Research and Development alone	
Destination Sector	DM million	%	DM million	%
1) Establishments of Public Administration, Institutes of Higher Education, University Hospitals	2,784	32.3	1,131	17.2
Departmental Research Institutes, Federal and States	217	2.5	217	3.3
Scientific Libraries, Museums, Archives	110	1.3	-	-
Total 1	3,111	36.1	1,348	20.5
2) Private Industry (Individual Firms and Associations)	3,800	44.0	3,800	57.6
3) Non-Profit-Making Institutions (other than State-operated				
German Research Association and Max Planck Society	264	3.0	264	4.0
Nuclear Research Centres and Other Special Establishments for Nuclear Research	368	4.3	368	5.6
Other Institutions	410	4.8	410	6.2
Total 3	1,042	12.1	1,042	15.8
4) International Organizations and Establishments	400	4.6	400	6.1
5) Recipients of Student Aid, Individual Recipients and Others	275	3.2	-	-
Total 1-5	8,627	100.0	6,590	100.0
Source Sector				
Public Administration	4,616	53.5	2,912	44.2
Private Industry	3,331	38.6	3,331	50.5
Others	680	7.9	347	5.3

Source: "Federal Report on Research II". Annex Table 25

VI. EXPENDITURE OF FOUNDATIONS ON SCIENCE

The contribution of private foundation to the financing of science in the Federal Republic is relatively small. The two large private foundations - Volkswagen and Fritz Thyssen - together make about DM 120 million available to science and research every year. In addition, the Donors' Association channels annually about DM 25-30 million of free funds donated by industry into science and research.

VII. GENERAL SURVEY OF SCIENCE FUNDS BY SOURCE AND DESTINATION

Table 5 gives a survey of the source and destination of the total national funds (including those of insurance companies) for science (in the larger sense of the term), research and development in 1964. (Source: "Federal Report on Research II", Annex Table 25).

NOTE ADDED AT PROOF STAGE

Substantially increased support for science and research is proposed in the *Federal Budget for 1969*; the increase amounts to about DM 257 million (13.4 per cent). Activities benefiting from the increase include nuclear research and technology, space and aviation research, data processing, oceanography and university expansion. Federal finance plans up to 1972 continue to give high priority to the promotion of science and research, with annual increases approaching 16 per cent.

Part four

SCIENTIFIC WORKERS AND RESEARCH TECHNICIANS

I. THE ORGANIZATION OF ADVANCED EDUCATION

The term " institutions of higher education " ("Hochschulen") in the present context covers universities, technological universities (" Technische Hochschulen"), theological and ecclesiastical institutions of higher education and teacher training colleges (" Pädagogische Hochschulen " for training elementary school teachers), as well as some others in certain special fields.

1. In order to enable these institutions to continue fulfilling their double functions as centres for research and for the training of qualified personnel, a new approach to the relationship between research and teaching, and the adaptation of university organization to the altered needs and demands of society have for some time been considered essential. The main *reform measures* at present being tried in the higher education system in Germany may be identified as follows :

- The creation of institutes constituting an interdisciplinary bridge between different faculties ;
- The splitting up of large institutes and traditional faculties into smaller subject units (departments), and the co-ordination of chairs in departments (" Departmental System ");
- The development of technological universities into comprehensive universities on the one hand, by the addition of other disciplines and the addition of technological disciplines to the traditional universities on the other hand;

TABLE 6: NUMBER OF HIGHER EDUCATION INSTITUTIONS BY STATES, 1967

State	Universities	Technological Universities	Other Institutions of Univ. Rank	Teacher Training Colleges	Institutions below Univ. Rank	Total
Baden-Württemberg	5	2	2	8	-	17
Bayern	4	1	-	8	8	21
Berlin	1	1	-	1	1	4
Bremen	-	-	-	1	-	1
Hamburg	1	-	-	1	-	2
Hessen	3	1	-	2	4	10
Niedersachsen	1	3	2	10	-	16
Nordrhein-Westfalen	5	1	-	15	3	24
Rheinland-Pfalz	1	-	-	6	1	8
Saarland	1	-	-	2	-	3
Schleswig-Holstein	1	-	-	2	-	3
Total	23	9	4	56	17	109

TABLE 7: INSTITUTIONS OF HIGHER EDUCATION, POPULATION, AND ACADEMIC STAFF, 1961-1965

	1961	1962	1963	1964	1965
Institutions	98	100	100	104	104
Population[1] (thousands)	56,589	57,247	57,865	58,588	59,297
Population per Institution (thousands)	577	572	577	538	544
Universities (including Technological)	27	27	27	27	27
Population per University (thousands)	2,164	2,182	2,191	2,206	2,220
Faculty (professorial[2] rank)			10,116	11,951	13,259
Scientific Personnel in Higher Education (Faculty and Assistants)			25,042	28,649	31,680

1. At 31 December of each year.
2. Budgeted positions, 1 January each year.

- The development also of other institutions of higher education, at present covering limited fields, into comprehensive universities;
- The reform of study programme in line with the revision of examination requirements in accordance with modern needs of professional training, clearer definition of study programmes, assessment of achievement by interim examinations in all subjects, and the introduction of a time limit on the total period of study for which a student may enrol.

There are at present 109 institutions of higher education in the Federal Republic, including: 23 universities, 9 technological universities, 4 institutions of university rank limited to special fields (e.g. medicine), 56 teacher training colleges, and 17 others (mainly for theology).

Their geographic distribution between the individual states is shown in Table 6: it does not lend itself to meaningful interpretation, being rather the result of a history that is much older than the present State boundaries. From the point of view of student origin, all universities are national rather than State institutions.

2. At present, there is one institution of higher education for every 550,000 residents in the Federal Republic, taking into account institutions of various kind and sizes. Considering only the universities proper and the technological universities, there is only one for every 1.7 million of population. This reflects the general tendency in the Federal Republic to enlarge and develp the existing institutions rather than to create a large number of specialized institutions.

For obtaining a clear idea of the state of development of the higher education system, the numbers of *staff* are thus more indicative than the numbers of institutions. From 1963 to 1965 alone, the number of faculty positions at professorial level increased from 10,116 to 13,259. The total of fully qualified academic staff – i.e. professors, assistants and lecturers ("Oberassistenten") increased over the same two years from 25,042 to 31,680, i.e. by 26%; this is the more remarkable since it had already increased by about two-thirds in the previous three years. Thus over a period of five years, the number of qualified scientific personnel at the institutions of higher education has about doubled.

The numbers of higher education institutions and academic staff are shown in relation to the population numbers in Table 7.

II. THE FINANCING OF ESTABLISHMENTS FOR HIGH EDUCATION

The institutions of higher education are financed almost entirely from State funds, i.e. the individual States and – with a share in investment expenditure – the Federal Government. Of other *sources*, payments for contract research may become of appreciable importance in individual cases.

The annual budget of each institution is set up in co-ordination with the authorities of the autonomous academic community and constitutes a part of the budget of each State.

2. *Public expenditure for the institutions of higher education* (including university hospitals) more than doubled from 1961 to 1965 (from DM 1,652.4 million to DM 3,747.6 million, i.e. an increase of 127 per cent). At the same time, the number of students increased by only 17 per cent. A large part of the expenditure increase may reasonably be assumed to have gone to the development of research capacity.

This conclusion is confirmed by the trend of non-recurrent, i.e. mainly investment expenditure, alone.

In 1962, this was 21.2 per cent of the total; by 1965, its share had increased to 35.9 per cent. This rise from about one-fifth to over one-third of a total which itself had gone up steeply occurred in spite of the higher demand for recurrent funds corresponding to the increase in personnel. The rise in total expenditure for higher education was moreover much steeper than the increase of gross national product: from 1961 to 1965, its share of the GNP rose from about 0.5 per cent to about 0.8 per cent. The variation of the share of higher education expenditure in the total State budgets shows a similar development (see Table 9). These figures increase in significance when viewed together with other related fields of public expenditure: for the whole field of the educational system at all levels, the increase was from DM 9.4 billion in 1961 to DM 16.9 billion in 1965; in relation to GNP, the proportion rose from 2.9 to 3.8 per cent. Thus expenditure for education is taking an increasing share of all public funds available. Total expenditure for education did not, however, rise quite as steeply as that for higher education alone. This indicates special priority for the higher education sector within the general priority area of education and research.

In view of the need for further development and capacity in higher education, this expenditure increase may be expected to continue. The investment needs of the institutions of university rank over the 1966-1975 decade have been estimated at about DM 20 billion, based on 1966 prices; of this amount, DM 15 billion would be for expansion and development of existing institutions, DM 5 billion for new establishments. About one half of the total would be needed by 1970, the other half in the remaining five years, which means that this is not just a need arising from a certain backlog which might be worked off by a relatively short, though strenuous effort, but should rather be regarded as a steady financial burden of about DM 2 billion per year, whereas actual investment expenditure in that sector in 1965 was DM 1.3 billion.

It is not possible to make an exact calculation of the share of research and development, as distinct from that of education and general training, in the total expenditure for higher education. Various attempts have been made at national and international levels to establish the necessary criteria, but no really satisfactory results have so far been obtained. For the German institutions of higher education, a rough estimate is that the proportion is one-half of the total expenditure; the 1965 investment of DM 1.3 billion and the recurrent expenditure of DM 2.5 billion in higher education together amounted to DM 3.8 billion; the research share would thus be DM 1.9 billion.

Recurrent expenditure for institutions of higher education may be used to calculate the average cost per student. This of course varies greatly between different types of institutions and fields of study. At the technological universities, for example, recurrent expenditure per student was DM 10,400 in 1966. The average amount of public funds needed for training a graduate engineer ("Dipl. Ing"), whose average period of study is six years, is thus about DM 60,000.

III. STUDENTS AND EXAMINATIONS AT INSTITUTIONS OF HIGHER EDUCATION.

1. The *entrance qualification for university study* in the Federal Republic is the "Abitur", i.e. the long-course secondary school (Gymnasium, age 10/12 - 19) leaving certificate.

In the various academic disciplines, higher education studies may lead to one or several of the following certificates or *degrees*: diploma, state examination, magister, doctorate. In some fields, these final qualifications can only be obtained via interim examinations.

Study duration varies somewhat with the disciplines, but will always be at least four years for a first degree; in medicine, it is five to six years, with a period of practical training in addition.

The final degree at the technological universities is that of the "Diplomingenieur", requiring at least four years of study. The doctorate will require a more prolonged period. A special post-doctorate degree, the "Habilitation" is, as a rule, required of a candidate for a professorship (except in technology, where the appointment of eminent persons from industry is a frequent practice).

2. *Development of student numbers.* The number of students at institutions of university rank has about doubled over the past ten years. In the five years from 1961 to 1965, it rose from about 234,000 to about 275,000. In view of the demographic situation, the curve is expected to flatten gradually until the mid-seventies, and then to rise steeply again. Recent calculations, notably those of the Science Council, lead to the assumption that the present student numbers will have doubled again by 1983.

The proportion of women students in the total remained constant at 28 per cent from 1961 to 1965. However, this does not necessarily mean that the number of women students compared to the total female population is that much smaller than the corresponding ratio for the male population; it seems that the average study period for a woman student is somewhat shorter than that for her male colleague, since women are particularly numerous in disciplines requiring a relatively short period of study (pharmacy; elementary and short-course secondary school teaching), and since many of them leave university before finishing their studies.

In view of the special importance of these fields for future social and economic development, more detailed data on the situation in science and technology seem of particular interest. From 1961/62 to 1965/66 (winter terms) the total number of students enrolled in science increased from 35,865 to 39,827, but as a proportion of the fast-growing total student population this represented a decrease from 15.3 to 14.5 per cent. In technology (including architecture), the same trend is even stronger: the absolute number of students remained almost constant from 1961/62 (34,155) to 1964/65 (34,042), but fell to 32,773 in 1965/66; the proportion of the total student population fell from 14.6 to 12.6 per cent in these four years. The following figures for new enrolments in technology over the last few years reinforce this picture and seem to indicate that the trend is likely to continue:

1961/62: 6,664 (11:1 per cent of total first-year students)
1962/63: 6,177 (10.0 per cent of total first-year students)
1963/64: 5,712 (9.4 per cent of total first-year students)
1964/65: 5,378 (8.9 per cent of total first-year students)
1965/66: 4,595 (8.0 per cent of total first-year students)

(Note: The percentage of technology students in first year is lower than that in the total student numbers, due to the lower 'drop-out' rate in technology. Furthermore, in interpreting these figures the important role of the "Ingenieurschulen" – technical colleges of engineering – which have been rapidly expanding, should be kept in mind.)

In agriculture and forestry, the relatively small number of 3,433 students in 1961/62 increased to 3,963 by 1965/66, the share of the total dropping from 1.5 to 1.4 per cent.

In medicine (including dental medicine, but excluding veterinary science) the development has been markedly influenced by the introduction of admission restrictions that began to take effect in 1963; from 1961/62 to 1962/63, the number of students jumped from 26,791 to 29,618, but in the following years increased by only about 1,000 per year; for first-year students, it even dropped from 6,780 in 1962/63 to 5,041 in 1965/66. Admission restrictions have been maintained since and are believed to have had an even greater effect. The reason for their imposition is lack of facilities rather than professional policy or manpower planning; there is no uniform opinion as to whether and to what degree the stagnation in student numbers might lead to a serious shortage in the medical profession.

The main points of the situation in 1965/66 are the following: Of all students at institutions of university rank, about 110,000 (40.5 per cent) were enrolled in pure science (including mathematics) and applied science (technology, agriculture, forestry, medicine); another 58,000 studied at colleges of engineering.

The number of women students in most of these disciplines is only small. The exception is medicine, though here too there is a drop from a peak of 34.5 per cent in 1961/62 to 28.8 per cent in 1965/66. It is possible that the admission restrictions are especially discouraging to women. In science and mathematics, the proportion of women is constant around 19 per cent, with a special concentration in pharmacy. In agriculture and forestry, the proportion rose from 11.5 per cent in 1961/62 to 13.4 per cent in 1965/66. In the technological disciplines, the proportion of women students is especially low (except in architecture): 2.1 per cent in 1961/62, 2.5 per cent in 1965/66. At the colleges of engineering, only 1.3 per cent of the students in 1965/66 were women.

3. The *final examinations* to be considered here are: diploma state examination; doctorate as first degree. The total number of successful examinees gives the number of personnel qualified for professional careers, though some of these will stay on for a second-degree doctorate; this number has increased, roughly in correspondence with the increase in enrolment numbers, from 36.556 in 1960/61 to 47.387 in 1963/64 – the last year for which the data have so far been published – i.e. by about 30 per cent. Of the 1963/64 graduates, 3,288 (13.7 per cent) were in science, 4,142 (17.3 per cent) in technology, 3,261 (13.6 per cent) in medicine, and 698 (2.9 per cent) in agriculture and forestry. These disciplines together thus had 48 per cent of successful final examinees (if those at teacher training colleges are left out of the calculation); the proportions are thus more favourable as regards successes in final examinations than as regards enrolment, due to a somewhat lower average duration of studies in technology and to the lower 'drop-out' rate.

To complete the picture, the numbers passing their final examinations at the Colleges of Engineering must included. Within four years, these increased by no less than 50 per cent, and in view of the present enrolments they may be expected to rise further. The numbers of nationals passing their final examinations at these institutions in recent years were as follows:

1961 – 10,679
1962 – 12,668
1963 – 13,553
1964 – 14,580
1965 – 15,308

On adding the number for 1964 to that of successful final examinees in science and technology at

institutions of university rank, the total is about 26,000, of which about 3,300 were in science and mathematics, 18,700 in engineering and technology (technological universities and colleges of engineering), 3,300 in medicine, and the remainder in agriculture and forestry.

We may then try to estimate, even though only very roughly and with many reservations, the extent to which this output of qualified manpower can satisfy the future needs of society. Assuming that 90 per cent of the graduates actually take up the corresponding careers and will be professionally active for an average of 30 years (this average may be put rather high in view of the small number of women graduates in these disciplines, except for medicine), the above graduation figures would suffice to maintain a professionally active population of 90,000 in science and mathematics, 505,000 in engineering (both levels), and 90,000 in medicine.

Another calculation is based on the estimated future trend of the number of people obtaining the university entrance qualification ("Abitur"), the resulting numbers of new entrants to universities, and certain assumptions concerning the choice of disciplines, to arrive at an estimate for the number of successful final examinees in 1985. The resulting numbers are two or three times those for 1964: the estimated number of 1985 graduates in science and mathematics is over 10,000, in technology (technological universities alone) about 8,000; the latter estimate presupposes, however, that the recent downward trend in these disciplines in comparison to total student enrolment will not continue.

As part of the task of meeting the future needs for qualified manpower, the sector of recruitment for academic training and research constitutes a special problem. From the point of view of statistical analysis and forecasting, it is complicated by the fact that the study programme at the universities is the same for the majority of students preparing for non-academic professional careers and for the minority planning academic careers as teachers and researchers. In the long run, clearly, the manpower situation in non-academic research and development will depend on university development as much as that in the academic professions.

In Germany, however, the special post-doctorate degree termed "Habilitation", which in most disciplines is considered a necessary qualification for a professorship, is taken practically only by those wishing to enter that career. Thus the number of "Habilitationen" gives an indication of the number qualifying for top-level university positions (except for technology, where it is a common practice to appoint professional people to professorships without prior "Habilitation"). In the years 1960 to 1965, there were about 500 "Habilitationen" annually, with a slight increase during the later years. The large majority of candidates for the "Habilitation" who hold assistantships has increased over the past few years, and it may thus be assumed that the number of assistantships available will have a direct bearing upon the number of "Habilitationen". Since this number has been greatly increased over the past six years, the annual average for "Habilitationen" may be expected to rise to about 700 in the future. Even so, the more rapid pace of university expansion to be expected from present plans and forecasts would still leave a shortage of about 2,000 people with professorial qualification in 1971.

Universities and public authorities are at present endeavouring by material aid and institutional measures to attract a greater number of highly qualified young scientists and scholars into academic careers, and to facilitate their fulfilling the "Habilitation" requirements in a shorter time.

IV. QUALIFIED MANPOWER[1] IN SCIENTIFIC AND TECHNOLOGICAL RESEARCH AND DEVELOPMENT

The latest data on qualified manpower in the Federal Republic were obtained from a 1964 sample census. Of the 27.15 million inhabitants in gainful employment that year, about 250,000 (close to 1 per cent) were in research and development. Of the total in gainful employment, about 3 per cent had completed an academic education, but of these only 52,000 (6.2 per cent) were active in research and development. This leaves about 198,000 people in research and development without a completed university education; many of them are graduates from engineering schools and technicians. Stated in different terms, only one out of every five people engaged in research and development is a university graduate, and only one out of every sixteen university graduates is engaged in research and development. It is obvious, however, that considerable problems of definition must arise in these classifications, e.g. as regards research *versus* teaching, administration and production activities.

With due allowance for the incidence of these problems in various branches of industry, a rough estimate of research and development manpower by discipline may be ventured: almost two thirds (64 per cent) were natural scientists or engineers, only 15 per cent in the social sciences and humanities, a noteworthy 16.5 per cent in medicine and 4.5 per cent in agricultural science. The criteria

1. In the present context this term covers not only academically qualified personnel, but also certain others employed in research and development.

are inevitably somewhat rough, and in some cases arbitrary; thus every medical graduate employed in the research division of a pharmaceutical plant was counted as a researcher, while every graduate science teacher at a "Gymnasium" was considered as not doing research.

The above figures may be compared with the share of the same subject sector in the qualified manpower as a whole, whereupon the relative importance of the individual disciplines for the research potential can be calculated: Natural Science and Engineering (university level) accounted for only 24.3 per cent of the total of university graduates in employment, but 64 per cent of research and development personnel. Social sciences and humanities, on the other hand, provided 50.4 per cent of the total, but only 15 per cent in research and development. Again in different terms: one out of every five natural scientists and university engineers went into research and development, but only one out of every 13 in agriculture, one out of every 17 in medicine, and one out of every 20 in social sciences and humanities.

V. THE SECTORIAL DISTRIBUTION OF QUALIFIED MANPOWER

1. *Independent research establishments*

The main groups of non-profit-making research establishments which are *independent* legal bodies are the institutes of the Max Planck Society, the Nuclear Research Establishments, and the Institutes for Aviation and Space Research. In 1964, about 16 per cent of the national stock of research manpower was employed in these establishments. The number of scientific personnel in the Max Planck institutes, for example, was 1,160 in 1964, an increase of 26.5 per cent over 1960.

2. *State research establishments*

This group comprises all *establishments* that are legally part of the *Federal or individual States* administrations. The number of scientific personnel is not known, but is not more than 2 or 3 per cent of the total research manpower.

3. *Higher education establishments*

Of the total research manpower with a completed academic training, about 50 per cent are employed in this sector (80 per cent of those in the social sciences and humanities, 28 per cent of those in the natural sciences and technology). Their distribution over the main groups of disciplines in 1964 was as follows: science and mathematics: 23.2 per cent; engineering and technology: 14.1, medicine: 33.1 per cent; agriculture: 3.5 per cent; social sciences and humanities: 26.1 per cent.

In 1964, about 33,000 scientists were employed in higher education institutions and independent institutes together.

4. *Private industrial research establishments*

In 1964, 34 per cent of national research manpower with a completed university education were employed in *private industrial research establishments.* The share in research manpower without a full academic training, however, was 60 per cent, which may be taken as an indication and result of the close relation of research and development to production in industry. As regards disciplines, the large majority are, of course, natural scientists or technologists. Of the national total of qualified personnel engaged in research in these disciplines, private industry employed 53 per cent. This may be taken as a further indication of the close relation between university-trained manpower in science and engineering, and innovation and development in the interests of industrial productivity.

Within the private economy sector, research is concentrated in manufacturing industry, and within that broad field again, in the chemical and electrical branches, followed by precision-tool manufacture and the optical industry, i.e. branches which are generally considered of special importance for future growth and economic prosperity. They are thus the branches which depend most strongly on the availability of scientific mapower. Chemical industry alone employed 33 per cent of university-trained and 29 per cent of other research personnel in manufacturing industry as a whole. Moreover, chemists are strongly represented on the research staff of other branches, too.

VI. STATUS, WORKING CONDITIONS AND CAREER PROSPECTS OF SCIENTISTS AND ENGINEERS IN RESEARCH ESTABLISHMENTS

1. The term *"working conditions"* comprises a wide range of factors, not all of which, nor their relative importance for the individual's attitude and reactions, have been sufficiently analysed. In the research field, some of the most important seem to be: the chance to work independently; status within the staff and society generally; job security; and what is called "shop climate".

The degree to which these conditions are fulfilled naturally varies between the different types of establishment. In the universities, scientists who do not occupy a chair themselves frequently complain of the hierarchical structure of faculty and research staff, and these complaints have become more frequent rather than otherwise with the recent expansion of research capacity at the universities. In private industry and in State institutes, research

scientists often feel that they do not have enough independence in the determination of research projects and procedure. Scientists at Max Planck institutes enjoy high social prestige, but sometimes express regret at their isolation from the university and its better career opportunities.

Reports on the emigration of scientists have called public attention to the fact that future research potential will to a large extent depend on attractive working conditions. In this context, mention may be made of the proposals of the Science Council and other competent bodies to re-organize and divide the responsibilities in large research establishments and universities. Poor career prospects, rigidity of staff structure, and comparatively low social status in a staff that is predominantly academically oriented also probably contribute to the notably high rate of turnover of non-academic research personnel at university and state research institutes.

2. For the academically qualified research personnel, again, other important factors besides adequate organizational structure are *career prospects and salaries* in relation to those in other types of professional activity demanding the same formal qualifications. It seems that these factors play a more important part in attracting high-quality personnel into research than is acknowledged, for instance, by the universities which train the future research scientists.

The general principle is that scientific and technical personnel in research establishments which are maintained entirely or mainly from public funds are subject to the regulations for civil servants or public employees as regards salary scales, pension rights, formal qualifications demanded for certain positions, promotion and seniority. Consequently, career and salary are governed by the same system of hierarchical positions and seniority as applies to the public service in general, even though this is not felt to correspond to the special activities of a highly gifted young research scientist or to the relation between age and efficiency in scientific work. In addition, the traditional "Juristenmonopol" (monopoly of law graduates in the higher ranks of public administration) has led to the formal qualifications for a civil service career in administration being rather one-sidedly based on a formal training in law, although this would seem to be no longer adequate to the needs of modern administration and certainly not to those of research administration in the public interest. Though it does not affect the university professors, who are civil servants with a special status, or research scientists in independent institutes, this condition does apply to public research institutes, and makes it difficult to attract scientists into public administration.

After a period of public discussion of these issues, a sub-committee of the Federal Cabinet Committee on Science made a number of suggestions which have recently been put into effect. The main features are: The possibility of payments supplementary to the regular salary according to scale, for civil servants and employees with special responsibilities in research work; outstanding senior scientists and exceptionally qualified young scientists in "big science" research establishments may receive special contracts providing for salaries above the scale allowed under traditional regulations; for certain steps in the scale, the requirements for formal qualifications have been altered to permit a more favorable placement of scientists and technicians in research; at the same time, general salary increases for all civil servants and public employees have helped to ease the situation.

At the universities and institutions of equivalent rank, there is a special salary scale for full faculty members, who are civil servants of the individual State, whereas assistants and other personnel come under a general civil service scale applicable to the higher ranks of administration, or the scale for public employees. Faculty salaries have in recent years been considerably increased, so that a professor today may be considered well-paid. The problem which remains is that of too limited promotion opportunities for other scientific staff, notably the assistants.

In private industry, career and salary prospects may be regarded as very good for those scientists who can make full use of their qualifications and are not deprived of the necessary independence for their work, as often seems to be the case in large firms. Recent studies have shown that, contrary to a wide-spread opinion, the average salary of the young graduate starting on a career in industrial research is no longer higher than that of his colleague who goes into a public research institute, university research, or administration; in the course of years, however, the income of the successful research scientist in industry will gain a lead which the university research worker can only hope to catch up with if he becomes a full professor.

VII. SCIENTISTS AND ENGINEERS IN INDUSTRY: SUPPLY AND DEMAND

1. *Forecasts of supply and demand* for university-trained manpower in Germany were already made in the nineteen-thirties, in connection with the public vocational guidance programme. After the war, reconstruction in industry and the educational system faced such a general shortage in qualified manpower that no practical need was felt for demand forecasts. The first post-war surveys that were made, in connection with international comparisons, concentrated on the demand for engineers having various levels of qualification. For this group alone, seven surveys

were conducted; though the great methodological problems of manpower demand forecasting became evident in the process and in the results, they all agreed that at least until the late sixties there would be a considerable shortage of engineers which could not be made good with the education and training facilities then existing.

The supply side was also investigated by a number of surveys, some conducted by private persons, some by public offices such as the Federal Ministry of the Interior, the Science Council, and the Ministries of Education of the individual States.

Quite recently, a comprehensive study was published on the demand for (as well as the probable supply of) university graduates in all disciplines, up to 1980[1]. Such forecasts of course involve considerable methodological problems. Specialists are of the opinion that a number of questions need further study, such as: to what extent certain professional functions can be taken over by substitutes, what are the mutual relations and influences of manpower and technological progress (including rationalization); what are likely to be the effects of certain measures of economic and educational policy. These reservations must be borne in mind when considering the manpower problem.

2. *Discussion of Forecast Findings*

The following are the main findings of the Riese study on the future demands of society and industry for university graduates in general, and for those in science and engineering in particular: From 1961 (the year of the last census) to 1981, the general demand for university graduates will rise by 61 per cent, corresponding to an annual rate of increase of 2.4 per cent, whereas the expected rate of increase for the working population as a whole is only 0.3 per cent annually. This means that the proportion of university graduates within the working population will have to increase by at least 50 per cent.

Within this general picture, there are considerable differences as regards the expected demand in the individual disciplines. Mathematics takes the lead with an estimated increase of 135 per cent, followed by biology and geography (108 per cent) and physics (102 per cent), whereas the demand in chemistry is estimated to increase by only 59 per cent. Next to science are the teaching professions, with 98 per cent for high-school teachers (i.e. university graduates) in the humanities and 75 per cent for elementary school teachers (teacher training college graduates); in these professions, the forecast demand is based on the assumption that certain policy aims[2] regarding maximum size of classes, teacher/pupil ratio, and teaching load can be fulfilled. A large increase in the demand is expected also in the engineering professions, excepting mining and metallurgy, which will be affected by structural changes in industry, but including architecture. For electrical engineers, the demand is expected to increase by 81 per cent, for mechanical engineers by 71 per cent. In medicine, the increase is estimated at 21 per cent, in dentistry at 23 per cent, in agriculture and forestry at 37 per cent.

In order to arrive at the actual output necessary to meet the demand the annual replacement quota for manpower retiring from professional activity must be added to the increase quota. This depends on the size and age structure of present stock. Riese arrives at the following figures for the total demand on university output in the main disciplines, between 1961 and 1981:

In science (including pharmacy and geography), about 96,000, or 4,800 per year. Since the actual number of graduates in the 1963/64 academic year was 3,300, it is obvious that the full need can only be met if student numbers continue to rise as projected.

In technology (including architecture), Riese puts the total required output at 122,000, i.e. 6,100 annually or about double the actual number of graduates in 1963/64. Even if, as estimated, total student numbers were to double by 1981, the present downward trend of the proportion of technology students in the total makes it doubtful to what extent that field would benefit from the general increase, and considerable shortage seems certain to exist for some time. A more hopeful aspect is the much larger number of Engineering College graduates; it remains to be seen to what extent they can be used to fill the gap. There is already a general tendency to reserve the top positions for the Dipl.Ing. of the technological universities and to employ the Ing. Grad. of the Engineering Colleges in the middle layer of management and production functions where personnel demand increases particularly rapidly.

In medicine, the total demand for graduate output is put at about 78,000, i.e. 3,900 per year as compared to 3,300 actual graduations in 1963/64. Judging from enrolment figures in recent years, the annual output may be expected soon to increase, so that a tolerable balance between supply and demand may be achieved.

In agriculture and forestry, 1,200 graduates per year would be needed to meet the estimated required output of 23,300 by 1981. The actual number of graduates in 1963/64 was about 700. Since the total numbers involved are relatively small, however it

1. Hajo Riese. "Die Entwicklung des Bedarfs an Hochschulabsolventen in der Bundesrepublik"; F. Steiner Verlag, Wiesbaden, 1967. (The Development of the Demand for University Graduates in the Federal Republic.)
2. See "Schulbesuch 1961 bis 1970" (School attendance, 1961 to 1970). Permanent Conference of the States Ministers of Education, Document 15, June 1965.

would seem possible to achieve the necessary increase in the course of the general development of student numbers.

Based on the above calculations, Riese arrives at the following demand for professionally active university graduates in 1981 in the main disciplines:

	Number of graduates	Percentage of teachers included
Mathematics	21,300	79.4
Physics	20,000	28.3
Chemistry	36,100	18.4
Biology, Geography	21,600	71.5
Pharmacy	27,200	1.1
Architecture	24,800	4.5
Mining, Metallurgy	8,800	8.8
Technology	57,000	8.8
Mechanical Engineering	44,700	6.7
Electrical Engineering	33,800	6.8
Medicine	104,000	2.9
Dental Medicine	40,800	0.3
Agriculture, Forestry	25,300	19.0
Humanities	263,200	78.3
Teaching, Elementary School	257,000	(96.0)

The main points may be summed up as follows: although the rate of growth of the economy is slowing down, the need for University and Engineering College graduates will continue to rise in absolute terms as well as in relation to the working population as a whole. It seems hardly possible that the gap in engineering can be completely filled, and it will be quite hard to meet the demand for scientists; in the other disciplines, a tolerable balance may be hoped for. An important factor within the overall development is the teaching profession; there the situation again depends to a large extent on educational policy aims and measures, which will thus also have marked repercussions on the relations between supply and demand in the sciences as well as in the humanities.

Other data relate to the demand for university graduates up to 1981 in industry alone, as one of the consumer sectors competing with others for the available qualified manpower on a market where demand exceeds supply. To what extent industry will be able to recruit personnel of the necessary quality will largely depend on the comparative attractiveness of salary, job security, working conditions, career prospects, as well as social prestige.

For the private enterprise sector, i.e. production and service industries (but excluding independent service professions, such as solicitors, physicians, pharmacists), Riese estimates the demand for graduates over the two decades from 1961 to 1981 at about 144,000, which would mean an increase of 49 per cent.

Of these, 60,600, i.e. over 3,000 per year, would be in engineering and science and 21,600 in architecture; both these figures would lead to an increase of 73 per cent over 1961; in agriculture and forestry, only 600 of the calculated increase would be needed by industry, in all the other disciplines about 60,700.

Of the 60,600 in science and engineering, science accounts for about 18,000, which breaks down into 1,700 mathematicians, 6,800 physicists, and 9,500 chemists. It seems that these estimates are rather conservative, at least as regards chemists, as future projections have been influenced by the present shortage.

The data used above also give certain indications as to the future requirements of research in industry, higher education and other establishments for qualified personnel; a separate estimate is, however, not available, and various attemps at developing satisfactory models for forecasting demand in this sector on the international scale do not seem fully satisfactory.

It is generally assumed, however, that within the rising proportion of university graduates in the total working population, that of graduates working in research and development will rise even more quickly. This is mainly due to the expected requirements of research in "big science", such as nuclear energy, plasma physics, space, aviation, electronics and data processing, and oceanography. It seems certain that the typical growth industries, e. g. chemical industries, will have to increase their research effort to maintain their positions in enlarging markets.

Finally, continued university expansion to meet the expected increase in student numbers will call for a considerable increase in qualified research personnel if the principle of the unity of research and teaching at the university is to be maintained.

Part five

PRINCIPAL AIMS OF NATIONAL SCIENCE POLICY

I. GENERAL

The Federal Republic has no comprehensive plan for economic and social development. However, in June 1967, the Federal Cabinet for the first time formulated a medium-term financial policy plan, which covers the period up to 1971 and involves a number of legislative measures.

The economic basis of the financial plan is provided by development projections and policy aims with regard to the national economy as a whole. The average annual growth rate of GNP is estimated at 5 to 5.5 per cent (corresponding to a real growth rate of 4 per cent); one policy aim is to achieve stability of the level of prices. The average annual growth rate for public expenditure (Federal, States, communities, public social insurance) is put at 6 per cent. As a means of achieving the economic policy aims, a larger share of public funds than hitherto is to be allocated for investment, i.e. public investments will increase at a greater rate than public expenditure as a whole.

The Federal budget alone is expected to rise from DM 74.51 billion in 1967 to DM 93.6 billion in 1971. Federal expenditure for science is planned to increase by an annual average of 16 per cent, which means that science and research will benefit from the highest growth rate for any sector of Federal expenditure.

The aims of Federal science policy for the next few years, as outlined below, are defined in detail in the Federal Government's second report covering all measures related to Federal policy for the promotion of science ("Federal Report on Research II") which was placed before Parliament in the autumn of 1967. In its 1965 "Federal Report on Research I", the Government had presented a survey on the principles and present situation of Federal activity for the promotion of science, and in that context presented a general picture of the status and organization of science and research in the Federal Republic. This second report focuses attention more closely on the future. In addition to these reports, which document the activities and policy concept of the public authorities, there are other development plans covering a certain span of years which have been put before the public by large organizations of the scientific community. Thus the German Research Association has published special reports on its plan and projections for 1963 - 1965, 1966 - 1968, and 1969 - 1971.

As in any country, the national science policy aims, as presented in these publications or to be gathered from other declarations of the representatives of politics and science, are quantitative as well as quantitative.

As already indicated in its 1965 "Federal Report on Research I", the Federal Government envisages that the total national expenditure on scientific research shall reach 3 per cent of the GNP by 1970; this would include expenditure for higher education. According to recent statements, about DM 10 billion of this total are to come from public funds (Federal and State); actual expenditure has gradually approached this amount over the past few years.

In the pursuit of the policy aims, the organizations and members of the scientific community will continue to be largely independent as regards the determination and choice of research projects, aims and methods. Responsible politicians have acknowledge that it is an essential function of science policy to secure for all fields of science the institutional and financial means essential for such free development.

The public authorities, the Federal Government in particular, will continue and probably increase their special efforts to promote certain fields of science which are considered of particular importance for social and economic development in a modern industrial society. Whereas in the post-war period the emphasis was on general reconstruction, modernization and expansion of research facilities, selective promotion of individual priority disciplines now gains in policy importance.

The most important priority disciplines are nuclear research, space research, data processing, certain special departmental research projects, and possibly other fields for which special promotion programmes are just being developed, such as oceanography. Extending over a fairly long period, the development of these programmes marks a structural change in national science policy in recent years.

II. UNIVERSITIES AND INSTITUTIONS OF UNIVERSITY RANK

One of the main aims, to be achieved in close co-operation between the Federal and States administrations, will be the further expansion of higher education facilities. The guide-lines for long-term development policy were provided by the 1960 recommendation of the Science Council. In following these recommendations and in some parts even exceeding them, the States have in their budgets established about 12,200 new posts for personnel in higher education. Financial investment in higher education increased by 115 per cent from 1963 to 1966. In spite of these efforts, there still exists a great demand. The Science Council's 1967 follow-up to the 1960 recommendations on university expansion estimates that about DM 5.6 billion will be needed from public funds between 1967 and 1970 to expand and modernize the existing institutions of university rank. The States estimate the total investment requirements (including the construction of new universities) for the years 1965 to 1975 at DM 20 billion.

Federal Government plans envisage a steep rise in Federal funds for university expansion in 1968 (DM 630 million) and 1969 (DM 730 million).

Besides the financial considerations, there are the equally important problems of structural reform and development in higher education. The " Federal Report on Research II "[1] in its section dealing with future development indicates that the following are considered the most urgent issues :

1. To clear the way for Federal participation in the financing of the construction of new universities ;
2. To speed up the expansion of the existing universities within the framework of medium-term finance plans covering a period from three to five years ; these plans must be worked out in co-ordination between Federal and States administrations in accordance with the priorities recommended by the Science Council ;
3. To implement organizational measures in order to insure full utilization of existing space and facilities, especially as regards lecture rooms and laboratory facilities ;
4. To exploit all possibilities for rationalization in university construction programmes (standardization of buildings and construction elements for mass production ; use of modern production and construction methods, especially as regards pre-fabricated construction units) ;
5. To organize the national research effort into a number of regional units comprising university as well as other research institutes ;
6. To put into full effect as soon as possible the reform of university studies in order to achieve greater efficiency and shorter study duration ;
7. To examine the possibilities of using programmed instruction material and correspondence courses to supplement traditional methods of full-time education and " refresher " programmes.

Another project envisages the identification of special fields of research (" Sonderforschungsbereiche ") to receive reinforced support in certain " Centres of Excellence ". These plans result from the realization that it is no longer possible to adhere to the idea that research in all disciplines should be represented at every university with equal strength. Instead, manpower, facilities and financial support for certain projects within those special fields of research are to be concentrated in a limited number of places ; at the same time, sufficient flexibility is to be maintained to allow for adjustment to future changes and developments. The German Research Association is to be responsible for defining the special fields and centres, sponsoring the centres and deciding if and when they should be closed down. This system is expected to have considerable influence on the organizational structure of research in Germany.

Expansion of university research has led to increased demands on support from the German Research Association. The Federal and States administrations, the main sources of the Association's funds, have responded to this situation by considerably increasing their contributions over the past years. The envisaged further increase of university staff is sure to lead to a corresponding increase in applications from university scientists for support from the Association. The Association has already for a number of years established and supported priority research projects in fields of special public importance, such as food research, air and water pollution, protection against noise. Other important problems, especially in the field of public health, are still to be investigated (see Annex 7B).

1. Op. cit.

III. NUCLEAR RESEARCH AND DEVELOPMENT

One of the programmes coming under the immediate responsibility and sponsorship of the Federal Ministry of Research is nuclear research and development. In modern industry, successful technological development depends on a broad foundation of basic research, and there exists a strong mutual dependence between scientific knowledge and technological innovation. National science policy will therefore continue its priority support to basic research in nuclear science.

A first stage in the public promotion programme for nuclear research and technology has essentially been achieved with the attainment of international standard in many sectors. The planning, construction and operation of first-generation nuclear power stations has largely become a matter for the reactor industry and electricity companies. Within the framework of the National Programme for Nuclear Science and Technology, research and development at university and independent institutes, nuclear research centres, in industry, and co-operative international projects, are sponsored and co-ordinated.

Special support to research in high- and low-energy physics, plasma physics, nuclear solid-state physics, radiation and nuclear chemistry, nuclear medicine and radiobiology is likewise to be continued in the future.

Within nuclear technology, special projects for priority promotion include the development of advanced converter reactors and of breeders, and projects on the control of the fuel cycle and the utilization of radio-active material.

The work on these large research and development projects has led to a new style and structure of research in the "big science" research establishments, such as the large national nuclear research centres, which may serve as models for a new form of partnership between universities, industry, and State. University institutes have access to the research facilities and results of the centres and industry can exploit the research results on modern technological problems. Large projects in the following areas will remain of priority interest for the research centres: nuclear technology and development; high-energy physics; plasma physics; nuclear ship propulsion; radiation.

IV. SPACE RESEARCH

Space research in the Federal Republic is in a relatively early stage of development. A comparison of national figures on finance and manpower with the corresponding figures for the world powers shows that the Federal Republic is one of those industrial countries whose limited resources make large-scale national projects unattainable; a combined effort in international co-operation becomes the only practicable solution. The Federal Republic has therefore always attached great importance to its co-operation in the large international organizations of ELDO, ESRO and CTETS.

In a first phase, work was mainly concentrated on the basic aspects of extra-terrestrial research in geophysics and astrophysics, and on the technological problems involved. At present, emphasis is shifting towards satellite and space-probe projects. These projects, which are to be carried out partly within the European space research organizations and partly in bilateral partnerships, mainly with the United States and France, are defined in detail in the medium-term programme for the promotion of space research from 1967 to 1971, which envisages a national investment of over DM 2 billion for space research over that period.

V. ELECTRONIC DATA PROCESSING

In view of the special importance of electronic data processing for industry, administration and science, the Federal Government has followed the example of other countries in deciding to give public support to research and development in this field, under a programme to be set up by the Ministry for Scientific Research in co-operation with other Federal departments. About DM 300 million of Federal funds are to be provided over a five-year period.

VI. INDUSTRIAL RESEARCH AND DEVELOPMENT

Industrial research and development and policy measures to promote them will continue to be of special importance. Competitiveness today depends largely on new products and new technology as well as efficiency. There is a continued need to increase research-mindedness in small and medium-size industrial undertakings. According to a Donors' Association survey, industry invested DM 3.3 billion in its own research (including research associations) in 1964. It seems certain that this amount will have to be increased in the future.

Chemical industry is still the branch with the greatest volume of research in the Federal Republic; though it has only a 10 per cent share in turnover, it accounts for about one third of the total research effort in all manufacturing industries. Other branches with a relatively high volume of research and development are the electrical, vehicle, machine-tool, and the iron and steel industries. In the years to come, moreover, industrial research and development in the Federal Republic will have to increase its

efforts to meet the challenge of the new economic structure of Europe, of the technological gap that has developed between the world powers and smaller countries, and of continuous adjustment and rationalization of production according to new developments and market situations. To equip industry for this task, new forms of co-operation between State and industry will have to be developed.

VII. INTERNATIONAL CO-OPERATION

The importance ascribed to international co-operation by the Federal Republic and the Federal Government is clearly shown by the fact that in the year 1966 about DM 315 million was distributed to international organizations within the framework of such co-operation. This places the Federal Republic in the second position in the Western World after the United States, as regards the size of its financial contribution to co-operation.

Recognition of the need to complement national scientific efforts by international co-operation has gained wide acceptance since the end of the Second World War. This international co-operation proceeds not only within the large intergovernmental organizations such as Unesco, OECD, EUROPARAT, the European Economic Community, and the specialized organizations for nuclear and space research, but also to a not insignificant extent within the non-governmental organizations such as the International Council of Scientific Unions (ICSU) and its constituent unions and similar organizations. Through its appropriate academic organizations, the Federal Republic has participated and, where relevant, continues to participate, in all the major international scientific projects, including the International Geophysical Year, the International Quiet Sun Year, the International Hydrological Decade, the Indian Ocean Expedition, and the International Biological Programme.

In the field of nuclear research, the CERN organization is tremendously important for international co-operation. The Federal Republic provides some 23 per cent of its total budget, at the head of all the participating States. Also in this field, there is similar co-operation with EURATOM, as well as participation in the activities of the International Atomic Energy Agency in Vienna.

In the field of space research, the Federal Republic co-operates with ELDO, ESRO and CETS. The importance of international co-operation in this field is shown by the fact that out of the total Federal budget provision of DM 527 million for 1966, DM 210 million was allocated to national programmes and DM 317 million to German co-operation with the European organizations.

As well as participating in these major international programmes, the Federal Republic has entered into numerous bilateral arrangements.

The Federal Government and the scientific community of the Federal Republic are of the opinion that there will in the future be numerous problems which it will be possible to solve only within the framework of world-wide international co-operation. World food supplies, world health, prevention of water pollution and air pollution, and the maintenance of natural resources are problems in this class; co-operation in the struggle to deal with them will, for some years and decades to come, constitute one of the foremost tasks of State and Science in the Federal Republic.

Part six

THE DEMOGRAPHIC AND ECONOMIC BACKGROUND OF THE FEDERAL REPUBLIC OF GERMANY

The Federal Republic of Germany is a democratic, parliamentary State comprising eleven constituent States (the " Länder "). The present constitution formulated in the " Grundgesetz " (" Basic Law "), came into force on 24 May 1949.

The supreme *constitutional authorities* are the " Bundestag " (Federal Parliament), the " Bundesrat " (Federal Council), the " Bundesregierung " (Federal Government) and the " Bundespräsident " (Federal President). The Federal Parliament is elected by the people. The Federal Council is composed of representatives of the individual States and is the institution through which they are able to influence the Federal legislature. The Federal Government, i.e. the Federal Chancellor and the Federal Ministers, is the supreme executive body. The Federal President symbolizes the unity of the Federal Republic.

Articles 10 - 75 of the Basic Law define the legislative competence of the Federal Government and the individual States respectively. The latter have *legislative power* in so far as the Basic Law does not declare it to be a Federal prerogative. The following distinctions must be recognized :

- Fields where legislation is *the prerogative of the Federal Government* only : e.g. foreign affairs, Federal nationality, freedom of establishment, emigration and immigration, extradition, passport, currency, credit and foreign exchange, weights and measures, unity of customs and international commercial regulations, Federal railways, air traffic, postal services, status of Federal civil servants, safeguarding of the Federal Constitution and Federal statistics.
- Fields of *joint competence* where legislation can be enacted by the Federal Government and by the individual States : however, the latter may use this prerogative only where and in so far as the Federal Government itself fails to do so, e.g. in matters of of civil and criminal law, etc. ; the right to promulgate " framework laws ", whereby in specific circumstances, the Federal Government may issue general directives to be implemented by the individual States (e.g. in matters concerning the press, films, nature protection, etc.).
- Fields where the individual States have exclusive competence and where Federal legislation is precluded, e.g. : education, police, statutory regulations, etc.

Thus under the Basic Law, the individual States are the competent bodies for legislation and administration in *matters of education.* Under article 74.14 the Federal Government has joint competence with the States as regards legislation for the advancement of scientific research ; but the other Government powers and functions relating to higher education belong to the States.

The freedom of education and research is explicitly safeguarded in Article 5, paragraph 3 of the Basic Law.

The Federal Republic of Germany is 248,528 sq.km. (95,957 sq. miles) in area. The maximum distance from north to south is 832 km. (517 miles) and from east to west 453 km. (281 miles). According to the small-scale sample census of population and persons in gainful employment carried out every year and representative of the position obtaining at the time, the number of inhabitants in the Federal Republic of Germany in April 1963 was 57.7 million ; of these, 27.0 million were in gainful employment. Accordingly, for every ten persons in gainful employment there were eleven who were not so employed. Like the majority of her West European neighbours, the Federal Republic is a typical industrial country. In 1963 the number of persons engaged in industrial undertakings employing 10 or more persons totalled 8.26 million - including 6.5 million classed as " workers " - about 39 per cent of the total of " workers ", office staff and officials in the Federal area. Women constituted some 29 per cent of all industrial employees. The total sum paid out to industrial employees in

wages and salaries amounted to DM 66,400 million ($16,600 million).

In 1963 there were about 102,200 industrial concerns in the Federal Republic, of which 1.2 per cent were large-sized businesses employing 1,000 people or more and 6.2 per cent were in the medium-sized category (200 to 999 employees). Businesses of the smallest size, with fewer than 10 employees, constituted 43.3 per cent of all industrial enterprises, although as regards both the number of persons employed and the turnover their share in the total industrial sphere was only about 2.0 per cent. Eighty per cent of all persons employed in industry are engaged in enterprises with over 100 employees. Although a process of concentration is under way, it is restricted mainly to the basic industries and the first stages of manufacturing processes. It is to be counteracted through a reform of the turnover and income taxes.

In industrial output the main emphasis is on the manufacturing industry. In 1963 this sector accounted for 88 per cent of the total, the breakdown being as follows: basic materials and production goods industries, 25 per cent; capital goods industries, 31 per cent; consumer goods industries, 18 per cent; food industry (including coffee, chocolate, etc.) 14 per cent. Mining accounted for 5 per cent of industrial output, the power industry for 5 per cent, and the building industry for 2 per cent. According to the number of persons employed, engineering took first place with 12.6 per cent; according to the total turnover, the food industry led with 38,700 million DM ($9,675 million), followed by engineering with 32,100 million DM ($8,025 million), heavy industry with 27,100 million DM ($6,775 million) and chemical industry with 27,500 million DM ($6,875 million). Since 1950, industrial output had risen by 183 per cent. The Gross National Product (GNP) in 1963 totalled 376,900 million DM ($94,225 million).

The main industrial centres are the Rhine-Ruhr area, the Rhine-Main region, and in South-West Germany. The North German coastal region is also being progressively industrialized.

The Federal Republic is only moderately endowed with natural resources. Hard coal is mined chiefly in North-Rhine-Westphalia; the deposits in the Ruhr area alone are estimated at 65,000 million tons, enough to last 400 years. In 1963 the hard coal output of the 122 mines in the Ruhr and Aachen areas was 142.1 million tons – 63.2 per cent of the total produced by the six countries associated in the European Coal and Steel Community. Iron smelting is also mainly concentrated in this area. These two industries together employ 2.8 million men.

The total amount of lignite (brown coal) in the Federal Republic is believed to be over 5,000 million tons, the annual production in 1963 being 106.7 million tons. In the North-West are crude oil deposits, estimated to total 73 million tons, with an annual production (1963) of 7.4 million tons.

The potash deposits are estimated at 2,000 million tons (pure potash). The annual production of 18.5 million tons, with a K_2O content of 2,3 million tons, constitutes a quarter of the world output. The iron ore deposits contain about 3.000 million tons, though the ore is not of first-class quality. The quantity mined, 12.9 million tons a year (1963), covers only 35 per cent of home demands. As regards lead and zinc production, the domestic supply is more favourable through the mining of nearly 293,400 tons. With production amounting to 10,700 kilowatt-hours annually, the considerable hydraulic power, particularly in South Germany, is largely utilized for electric light and power production. Statistical data on population, economic aggregates, trade, etc. are given in Tables 15 to 23.

TABLES

TABLE 8 : TOTAL NATIONAL EXPENDITURE ON SCIENTIFIC AND TECHNICAL RESEARCH

Expenditure	1962	1963	1964	1965	1966
Absolute values :					
million DM	4,521	5,481	6,590	7,724	8,800
million $	1,130	1,370	1,648	1,931	2,200
Growth indices	100	121.2	145.8	170.8	194.6
As percentage of the national income	1.7	1.9	2.1	2.3	2.4
As percentage of the gross national product at market prices	1.3	1.5	1.6	1.7	1.8
Per inhabitant :					
DM	82.50	99.47	113.03	130.69	147.40
$	20.62	24.87	28.33	32.67	36.85

Source : Federal Report on Research II : Figures up to 1964 show actual expenditure ; later figures are partly estimates.

TABLE 9 : NATIONAL EXPENDITURE ON SCIENTIFIC AND TECHNICAL RESEARCH : BREAKDOWN ACCORDING TO THE ORIGIN AND ALLOCATION OF FUNDS BETWEEN THE VARIOUS SECTORS OF ACTIVITY

Breakdown of Expenditure	1962[a]	1963[b]	1964[a]	1965[b]	1966[b]
By Origin of Funds					
Public Sector					
million DM	2,070	2,709	2,912	3,847	4,300
million $	517	677	728	962	1,075
%	45.8	49.4	44.2	49.8	48.9
Industry					
million DM	2,218	2,772	3,331	3,877	4,500
million $	555	693	833	969	1,125
%	49.1	50.6	50.5	50.2	51.1
Higher Education[e]					
million DM	-	-	-	-	-
million $	-	-	-	-	-
%	-	-	-	-	-
Other[c]					
million DM	233	-	347	-	-
million $	58	-	87	-	-
%	5.1	-	5.3	-	-
TOTAL					
million DM	4,521	5,481	6,590	7,724	8,800
million $	1,130	1,370	1,648	1,931	2,200
%	100	100	100	100	100
By Allocation of Funds					
Public Sector					
million DM	178	195	217	250	300
million $	45	49	54	63	75
%	4.0	3.6	3.3	3.2	3.4
Industry					
million DM	2,468	-	3,800	4,300	5,000
million $	617	-	950	1,075	1,250
%	54.6	-	57.6	55.7	56.8
Higher Education					
million DM	878	970	1,131	1,500	1,750
million $	220	243	283	375	438
%	19.4	17.7	17.2	19.4	19.9
Other[d]					
million DM	997	-	1,442	1,674	1,750
million $	249	-	361	418	437
%	22.0	-	21.9	21.7	19.7

a) Source : Federal Report on Research II ; Tables 25 and 26
b) Distribution between sectors partly estimated
c) Railway and Post-Office, private sources, public insurance
d) Non-profit-making institutions, international organizations
e) Included in Public Sector

TABLE 10 : PUBLIC EXPENDITURE (1) ON SCIENTIFIC AND TECHNICAL RESEARCH (CIVIL AND DEFENCE)

Expenditure	1962	1963	1964	1965	1966
Absolute values :					
million DM	2,070	2,709	2,912	3,847	4,300
million $	517	677	728	962	1,075
Indices	100	130.9	140.7	185.8	207.7
As percentage of total national expenditure on scientific and technical research (see table 8)	45.8	49.4	44.2	49.8	48.9
As percentage of State budget (1) (expenditure)	1.9	2.3	2.3	2.8	2.9
Expenditure on civil research :					
million DM	1,660	2,161	2,263	3,144	3,539
as percentage of total expenditure on scientific and technical research	36.7	39.4	34.3	40.7	40.2
as percentage of total public research expenditure	80.2	79.8	77.7	81.7	82.3
Expenditure on defence research :					
million DM	410	548	649	703	761
as percentage of total expenditure on scientific and technical research	9.1	10.0	9.8	9.1	8.6
as percentage of total public research expenditure	19.8	20.2	22.3	18.3	17.7

(1) Federal Government, individual States, local authorities.

TABLE 11 : PUBLIC EXPENDITURE ON SCIENTIFIC AND TECHNICAL RESEARCH IN HIGHER EDUCATION (1)

Expenditure	1962	1963	1964	1965	1966
Absolute values :					
million DM	878	970	1,131	1,500	1,750
million $	220	243	283	375	483
Indices	100	110.5	128.8	170.8	199.3
As percentage of total public expenditure on scientific and technical research	42.4	35.8	38.8	39.0	40.7
As percentage of total national expenditure on scientific and technical research	19.4	17.7	17.2	19.4	19.9
As percentage of public expenditure on higher education	47.0	43.9	41.6	44.3	44.8

(1) *Public expenditure* covers expenditure from the budget of the public authorities (central and local governments).

TABLE 12: PUBLIC EXPENDITURE ON SCIENTIFIC AND TECHNICAL RESEARCH FOR INDUSTRY (1)

Expenditure	1962	1963	1964	1965	1966
Absolute values :					
million DM	340	-	535	540	683
million $	85	-	134	135	171
Indices	100	-	157.4	158.8	200.9
As percentage of public expenditure on scientific and technical research	16.4	-	18.4	14.0	15.9
As percentage of total national expenditure on scientific and technical research	7.5	-	8.1	7.0	7.8
As percentage of industry's expenditure on scientific and technical research	15.3	-	16.1	13.9	15.2

(1) *Public expenditure* covers expenditure from the budget of the public authorities (central and local governments).
Industry : includes the extractive (quarrying, mining) and manufacturing industries.

TABLE 13: PUBLIC EXPENDITURE ON INTERNATIONAL SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES (1)

Expenditure	1962	1963	1964	1965	1966
Absolute values :					
million DM	190	–	380	438	436
million $	47	–	95	110	109
Indices	100.0	–	200.0	230.5	229.5
As percentage of total public expenditure on scientific and technical research	9.2	–	13.0	11.4	10.1

(1) *Public expenditure* covers expenditure from the budgets of the public authorities (central and local governments).

TABLE 14: EXPENDITURE BY INDUSTRY ON SCIENTIFIC AND TECHNICAL RESEARCH (1)

Expenditure	1962	1963	1964	1965	1966
Absolute values :					
million DM	2,218	2,772	3,331	3,877	4,500
million $	555	693	833	969	1,125
Indices	100	125	150.2	174.8	202.9
As percentage of total national expenditure on scientific and technical research	49.1	50.6	50.6	50.2	51.1

Industry: includes the extractive (quarrying, mining) and manufacturing industries.

TABLE 15: PRINCIPAL NATIONAL ECONOMIC AGGREGATES AND POPULATION

Aggregate	1962	1963	1964	1965	1966
State budget (1) (expenditure)					
billion DM	107.0	116.3	127.6	139.7	147.7
billion $	26.75	29.1	31.9	34.9	36.9
National Income					
billion DM	271.9	289.0	316.5	341.5	362.5
billion $	68.0	72.25	79.1	85.4	90.6
Gross national product at market prices					
billion DM	354.5	377.6	413.8	449.6	477.9
billion $	88.6	94.4	103.45	112.4	119.5
Population thousands (2)	56,938	57,587	58,266	59,012	59,676

(1) Central Government, individual States and local authorities
(2) Including West Berlin: mid-year estimates.

TABLE 16: DISTRIBUTION OF POPULATION BY SEX AND AGE GROUPS
(Present position and forecast) (in thousands)

Age Group	1960			1966			1970			1980			1985		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
0 - 4 years	2240	2123	4363	2589	2464	5053	2603	2467	5070	2550	2418	4968	2696	2557	5253
5 - 9 years	2011	1912	3923	2270	2157	4427	2536	2420	4956	2532	2403	4935	2538	2410	4948
10 - 14 years	1827	1746	3573	2001	1908	3909	2192	2083	4275	2584	2455	5039	2525	2399	4924
15 - 19 years	2082	1996	4078	1926	1827	3753	1994	1903	3897	2521	2410	4931	2575	2451	5026
20 - 24 years	2420	2308	4728	2050	1921	3971	1809	1722	3531	2165	2073	4238	2502	2405	4907
25 - 29 years	1913	1831	3744	2582	2367	4949	2285	2135	4420	1962	1892	3854	2149	2067	4216
30 - 34 years	1864	1930	3794	2060	1893	3953	2489	2289	4778	1779	1708	3487	1947	1884	3831
35 - 39 years	1618	2173	3791	2000	1964	3964	1987	1835	3822	2244	2112	4356	1762	1698	3460
40 - 44 years	1126	1536	2662	1665	2189	3854	1913	1985	3898	2431	2253	4684	2213	2092	4305
45 - 49 years	1656	2204	3860	1157	1594	2751	1624	2213	3837	1919	1794	3713	2382	2222	4604
50 - 54 years	1826	2261	4087	1583	2146	3729	1037	1441	2478	1810	1917	3727	1855	1757	3612
55 - 59 years	1759	2025	3784	1711	2240	3951	1581	2190	3771	1474	2099	3573	1704	1859	3563
60 - 64 years	1318	1735	3053	1602	1977	3579	1570	2105	3675	876	1325	2201	1326	1996	3322
65 years and over	2439	3557	5996	2757	4347	7104	3072	4795	7867	3394	5689	9083	2925	5216	8141

Source : Statistisches Bundesamt, "Wirtschaft und Statistik" Nr. 11/1966, pages 741/42.

TABLE 17 : DISTRIBUTION OF ACTIVE POPULATION BY SEX
(mid-year) (in thousands)

Population	1955	1960	1965
Men	15,435	16,620	17,372
Women	8,730	9,898	9,928
TOTAL	24,165	26,518	27,300

TABLE 18 : GEOGRAPHICAL DISTRIBUTION OF THE POPULATION IN 1961 (1), BY INDIVIDUAL STATES

Areas	Population (thousands)
Schleswig-Holstein	2,317
Hamburg	1,832
Niedersachsen	6,641
Bremen	706
Nordrhein-Westfalen	15,912
Hessen	4,815
Rheinland-Pfalz	3,417
Baden-Württemberg	7,759
Bayern	9,516
Saarland	1,073
Berlin (West)	2,197
Total	56,185

(1) The year of the last population census.

TABLE 19 : STRUCTURE OF FOREIGN TRADE - 1965

Main exports	%	Main imports	%
Machinery (excluding electrical)	20.9	Textiles and clothing	10.6
Vehicles (excluding watercraft)	15.1	Mineral oil, tar, and products therefrom	7.2
Chemical products (including raw materials)	12.4	Fruit and vegetables etc.	6.5
Iron and ironware	12.3	Non-ferrous and precious metals and products therefrom	6.3
Electrical products (including machinery	9.0	Machinery (excluding electrical)	6.2
Textiles and clothing	5.7	Iron and ironware	6.1
Other goods	24.6	Chemical Products (including raw materials)	6.0
		Motor vehicles, aircraft	3.4
		Ores	3.4
		Other goods	44.3
Total :	100.0	Total :	100.0

TABLE 20 : ORIGIN OF THE GROSS DOMESTIC PRODUCT (1), PERCENTAGES

Sector of Activity	1960	1961	1962	1963	1964
Agriculture, forestry, fisheries	6.0	5.5	5.1	5.1	4.9
Mines	5.3	4.9	4.7	4.7	4.2
Manufacturing industries	41.2	41.5	41.4	40.4	40.6
Construction	6.8	7.1	7.4	7.6	7.9
Transport and communications	6.5	6.3	6.1	6.1	6.0
Commerce	13.2	13.1	13.6	13.5	13.4
Public administration, defence	7.4	7.8	7.8	8.2	8.2
Other	13.6	13.8	13.9	14.4	14.8
TOTAL	100	100	100	100	100

(1) Breakdown by sectors of activity following the United Nations Statistical Yearbook.k.

TABLE 21 : GROSS INVESTMENTS IN THE ECONOMY (1)

Sector of activity	1960	1961	1962	1963	1964
Agriculture, forestry, fisheries	6.9	6.4	5.9	6.1	5.8
Mines	4.9	4.4	4.3	4.1	3.8
Manufacturing industry	39.1	39.5	39.5	38.4	38.5
Construction	7.4	7.8	8.1	8.3	8.7
Transport and Communications	12.3	12.0	12.4	12.3	12.3
Commerce	6.5	6.3	5.9	5.9	5.7
Public administration ; defence	20.9	21.6	22.0	23.0	23.1
Other	2.0	2.0	1.9	2.0	2.0
Total : percentage	100	100	100	100	100
million DM	229.6	252.0	272.3	289.4	317.3
million $	57.4	63.0	68.1	72.4	79.3

(1) Breakdown by sectors of activity following the United Nations Statistical Yearbook.

TABLE 22 : RATE OF DEVELOPMENT OF THE EXTRACTIVE AND MANUFACTURING INDUSTRIES

	1962	1963	1964	1965
Mining	100	102	103	101
Manufacturing Industry	100	104	113	120
Iron and Steel Producing Industry	100	96	114	114
Chemical Industry	100	110	125	139
Investment Industry	100	102	110	118
Textile Industry	100	104	108	112
Food Industry	100	105	110	114
Energy	100	110	121	127
Total :	100	104	113	119

Source : Statistical Yearbook 1966, page 63.

TABLE 23 : CHANGES IN THE COST OF LIVING INDEX

1962	1963	1964	1965	1966	1967
100	103	105	109	112.8	114.4

CHART 1 : ORGANIZATION OF SCIENCE AND RESEARCH
IN THE FEDERAL REPUBLIC OF GERMANY

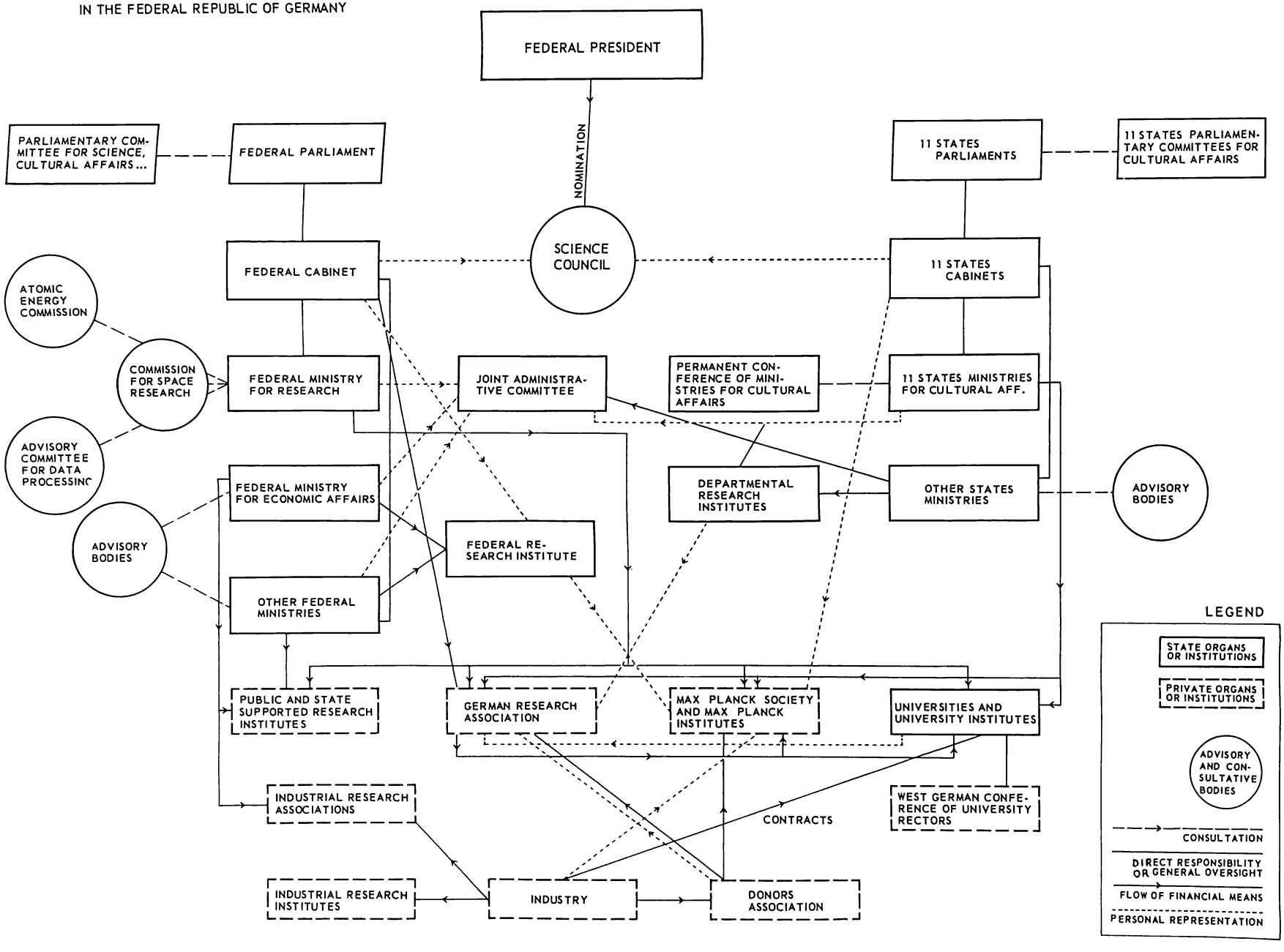


CHART 2 : ORGANIZATION OF THE FEDERAL MINISTRY FOR SCIENTIFIC RESEARCH

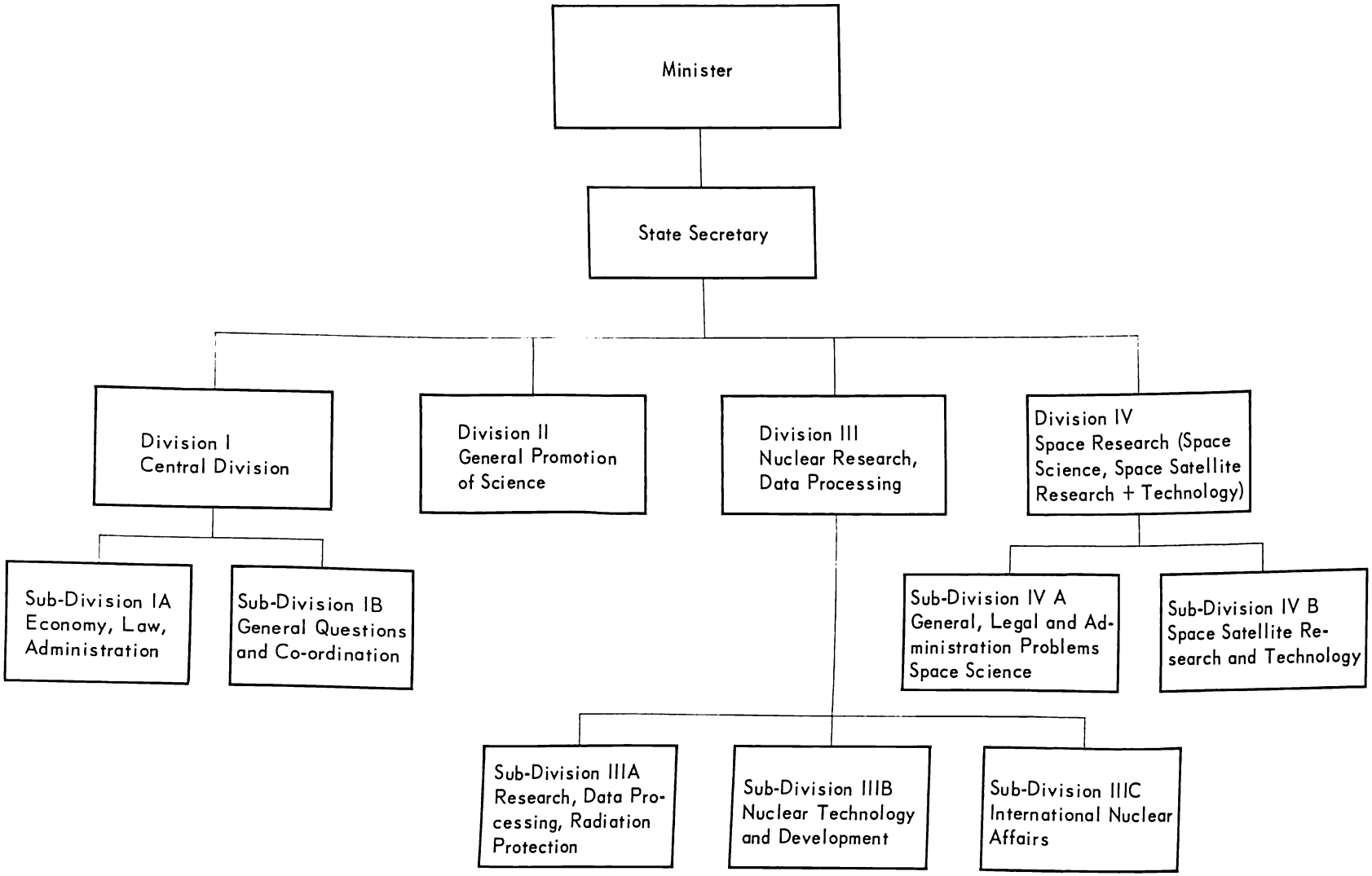


CHART 3 : ORGANIZATION OF THE GERMAN RESEARCH ASSOCIATION

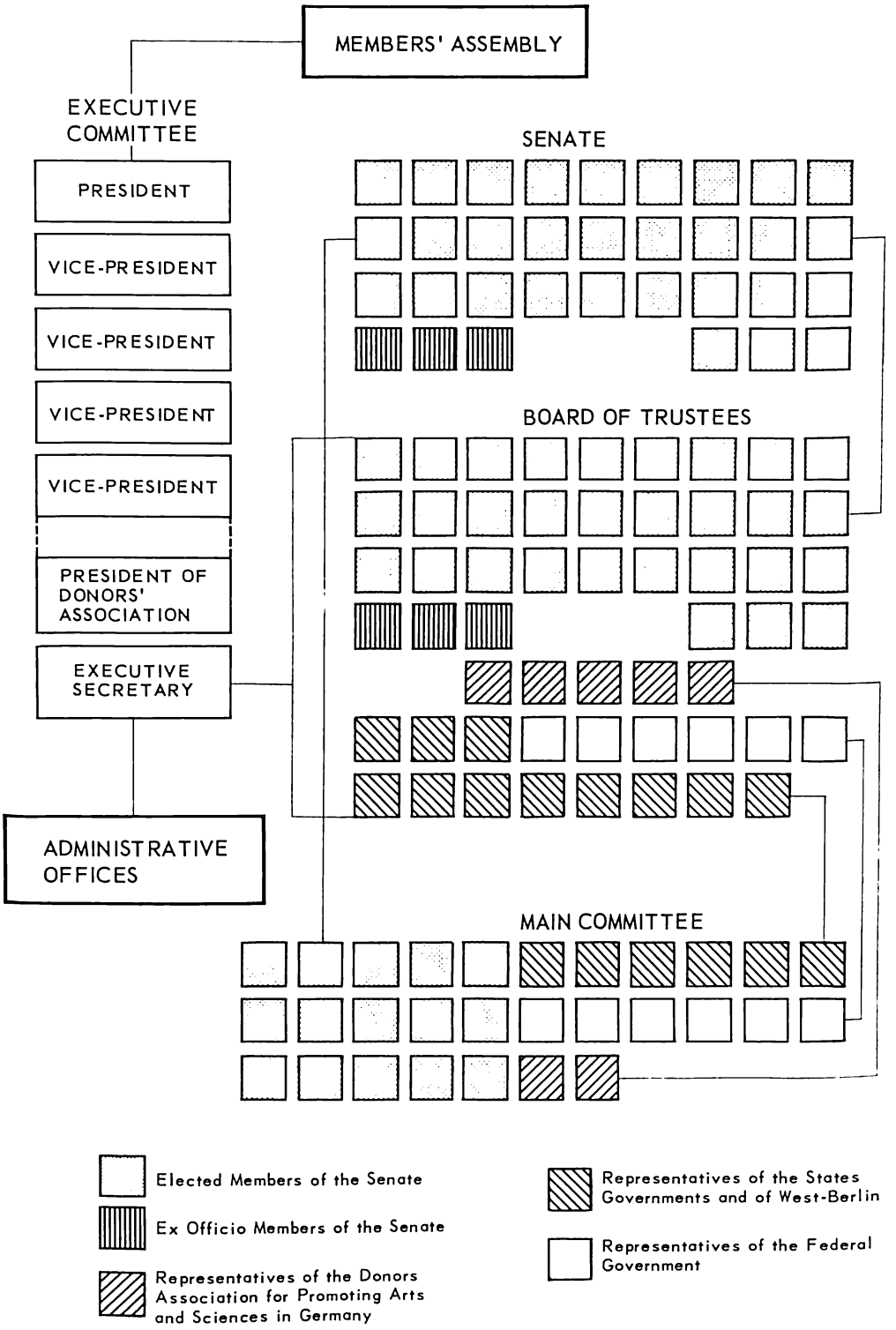


CHART 4 : ORGANIZATION OF GERMAN ATOMIC ENERGY COMMISSION

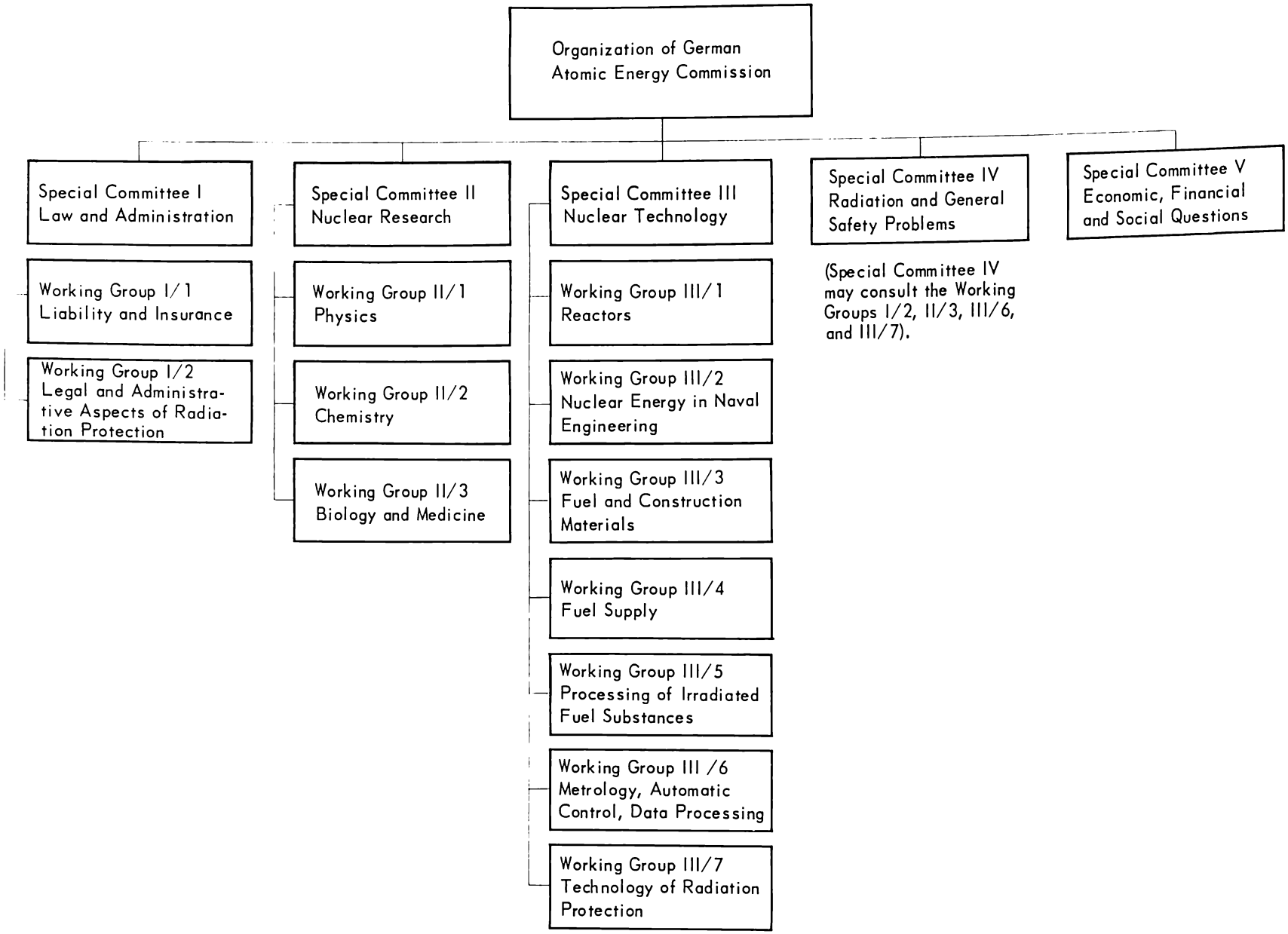


CHART 5 : ORGANIZATION OF GERMAN COMMISSION FOR SPACE RESEARCH

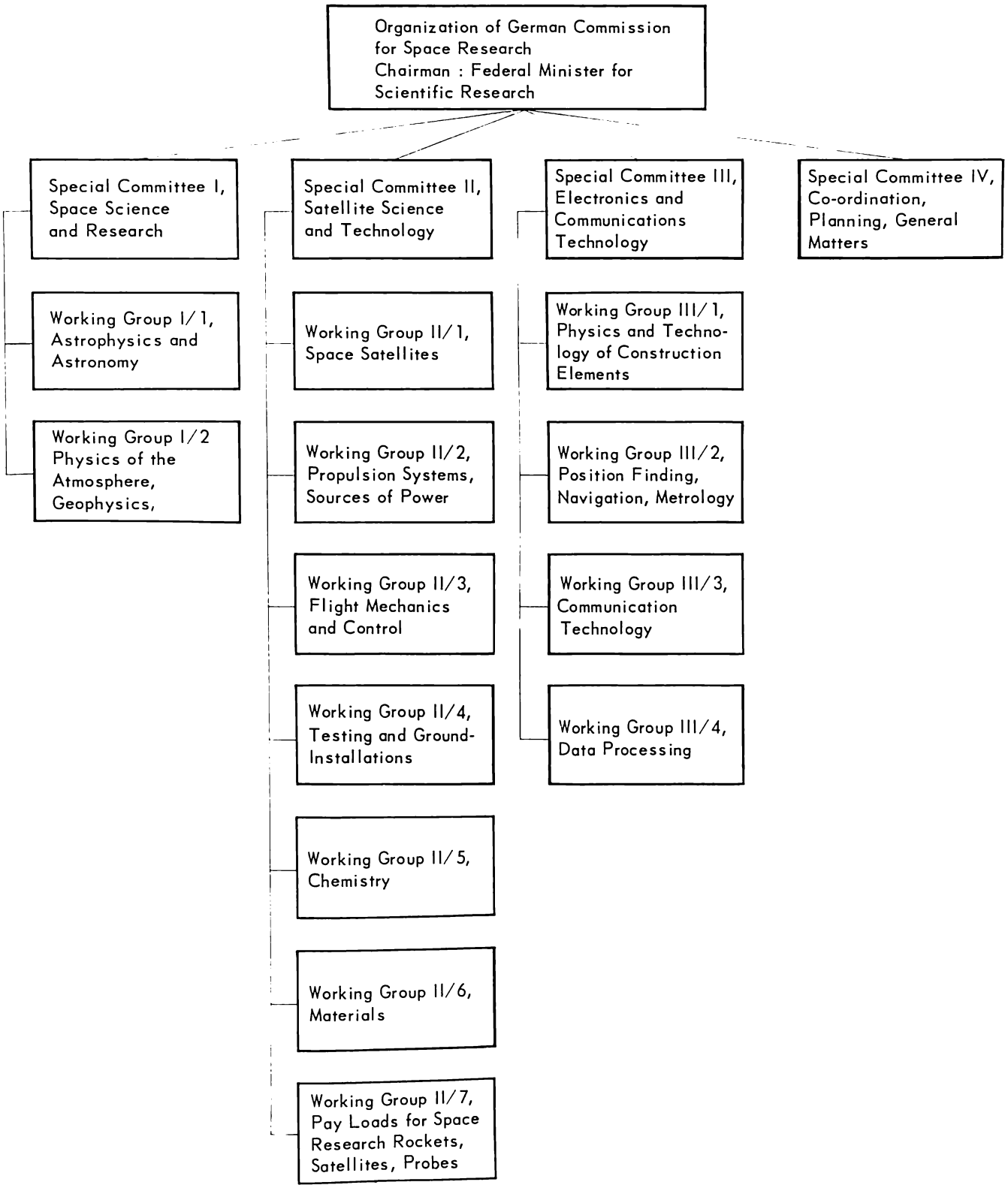


CHART 6 : ORGANIZATION OF THE PERMANENT CONFERENCE OF THE MINISTERS OF EDUCATION AND CULTURAL AFFAIRS OF THE STATES OF THE FEDERAL REPUBLIC OF GERMANY

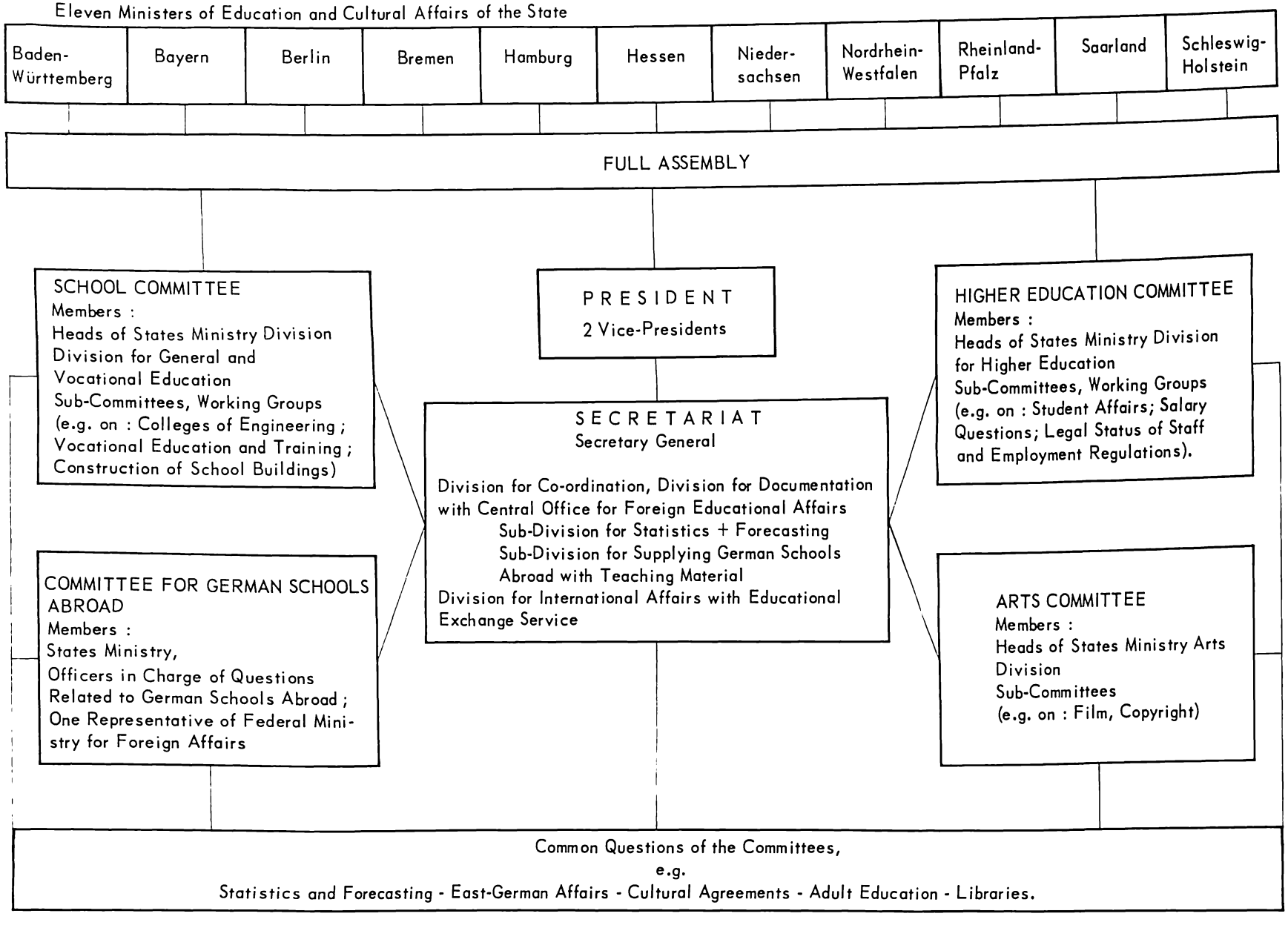
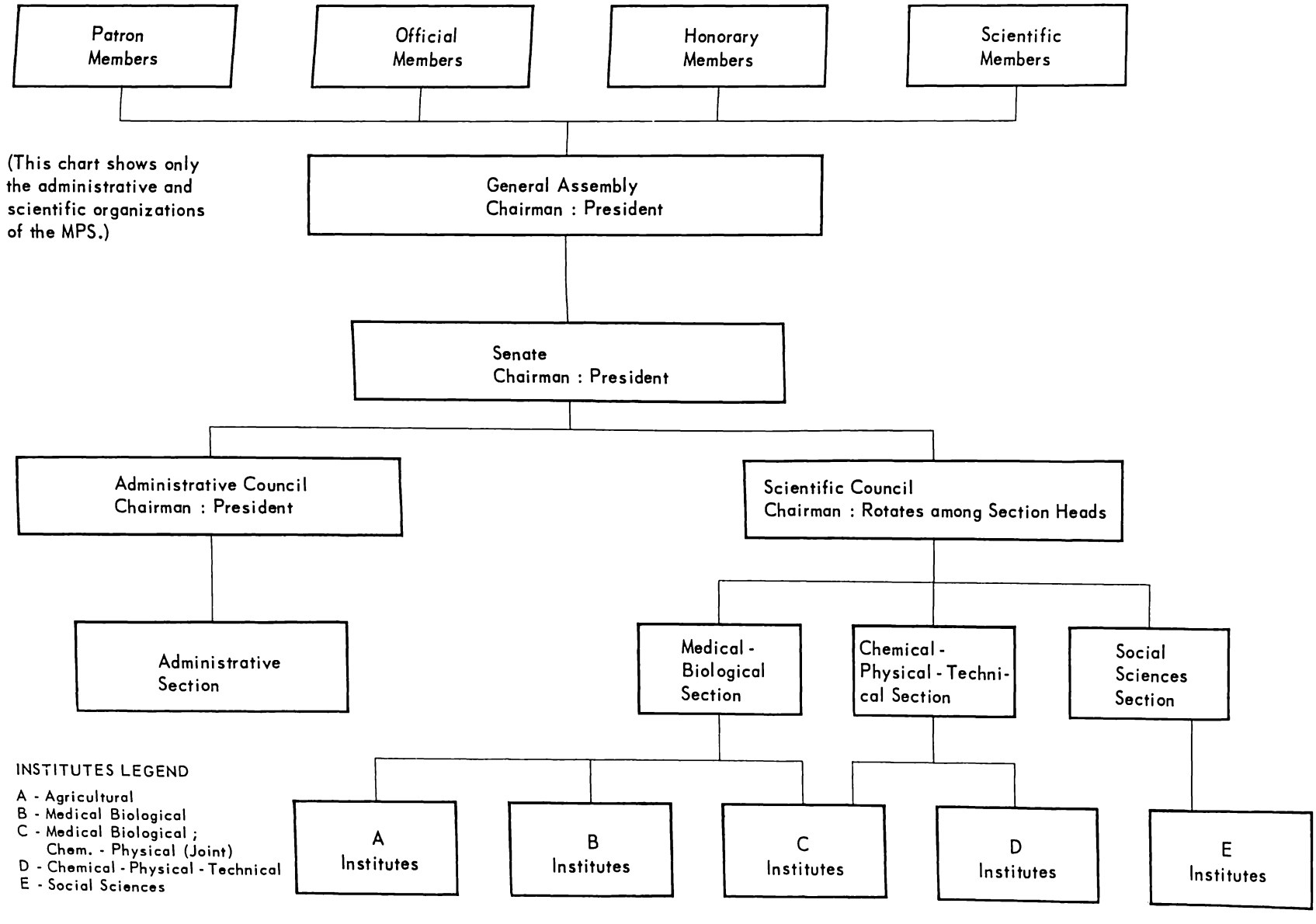


CHART 7 : ORGANIZATION OF THE MAX PLANCK SOCIETY



ANNEXES

Annex I

INSTITUTIONS CONCERNED WITH THE PROMOTION OF SCIENCE IN THE FEDERAL REPUBLIC OF GERMANY

Bavarian Academy of Sciences (Bayerische Akademie der Wissenschaften), München 22, Marstallplatz 8.

Chemical Industry Foundation for the Promotion of Research, Science and Teaching (Fonds der Chemischen Industrie für die Förderung von Forschung, Wissenschaft und Lehre), Düsseldorf, Breitestr. 8.

Donors' Association for Promoting Arts and Sciences in Germany (Stifter-Verband für die Deutsche Wissenschaft), Essen-Bredeney, Brucker Holt 42.

Fraunhofer Society for the Promotion of Applied Research (Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.), München 19, Romanstr. 13.

Fritz Thyssen Foundation (Fritz-Thyssen-Stiftung), Köln, Habsburger Ring 9-13.

German Engineers' Association (Verein Deutscher Ingenieure), Düsseldorf, Graf-Reckestr. 84.

German Federation of Technical-Scientific Asssociations (Deutscher Verband technisch- wissenschaftlicher Vereine), Düsseldorf, Graf-Reckestr. 84.

German Research Association (Deutsche Forschungsgemeinschaft), Bad Godesberg, Kennedyallee 40. (Contract Research Clearing-house - Vermittlungsstelle für Vetragsforschung)

Göttingen Academy of Sciences (Akademie der Wissenschaften zu Göttingen), Prinzenstr. 1.

Heidelberg Academy of Sciences (Heidelberger Akademie der Wissenschaften), Karlstr. 4.

Mainz Academy of Sciences and Literature (Akademie der Wissenschaften und Literatur, Mainz), Geschwister-Schollstr. 2.

Max Planck Society for the Promotion of Science (Max-Plank-Gesellschaft zur Förderung der Wissenschaften e.V.), Göttingen, Bunsenstr. 10.

Ministry for Scientific Research (Bundesministerium für wissenschaftliche Forschung), Bad Godesberg, Luisenstr. 46.

Organization of Industrial Research Associations (Arbeitsgemeinschaft industrieller Forschungsvereinigungen), Köln, Deutscher Ring 26.

Permanent Conference of the States Education Ministers (Ständige Konferenz der Kultus-Minister der Länder), Bonn, Nassestr. 11.

Science Council (Wissenschaftsrat), Köln-Marienburg, Marienburgerst. 8.

Volkswagen Foundation (Stiftung Volkswagenwerk), Hanover-Döhren, Schützenallee 9-11.

West German Conference of University Rectors (Westdeutsche Rektorenkonferenz), Bad Godesberg, Ahrstr. 39.

Annex II

INSTITUTIONS OF UNIVERSITY RANK (WISSENSCHAFTLICHE HOCHSCHULEN) IN THE FEDERAL REPUBLIC OF GERMANY

The Free University of Berlin (die Freie Universität Berlin), Berlin-Dahlem, Boltzmannstr. 4. (1948).

Bochum University (Ruhr-Universität Bochum), Bochum-Querenburg, Lennershofstr. 66. (1961).

Bonn University (Rheinische Friedrich-Wilhelms-Universität Bonn). Liebfrauenweg 3. (1818).

Düsseldorf University (Universität Düsseldorf), Moorenstr. 5. (1922, 1961, 1966).

University of Erlangen-Nürnberg (Friedrich-Alexander-Universität Erlangen-Nürnberg), Erlangen, Schlossplatz 4. (1743).

Frankfurt University (Johann-Wolfgang-Goethe-Universität Frankfurt), Frankfurt/Main, Mertonstr. 17-25. (1914).

Freiburg University (Albert-Ludwig-Universität Freiburg), Belfortstr. 11. (1457).

Giessen University (Justus-Liebig-Universität Giessen), Ludwigstr. 23. (1607, 1957).

Göttingen University (Georg-August Universität Göttingen), Wilhelmplatz 1. (1736).

Hamburg University (Universität Hamburg), Edmund-Siemers-Allee 1. (1919).

Heidelberg University (Ruprecht-Karl-Universität Heidelberg), Grabengasse 1, Alte Universität. (1386).

Kiel University (Christian-Albrecht-Universität Kiel), Olshausenstr. 40-60, Neue Universität. (1665).

Köln University (Albertus-Magnus-Universität Köln), Köln-Lindenthal, Albertus-Magnus-Platz. (1388-1919).

Konstanz University (Universität Konstanz), Auf der Insel 1. (1964).

Mainz University (Johannes-Gutenberg-Universität Mainz), Saarstr. 21. (1477, 1946).

Marburg University (Philips-Universität Marburg), Marburg/Lahn, Biegenstr. 10. (1527).

München University (Ludwig-Maximilians-Universität München), Geschwister-Scholl-platz 1. (1472).

Münster University (Westfälische-Wilhelms-Universität Münster), Münster i.w., Schlossplatz 2. (1780, 1902).

Regensburg University (Universität Regensburg), Universitätsstr. 31. (1962).

Saarbrücken University (Universität des Saarlandes), Saarbrücken, St. Johanner Stadtwald. (1947).

Tübingen University (Eberhard-Karls-Universität Tübingen), Wilhelmstr. 7. (1477).

Ulm University, Medical-Science School (Universität Ulm, Medizinisch-Naturwissenschaftliche Hochschule), (1966).

Würzburg University (Bayerische Justus-Maximilian-Universität Würzburg), Sanderring 2, Neue Universität, (1402, 1582).

TECHNOLOGICAL UNIVERSITIES (Technische Hochschulen)

Technological University of Aachen (Rheinisch-Westfälische Technische Hochschule Aachen), Templergraben 55. (1870).

Technological University of Berlin (Technische Universität Berlin), Berlin-Charlottenburg 2, Hardenbergstr. 34. (1799, 1879).

Technological University of Braunschweig Technische Hochschule Carola-Wilhelmina zü Braunchweig), Pockelsstr. 4. (1745).

Technological University of Clausthal (Technische Hochschule Clausthal, Bergakademie), Clausthal-Zellerfeld, Adolf-Romerstr. 2A. (1775, 1961).

Technological University of Darmstadt (Technische Hochschule Darmstadt), Hochschulstr. 1. (1836, 1877).

Technological University of Hannover (Technische Hochschule Hannover), Am Welfengarten 1. (1831, 1847, 1879).

Technological University of Karlsruhe (Technische Hochschule Fridericiana Karlsruhe), Kaiserstr. 12. (1825).

Technological University of München (Technische Hochschule München), Arcisstr. 21. (1827, 1868).

Technological University of Stuttgart (Technische Hochschule Stuttgart), Huberstr. 16. (1829, 1879).

OTHER INSTITUTIONS OF UNIVERSITY RANK
(Wissenschaftliche Hochschulen)

Medical University of Hannover (Medizinische Hochschule Hannover), Bischofshofer Damm 15. (1963).

College of Veterinary Medicine of Hannover (Tierärztliche Hochschule Hannover), Hans-Böckler-Allee 16. (1778, 1887).

Hohenheim College of Agriculture (Landwirtschaftliche Hochschule Hohenheim), Stuttgart-Hohenheim, Schlossgebäude. (1818).

Mannheim College of Economics (Wirtschaftshochschule), Gutenbergstr. 15. (1908, 1929, 1946).

Annex III

INSTITUTES OF THE MAX PLANCK SOCIETY IN THE FEDERAL REPUBLIC OF GERMANY
(Institute der Max Planck-Gesellschat)

Baden-Württemberg

MPI für Kernphysik (nuclear physics), Heidelberg.

MPI für ausländisches öffentliches Recht und Völkerrecht (foreign and international public law), Heidelberg.

MPI für auslåndisches und internationales Strafrecht (foreign and international criminal law), Freiburg.

MPI für Metallforschung (metal research), Stuttgart.

MPI für Medizinische Forschung (medical research), Heidelberg:
- Institut für Chemie (chemistry)
- Institut für Physik (physics)

MPI für Virusforschung (virological research), Tübingen.
- Abteilung für Biochemie (biochemistry)
- Abteilung für physikalische Biologie (physical biology)
- Biologisch-Medizinische Abteilung (biomedical) research)
- Molekular-Biologische Abteilung (molecular biology)

Forschungsstelle für Bioakustik in der Max Planck-Gesellschaft (bio-acoustics), Tübingen.

MPI für Pflanzengenetik (plant genetics), Heidelberg.

MPI für Immunbiologie (immunobiology), Freiburg.

MPI für Biologie (biology), Tübingen.
- Abteilung Beermann
- Abteilung Melchers
- Abteilung Reichardt
- Abteilung Henning

Bayern/Bavaria

MPI für ausländisches und internationales Patent, Urheber- und Wettbewerbsrecht (foreign and international patent, copyright and competition law, München.

MPI für Silikatforschung (silicates research), Würzburg.

MPI (Deutsche Forschungsanstalt) für Psychiatrie (psychiatry), München.
- Theoretisches Institut (theoretical)
- Klininisches Institut (clinical).

Forschungsstelle für Psychopathologie und Psychotherapie in der MPG (psychopathology and psychotherapy), München.

MPI für Eiweiss- und Lederforschung (research on albumin and leather), München.

MPI für Biochemie (biochemistry), München.

MPI für Zellchemie (cell chemistry), München.

MPI für Verhaltensphysiologie (behavioural physiology),Seewiesen.
- Abteilung Aschoff
- Abteilung Lorenz
- Abteilung Mittelstädt
- Abteilung Schneider
- Vogelwarte Rudolfzell (vormals Rossitten) (ornithology).

MPI für Physik und Astrophysik (physics and astrophysics), München
- Institut für Physik
- Institut für Astrophysik
- Institut für extraterrestrische Physik

Institut für Plasmaphysik GmbH (plasma physics), München.

Berlin/ Berlin

MPI für molekulare Genetik (molecular genetics)

Fritz Haber-Institut der MPG.
Institut für Elektronenmikroskopie (electron microscopy)

MPI für Zellphysiologie (cell physiology).

Institut für Bildungsforschung in der MPG (Educational research)

Hamburg/ Hamburg

MPI für ausländisches und internationales Privatrecht (foreign and international private law).

Forschungsstelle für Kulturpflanzenzüchtung der MPG (plant breeding).

Hessen/ Hessen

MPI für Biophysik (biophysics), Frankfurt.

MPI für Hirnforschung (brain research), Frankfurt.
Neuroanatomische Abteilung (neuroanatomy), Frankfurt.
Neuropathologische Abteilung (neuropathology), Frankfurt.
Physiologische Abteilung (physiology), Göttingen.
Abteilung für Tumorforschung u. experimentelle Pathologie (tumour research and experimental pathology), Köln.
Abteilung für allgemeine Neurologie (general neurology), Köln.

William G. Kerckhoff-Herzforschungsinstitut der MPG (cardiac research), Bad Nauheim.
I. Physiologische Abteilung (physiology I)
II. Physiologische Abteilung (physiology II)
Kardiologische Abteilung (cardiology)

Gmelin-Institut für anorganische Chemie und Grenzgebiete (inorganic chemistry and allied subjects), Frankfurt.

Institut für Dokumentationswesen (documentation), Frankfurt

Zentralstelle für maschinelle Dokumentation (mechanized documentation), Frankfurt.

Institut für Europäische Rechtsgeschichte (European law history), Frankfurt.

Niedersachsen/ Lower Saxony

Generalverwaltung der MPG, Göttingen einschl. Verwaltungsstelle Berlin und Geschäftsstelle Düsseldorf (Head Office).

MPI für Aeronomie (aeronomy), Lindau/ Hann.
Institut für Ionosphärenphysik (physics of the ionosphere), Lindau.
Institut für Stratosphärenphysik (physics of the stratosphere), Lindau.

MPI fur Spektroskopie (spectroscopy), Göttingen.

MPI für Strömungsforschung (fluid mechanics), Göttingen.

MPI für physikalische Chemie (physical chemistry), Göttingen.
Abteilung für chemische Kinetik (kinetics).

MPI für Meeresbiologie (marine biology), Wilhelmshaven.
Abteilung Schweiger
Abteilung Bauer.

MPI für experimentelle Medizin (experimental medicine), Göttingen.
Abteilung Physiologie (physiology)
Abteilung Chemie (chemistry)
Abteilung Pharmakologie (pharmacology)

MPI für Geschichte (history), Göttingen.

MPI für Tierzucht und Tierernährung (animal breeding and nutrition), Mariensee.

Aerodynamische Versuchsanstalt Göttingen i.V. in der MPG (aerodynamics), Göttingen.

Nordrhein-Westfalen/ North Rhineland and Westphalia

MPI für Kohlenforschung (coal research), Mülheim/ Ruhr.

MPI für Eisenforschung (iron research), Düsseldorf.

MPI für Arbeitsphysiologie (physiology of work), Dortmund.

MPI für Züchtungsforschung (Erwin-Baur-Institut) (animal brreding), Köln.

MPI für Ernährungsphysiologie (physiology of nutrition), Dortmund.

MPI für Radioastronomie (radio astronomy), Bonn.

Limnologische Station Niederrhein in der Max Planck-Gesellschaft (limnological station/ Lower Rhine, Krefeld.

Rheinland-Pfalz/ Rhineland-Palatinate

MPI für Chemie (Otto-Hahn-Institut) (chemistry), Mainz.
- Massenspektroskopische Abteilung (mass spectroscopy)
- Kernphysikalische Abteilung (nuclear physics)
- Chemische Abteilung (chemistry).

MPI für Landarbeit und Landtechnik (agriculture and agricultural engineering), Bad Kreuznach.

Schleswig-Holstein

MPI für Limnologie (hydrobiology/ limnology), Plön.
- Abteilung Tropenökologie (tropical ecology)
- Abteilung Allgemeine Limnologie (general limnology)
- Zweigstelle : Limnologische Flusstation (river) limnology branch), Schlitz.

Bibliotheca Hertziana (Max Planck-Institut), Rom.

Annex IV

INSTITUTES COVERED BY THE KONIGSTEIN AGREEMENT (Königsteiner Abkommen)

Baden-Württemberg

Deutsches Hirnforschungs-Institut (brain research), Neustadt/ Black-Forest).

Deutsches Krebsforschungs-Zentrum (cancer research), Heidelberg.

Fraunhofer Institut, Fribourg.

Astronomisches Recheninstitut (astronomical calculations), Heidelberg.

Institut für Virusforschung (virological research), Heidelberg.

Heiligenberg Institut, Heiligenberg.

Bayern/ Bavaria

Deutsches Museum, München.

Fraunhofer Institut, München.

Germanisches Nationalmuseum, Nürnberg

Institut für Wirtschaftsforschung (economic research), München.

Monumenta Germaniae Historica, München.

Institut für Zeitgeschichte (contemporary history), München.

Zentralinstitut für Kunstgeschichte (history of art), München.

Deutsche Geodätisches Forschungsinstitut (geodetic research), München.

Berlin

Deutsches Institut für Wirtschaftsforschung (economics research).

Institut für Zuckerindustrie (sugar industry).

Bremen

Institut für Meeresforschung (oceanographic research), Bremerhaven.

Hamburg

Hamburgisches Weltwirtschafts-Archiv (world economic archive).

Bernhard-Nocht-Institut für Schiffs- und Tropenkrankheiten (tropical diseases and diseases contracted at sea).

Stiftung zur Erforschung der spinalen Kinderlähmung (polio research).

Heinrich-Pette-Institut für Experimentelle Virologie und Immunologie an der Universität Hamburg (experimental virology and immunology).

Deutsches Elektronen-Synchroton (DESY).

Hessen/ Hesse

Paul-Ehrlich-Institut, Frankfurt/ Main.

Forschungsinstitut Senckenberg, Frankfurt/ Main.

Mathematisches Forschungsinstitut (mathematical research), Oberwolfach.

Deutsches Rechenzentrum (calculations centre), Darmstadt.

Deutsches Institut für Internationale Pädagogische Forschung (pedagogical research).

Geschäftsstelle für das Königsteiner Staatsabkommen (Office of the Königstein Agreement), Wiesbaden.

Niedersachsen/ Lower-Saxony

Akademie für Raumforschung und Landesplanung (regional development and planning), Hannover.

Institut für Erdölforschung (petroleum research), Hannover.

Amt für Bodenforschung (soil research), Hannover.

Vogelwarte Helgoland (ornithology).

Technische Informationsbibliothek an der Technischen Hochschule Hannover (Technical Library of the technical University of Hanover).

Forschungsanstalt für Landwirtschaft (agricultural research), Braunschweig-Völkenrode.

Rheinland-Pfalz/ Rhineland-Palatinate

Römisch-Germanisches Zentralmuseum (museum), Mainz.

Institut für Europäische Geschichte (European history), Mainz.

Nordrhein-Westfalen/ North Rhineland and Westphalia

Rheinisch-Westfälisches Institut für Wirtschaftsforschung (economics research), Essen.

Institut für Spektrochemie und angewandte Spektroscopie (spectrochemistry and applied spectroscopy), Dortmund.

Zoologisches Forschungs-Institut und Museum Koenig (zoological research and museum), Bonn.

Schleswig-Holstein

Institut für Weltwirtschaft (world economics), Kiel.

Tuberkulose Forschungsinstitut (tuberculosis research), Borstel.

Annex V

FEDERAL GOVERNMENT RESEARCH ESTABLISHMENTS

Ministry of Agriculture

Biologische Bundesanstalt für Land- und Forstwirtschaft, Braunschweig-Gliesmarode und Institut in Berlin-Dahlem (Biological Station for Agriculture and Forestry).

Bundesversuchs- und Forschungsanstalt für Milchwirtschaft, Kiel (Dairy Science).

Bundesforschungsanstalt für Fischerei, Hamburg-Altona (Fisheries).

Bundesforschungsanstalt für Forst- und Holzwirtschaft, Reinbeck bei Hamburg (Forestry and Lumber).

Bundesforschungsanstalt für Kleintierzucht, Celle (Small Animal Breeding).

Bundesforschungsanstalt für Getreideverarbeitung, Detmold (Grain Processing).

Bundesanstalt für Fleischforschung, Kulmbach/Bayern (Meat Research).

Bundesforschungsanstalt für Lebensmittelfrischhaltung, Karlsruhe (Food Preservation).

Bundesanstalt für Qualitätsforschung Pflanzlicher Erzeugnisse Geisenheim/Rheingau (Quality of Plant Products).

Bundesanstalt für Tabakforschung, Forchheim b. Karlsruhe (Tobacco Research).

Bundesanstalt für Naturschutz, Landschaftspflege und Vegetations-kunde, Bad Godesberg, Stolzenau/Weser (Conservation of Wildlife and Scenery and for Plant-life Study) The conservation activities are at Bad Godesberg and the plantlife charting at Stolzenau.

Bundesforschungsanstalt für Viruskrankheiten der Tiere, Tübingen (Virus Diseases of Animals).

Bundessortenamt, Rethmar/Hannover (Plant Varieties).

Forschungsinstitut für Rebenzüchtung, Geilweilerhof in Siebeldingen/Pfalz (Viniculture).

Bundesanstalt für Fettforschung, Münster i.W. (Fats Research).

Ministry of Transport

Deutscher Wetterdienst, Offenbach/Main (Weather Service).

Deutscher Wetterdienst Seewetteramt, Hamburg (Marine Weather Office).

Deutsches Hydrographisches Institut, Hamburg (Hydrographic Institute).

Bundesbahn Versuchsanstalt, München (Railway Experimental Station).

Bundesanstalt für Strassenbau, Köln-Raderthal (Highway Construction).

Bundesanstalt für Wasserbau, Karlsruhe (Waterworks).

Bundesanstalt für Gewässerkunde, Koblenz (Hydrological Station).

Seezeichenversuchsfeld, Koblenz und Bonn (Signal Experimental Station).

Bundesanstalt für Flugsicherung, Frankfurt (Flight Safety).

Defence Ministry

Militärgeschichtliches Forschungsamt, Freiburg i.Br. (Military History Research).

Ministry of the Interior

Bundesanstalt für Landeskunde und Raumforschung, Bad Godesberg (Ethnology and Geographical Research) Research).

Institut für Angewandte Geodäsie, Frankfurt/Main (Applied Geodesy).

Deutsches Archäologisches Institut, Berlin (Archeological Institute, with branches in Athens, Baghdad, Istanbul, Cairo, Madrid, Rome).

Deutsches Historisches Institut, Rom (Historical Institute).

Bundesinstitut zur Erforschung des Marxismus-Leninismus (Institut für Sowjetologie), Köln (Research on Marxism-Leninism (Sovietology).

Bundesamt für zivilen Bevölkerungsschutz, Bad Godesberg (Protection of the Civilian Population).

Ministry of Economic Affairs

Physikalisch-Technische Bundesanstalt, Braunschweig and Berlin (Physics and Technology).

Bundesantalt für Materialprüfung, Berlin-Dahlem (Materials Testing).

Bundesanstalt für Bodenforschung, Hannover (Earth Sciences Research).

Ministry for Scientific Research

Deutsches Historisches Institut, Paris (Historical Institute).

Ministry for Post and Telecommunications

Forschungsinstitut des Fernmelde-Technischen Zentralamtes, Darmstadt (Telecommunications).

Ionosphären Institut, Breisach/Rhein (Ionosphere).

Health Ministry

Bundesgesundheitsamt /Bundesopiumstelle, Berlin (Health Opium Office).

Robert-Koch-Institut, Berlin (Bacteriology, Virus Research etc.).

Institut für Wasser, - Boden - und Lufthygiene, Berlin. (Water, Soil and Air Hygiene).

Max von Pettenkofer Institut, Berlin (Medical Sciences).

Annex VI

FRAUNHOFER SOCIETY INSTITUTES

Institut für angewandte Mikroskopie, Photographie und Kinematographie, Karlsruhe (applied microscopy, photography and cinematography).

Institut für hygienisch-bakteriologische Arbeitsverfahren, München (public health and bacteriological techniques).

Institut für Schwingungsforschung, Tübingen (vibrations research).

Institut für Technische Physik, Stuttgart (applied physics).

Institut für Elektrowerkstoffe, Freiburg (electrical materials).

Ernst-Mach-Institut, Freiburg i. Br.

Institut für Chemie der Treib-und Explosivstoffe, Berghausen bei Karlsruhe (chemistry of liquid and explosive fuels).

Institut für Aerobiologie, Grafschaft/ Hochsauerland (aerobiology).

Technische Forschungs- und Entwicklungsstelle, Lindau/ Bodensee (engineering research and development).

Laboratorium für Betriebsfestigkeit, Darmstadt (fatigue testing).

Institut für Physik und Chemie der Grenzflächen, Marienthal über Rockenhausen (physical and chemical aspects of surfaces).

Physikalisch-Bioklimatische Forschungsstelle, Garmisch-Partenkirchen (physical-bioclimatic research).

Institut für Radiometeorologie und Maritime Meteorologie, Hamburg (radiometeorology and maritime meteorology).

Institut für Produktionstechknik und Automatisierung, Stuttgart (production techniques and automation).

Annex VII A

SCIENTIFIC COMMISSIONS OF THE GERMAN RESEARCH ASSOCIATION

Commission for Research in the History of Concepts.

Commission for the Publication of Hegel's Works.

Commission for Germanics.

Commission for Urgent Social Questions.

Commission for the Study of the Medical Bases of Premature Invalidity.

Commission for Cancer Research and the Hinterzarten Circle.

Commissions for Toxic Materials in Industrial Plants.

Commission for Food Research.

Commission for Colouring Materials.

Commission for the Study of Food Preservation.

Commission for Agents in Plant-treatment, Plant-protection, and the Protection of Plant-products in Storage.

Commission for the Study of Impurities in Food.

Commission for the Study of Additives in Food.

Commission for Mutagenesis.

Commission for Teratology.

Commission for Aviation Research.

Commission for Electronic Computers.

Commission for Water Research.

Commission for Oceanography.

Commission for the Study of the Effects of Air Pollution.

Commission for Noise Abatement.

Annex VII B

PRIORITY PROGRAMMES OF THE GERMAN RESEARCH ASSOCIATION

Medicine

Cancer Research
Nervous System
Cardiovascular System
Kidney Research
Haematology
Dental Caries Research
Therapeutics Research
Research on Malformations
Immunobiology
Premature Invalidity
Chronic Bronchitis

Mathematics and Natural Sciences

Mathematics
- Mathematical Statistics

Biology
- Molecular Biology
- Membranes
- Biochemistry of Morphogenesis
- Cybernetics
- Physiological Parasitology
- Experimental Ecology

Physics
- International Quiet Sun Year
- High-Frequency Physics
- Direct Conversion of Energy
- Solid-State Physics
- Molecular and Atomic Collisions
- Stellar Astronomy

Chemistry and Mineralogy
- Analytical Chemistry
- Theoretical Chemistry
- Crystal Structure
- Physical and Chemical Aspects of Surfaces

Earth Sciences
- Geographical Problems of Densely Populated Areas
- Radio Meteorology
- Upper Mantle Project
- International Glaciological Greenland Expedition
- Oceanography
- "Meteor" Expedition
- Littoral Research
- Research on Sediments

Engineering Sciences
- Aviation Research
- Real Gases
- Cavitation
- Computers
- Data Processing
- Wear, Friction and Lubrication
- High Frequency Engineering
- High-Voltage Direct-Current Transmission
- Materials Science for Design and Construction
- Data Transmission

Agriculture and Veterinary Science
- Integrated Plant Protection

Multidisciplinary Programmes

Hydrological Research within the International Decade and Water Pollution
Nutrition Research
Air Pollution
Noise Abatement
Binational and Interdisciplinary Research in Puebla-Tlaxcala, Mexico ("Mexico Project")

Annex VIII

RESEARCH INSTITUTES IN THE FEDERAL REPUBLIC OF GERMANY : DISTRIBUTION ACCORDING TO DISCIPLINES

	University	Other
Theology	213	5
Philosophy, Psychology, Education, Information Media	106	12
Languages and Literature, Ethnology, National Cultures	290	25
History of Science and Technology	7	-
History	79	21
Fine Arts, Art History	86	12
Law	181	6
Economics and Sociology	308	42
Medicine (other than hospitals)	236	43
Veterinary Science	64	2
Mathematics	90	3
Physics	151	20
Chemistry	143	21
Pharmacy	25	-
Biology	100	7
Oceanography and Freshwater Fishery Research	4	9
Earth Sciences	81	12
Astronomy, Meteorology	27	8
Geography	30	2
Agriculture, Horticulture	114	23
Forestry, Wood Research	34	7
Agricultural Technology	12	12
Constructional Engineering, Geodesy, Materials Testing	133	16
Mechanical Engineering, Aviation and Space Research	190	37
Electrical Engineering	85	6
Mining and Metallurgy	51	7
City and Regional Planning, Architecture	56	4

Annex IX

CONCEPTS IN THE FIELD OF SCIENCE ORGANIZATION

(*Note:* In relation to the following definitions, it is emphasized that they are presented by the authors of this Study as a contribution towards international discussion, and do not necessarily coincide with the views of Unesco.)

THE SCIENCES, ARTS AND HUMANITIES (= Wissenschaft)

The Sciences, Arts and Humanities are research and teaching in all branches of knowledge.

RESEARCH

Research is activity by individuals or groups directed towards increasing knowledge by systematic and verifiable means.

TEACHING (= Lehre)

Teaching is the presentation of research findings and methods with the object of imparting subject knowledge and educating in systematic thinking methods.

BASIC RESEARCH

Basic Research (Fundamental Research) is carried out for its own sake (solely with the object of increasing scientific knowledge).

ORIENTED BASIC RESEARCH

Oriented Basic Research is basic research undertaken because of its relevance to a specially important practical field.

APPLIED RESEARCH

Applied Research is research conducted, exclusively or mainly, with the object of applying the findings.

DEVELOPMENT

Development is the utilization and application of research findings and experience, particularly technical and economic, with the object of introducing new systems, methods, processes, materials and products or improving existing ones.

Development includes performance evaluation studies needed to perfect the systems etc.

ACADEMIC RESEARCH

Academic Research is research which is carried out in institutions of higher education or their affiliated institutes and which interacts with their teaching activities.

NON-ACADEMIC RESEARCH

Non-Academic Research is research carried on in places other than institutes of higher education.

GOVERNMENT RESEARCH AND DEVELOPMENT (Excluding Academic Research)

Government Research and Development (excluding academic research) is research and development (R + D) supported and financed by public authorities and carried on in their own establishments or commissioned by them (through contracts or grants).

INDUSTRIAL RESEARCH AND DEVELOPMENT

Industrial Research and Development is research and development (R + D) carried on by companies or groups of companies in their own establishments or contracted by them.

COMPANY RESEARCH AND DEVELOPMENT

Company Research and Development is research and development (R + D) undertaken by a company in its own facilities mainly in the company's interest or under contract on their behalf.

CO-OPERATIVE INDUSTRIAL RESEARCH

Co-operative Industrial Research is research and development (R + D) carried out by a group or an association of companies either in common facilities or under contract on their behalf.

CONTRACT RESEARCH

Contract Research is research and development (R + D) conducted on the basis of an agreement between the contracting parties, such as public authorities, companies and groups or associations of companies on the one hand and researchers or research establishments on the other hand.

RESEARCH GROUP

A Research Group (Unit/ Team) consists of research workers from one or more disciplines brought together for a limited period to carry out specific research in a new or insufficiently supported field. The group may be headed by a director or consist of research workers of comparable standing, who may in turn assume responsibility.

PROMOTION OF SCIENCES AND ARTS

The Promotion of Sciences and Arts is support given in any form material or otherwise to stimulate research and teaching, including the encouragement of scientific and academic talent.

PATRONAGE OF SCIENCES AND ARTS

Patronage of Sciences and Arts is their voluntary altruistic support, through gifts or endowments from private sources, benefiting research and teaching inclusive of encouraging scientific and academic talent.

EXPENDITURE ON SCIENCE AND ARTS

Expenditure on Sciences and Arts from public or private funds are all costs which arise from activities in research and teaching (mainly at institutions of higher education) as well as in research and development.

Annex X

BIBLIOGRAPHY

I. *General Information on the Federal Republic*

H. Arntz. Germany in a Nutshell. Bonn, Press and Information Office of the Federal Government of Germany, 6th Edition, 1967.

" Deutsche Politik 1966 " (Report on the activity of the Federal Government). Bonn, Press and Information Office of the Federal Government of Germany.

Publications of the Federal Office for Statistics, Bonn, particularly " Wirtschaft und Statistik " (Economy and Statistics).

II. *General Reviews of Scientific Activity in the Federal Republic*

" Bundesbericht Forschung I " (Federal Report on Research I), Bonn, Federal Minister for Scientific Research, 1965.

" Bundesbericht Forschung II " (Federal Report on Research II), Bonn, Federal Minister for Scientific Research, 1967.

" Stand und Rückstand der Forschung in Deutschland in den Naturwissenschaften und den Ingenieurwissenschaften " (Status and Deficiencies of Research in Germany in the Natural and Engineering Sciences). Bad Godesberg, German Research Association, 1964.

" Kulturpolitik der Länder 1965/66 " (Cultural Policies of the German States). Bonn, Permanent Conference for Educational and Cultural Affairs of the Federal Republic of Germany.

III. *Publications of the Science Council*

" Empfehlungen zum Ausbau der Wissenschaftlichen Einrichtungen " (Recommendations for the Development and Expansion of Establishments for Science).

Part I: " Wissenschaftliche Hochschulen " (Universities and Institutions of University Rank), 1960.

Part II: " Wissenschaftliche Bibliotheken " (Scientific Libraries), 1964.

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V. *Annual Reports of the institutions listed in Annex 1.*

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