THE MEASUREMENT OF SCIENTIFIC AND TECHNICAL ACTIVITIES

Proposed Standard Practice for Surveys of Research and Experimental Development

"FRASCATI MANUAL"

ORGANISATION
FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The Organisation for Economic Co-operation and Development (OECD) was set up under a Convention signed in Paris on 14th December, 1960, which provides that the OECD shall promote policies designed:

— to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;

— to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development;

— to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The Members of OECD are Australia, Austria, Belgium, Canada, Denmark, Finland, France, the Federal Republic of Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

* * *

TABLE OF CONTENTS

PREFACE

In June 1963, the OECD held a meeting of national experts of R and D statistics at the Villa Falconieri in Frascati, Italy. The fruit of their labours was the first official version of the "Proposed Standard Practice for Surveys of Research and Experimental Development" better known as the "Frascati Manual". The present document, the "Frascati Manual 1975" is the third version of this standard practice. It incorporates more than two years of joint work by the Secretariat and the national experts.

Although the "Frascati Manual" is a technical document and, as such, has been less in the limelight than some of the more challenging and exciting reports issued by the Directorate for Science, Technology and Industry, it is one of the corner-stones of the Directorate's effort to increase understanding of science and technology problems by comparing national systems and approaches. From a practical point of view it has probably been one of the most influential documents issued by this Directorate over the fifteen years of its existence.

The concepts and definitions in the Manual have been adopted by virtually all OECD Member countries and form the theoretical base for the Biennial Surveys of Resources devoted to R and D in OECD Member countries undertaken by the Science Resources Unit of the Directorate. The results of these surveys (undertaken for 1963/64, 1967, 1969, 1971, 1973, 1975, etc.) are widely used in Member countries when preparing science reports and plans and within OECD both the Science Resources Unit for its own analytical studies and as a general data base for other projects in this and other directorates of OECD.

At least two regional organisations have used the concepts and definitions in the Manual as a basis for more complex systems of science statistics, the Scandinavian Council for Applied Research (Nordforsk) for its "Nordic Manual", the Committee for Scientific and Technical Research (CREST) of the European Economic Communities for their Nomenclature for the Analysis and Comparison of Science Programmes and Budgets.

Furthermore, although the Frascati Manual is designed to meet the needs for developed countries with market economies its basic concepts have been adopted by UNESCO for their worldwide surveys of R and D although the classifications have had to be adjusted somewhat to permit comparisons between OECD, CMEA and developing countries. The many requests for copies of the Manual received from a wide

variety of non-Member countries show that it is well known outside the OECD area.

If a statistical Manual is to be successful it must, of course, be technically sound. However, its main aim must be to facilitate the collection of statistics which can be used to answer questions which preoccupy policy makers. These questions change over time hence the various revisions which have take place in the Frascati Manual over the years; the most recent innovations being the introduction of norms for the collection of R and D statistics in the social sciences and humanities and of special classifications of the "objectives" of Government R and D support.

For the moment, the Frascati Manual gives standards for the measurement and classification of inputs into research and experimental development. It is hoped in future to widen its range to include some indicators of the output of R and D and also norms for the measurement of some other scientific and technological activities such as scientific information collection and diffusion.

Any such improvements will depend on the interest and good-will of Member countries. The success of the Frascati Manual so far has been largely due to the fact that although individuals and the Secretariat did much of the drafting, the result is the collective effort of the statistical experts representing virtually all OECD Member countries. We all know the old joke about the camel being a horse designed by a Committee. The Frascati Manual is a camel which has proved its worth over many years and in many different climates. I commend the 1975 model not only to statistical experts but also many others in the science policy field who, quite often, read or use R and D statistics without any very precise idea of what they include.

K. Oshima
Director for Science, Technology and Industry

BACKGROUND OF THE MANUAL

BRIEF HISTORY AND ORIGINS OF THE PRESENT MANUAL

1. Encouraged by the rapid growth of the amount of national resources devoted to research and experimental development (R and D), most OECD Member countries started the collection of statistical data in this field around 1960. They followed the pioneering efforts of a small number of countries, including the United States, Japan, Canada, the United Kingdom, the Netherlands and France. Differences in scope, methods and concepts, however, made international comparisons difficult and countries encountered theoretical difficulties when starting R and D surveys. An increasing need was, thus, felt for some attempt at standardization of the kind undertaken for economic statistics.

2. OECD interest in this question dates back to OEEC days. In 1957, the Committee for Applied Research of the European Productivity Agency of the OEEC began to convene meetings of experts from Member countries to discuss methodological problems. As an outcome of these meetings an "Ad Hoc" Group of Experts was set up, under the auspices of the Committee for Applied Research, to study surveys of research and development expenditure. The Technical Secretary of the Group, Dr. J. C. Gerritsen, prepared two detailed studies on the definitions and methods employed in the measurement of R and D in the Government sector of the United Kingdom and France and later of the United States and Canada. Other members of the Group circulated papers describing the methods and results of surveys in their own countries.

3. When the Directorate for Scientific Affairs took over the work of the European Productivity Agency in 1961, the time was ripe for specific proposals for standardization. At a meeting in February, 1962, the "Ad Hoc" Group (see paragraph 2) decided to convene a study conference on the technical problems of measuring R and D. In preparation for this Conference, the Directorate for Scientific Affairs appointed a consultant, Mr. C. Freeman, to prepare a draft document which was circulated to Member countries in the autumn of 1962 and revised in the light of their comments. The "Proposed Standard Practice for Surveys of Research and Development" was discussed,

revised and accepted by experts from the OECD Member countries at the conference which was held in Frascati, Italy, in June, 1963. *

4. Later in 1963 the OECD Directorate for Scientific Affairs invited the United Kingdom National Institute for Economic and Social Research to undertake an experimental comparison of research efforts in five Western European countries (Belgium, France, Germany, the Netherlands and the United Kingdom), the United States and the USSR. The Institute study, though based on statistics from surveys undertaken before the international standards had been decided on, also tested the first draft definitions. * The report concluded that the available statistical information still left a great deal to be desired; the main improvements suggested were:

a) A more rigorous conceptual separation of research and experimental development and "related scientific activities".
b) Careful studies in the Higher Education sector to estimate the proportion of time devoted to research by teaching staff and (post) graduate students.
c) A more detailed breakdown of R and D manpower and expenditure data to permit, inter alia, a more exact calculation of research exchange rates.
d) A more systematic measurement of expenditure flows between R and D sectors.
e) More data on the flow of technological payments and of international migration of scientific manpower.

5. In 1964, following the acceptance of the Frascati Manual by the Member countries, OECD launched the International Statistical Year (ISY) on Research and Experimental Development. Member countries returned data for the year 1963 or 1964. Seventeen countries took part, many of them conducting special surveys and enquiries for the first time. *

6. Following the publication of the Statistical Year findings, the OECD Committee for Science Policy requested the Secretariat to prepare a revision of the Frascati Manual in the light of the experience gained. An outline of the suggestions was circulated to Member countries in March, 1968. A draft revision, incorporating most of these suggestions, was examined at the meeting of national experts held in Frascati in December, 1968. A revised draft was examined by a small group of experts in July, 1969, and a revised version of the Manual published in September, 1970. *

* See Bibliography after the annexes, pp. 111 to 119. Throughout this volume, an asterisk denotes a reference to the Bibliography.

7. By 1973 Member countries had participated in four ISY's, covering 1963-64, 1967, 1969 and 1971.[1] The accuracy and comparability of the data had benefited from this continued experience. Survey techniques had greatly improved and this is reflected in the present revision of the Frascati Manual which goes more deeply into those subjects already treated and examines certain new subjects. In response to a growing demand from science policy makers the scope of the Manual has been expanded to cover research in the social sciences and humanities and greater stress has been given to "functional" classifications, notably the classification by "objectives" of R and D. A draft of this version was discussed at a meeting of experts held at OECD in December, 1973 and the final text was adopted in December, 1974.

EFFORTS OF OTHER INTERNATIONAL ORGANISATIONS

8. The problems of comparing R and D data, collected in different countries, with varying institutional patterns and traditions in education and research, have been considered by other international organisations as well as by the OECD.

a) UNESCO

UNESCO has been actively involved in collecting and publishing statistics in the field of science and technology on a world-wide basis since 1966. The information has been regularly published in the UNESCO Statistical Yearbook since 1969 and is used as a basis for studies and reports prepared for international meetings.

Further efforts to improve comparability between standards for data used in the CMEA (Council for Mutual Economic Assistance) and OECD countries were conducted within the framework of the UNESCO/ECE Joint Working Group on Science Statistics at which OECD and the ECE were represented. CMEA has defined certain "indicators" in the field of science and technology which differ somewhat from these proposed in this Manual. The collection of data by CMEA Member States in the form of these "indicators" will, nevertheless, make possible comparisons since the conceptual basis of the CMEA data will have been made more explicit. The Organisation of American States (OAS) has recently embarked on a more active programme in the field of science statistics and it may be expected that in the near future it will undertake an independent data collection.

1. The detailed results of these later surveys were not published. Copies of the 5 volumes of mimeo Statistical Tables and Notes for each ISY are available from the OECD Secretariat.

b) The European Economic Communities

Following a decision taken in July 1969 by the PREST Group (the Working Group on Scientific and Technical Research Policy, appointed by the Medium Term Economic Policy Committee), a working group of statistical experts has been collecting and issuing data on funds committed to R and D by central public administrations. These data are drawn from national budgets and are classified by "objective" using the "NASB" (Nomenclature for the Analysis and Comparison of Science Programmes and Budgets) of which the first edition was issued in 1970. * The group of statistical experts, which has been extended to include the new Member states, now works under the aegis of the Committee for Scientific and Technical Research (CREST) and is serviced by staff from the Directorate for Demographic and Social Statistics of the Statistical Office of the European Communities (SOEC). A revised version of NASB was completed in 1975. *

Work has also been undertaken on the possibility of assembling R and D data wholly within the System of National Accounts in the form of special satellite accounts.

c) NORDFORSK (The Scandinavian Council for Applied Research)

The main task of NORDFORSK (which groups research organisations in Denmark, Finland, Iceland, Norway and Sweden) is to initiate, promote and organise Nordic co-operation in scientific and industrial research. In 1968 it set up a special committee on R and D statistics whose various working groups have discussed a number of problems related to the production and analysis of R and D statistics, mainly with reference to inter-Nordic comparability of data. In 1974, the Committee published a "Nordic Manual"*(in the Nordic languages) which is a detailed supplement to the Frascati Manual. Some of the preliminary chapters* of the Nordic Manual have been translated into English and have been presented by NORDFORSK at various meetings of experts at the OECD.

ACKNOWLEDGEMENTS

9. Neither the original version of this Manual nor the revised editions could have been completed without the active collaboration of R and D statisticians in all OECD Member countries. Particular debts of gratitude are due to the National Science Foundation which pioneered the systematic measurement of R and D.

Among those who must be mentioned in connection with the first edition of the Manual are the late Dr. J. Perlman, Professor C. Freeman and the French Délégation générale à la recherche scientifique et technique (DGRST).

The late H. E. Bishop was chairman of the 1968 Frascati meeting and Mr. H. Stead (Statistics Canada), Mr. P. Slors (Netherlands Central Bureau of Statistics) and Dr. D. Murphy (Irish National Science Council) also made major contributions to the second edition of the Manual.

Amongst those who helped to prepare this third version our thanks are due to the late K. Sanow (National Science Foundation), Mr. J. Mitchell (Office of Fair Trading, United Kingdom) and Mr. K. Perry (United Kingdom Central Statistical Office) and to Mrs. K. Arnow (National Institutes of Health), chairman of the 1973 experts' meeting, and to the chairmen for special topics, Mr. T. Berglund (Swedish Central Statistical Office), Mr. J. Sevin (DGRST) and Dr. F. Snapper (Netherlands Ministry of Education and Science).

I

THE RELEVANCE OF R AND D STATISTICS AND THE AIM AND SCOPE OF THE MANUAL

1. 1. THE RELEVANCE OF STATISTICS OF RESEARCH AND EXPERIMENTAL DEVELOPMENT

10. Statistics of R and D are presently limited to the inputs. Nevertheless they provide useful measures of the scale and direction of those activities in various countries, sectors, industries, disciplines and other categories of classification.

Since R and D now enters into almost all aspects of national life, they are relevant to national objectives and policies in many different areas. For example they are now an essential part of the larger factual background necessary for informed discussion of many aspects of educational and economic policy, and for environmental and social policy. Their relevance to science policy itself is clear. In relation to education policy, it is evident that the measurement of a fundamental and costly activity of the universities is of great importance.

In relation to economic policy, R and D statistics are now increasingly significant for many types of analyses concerned with productivity, competition and international trade. Their importance here derives from the recognition that in contemporary industrial societies R and D is a major source of technological innovation. The value of R and D statistics is greatly enhanced as longer time series become available and as their coverage extends, permitting them to be used in conjunction with other statistics relevant to a wide range of national policies.

1. 2. THE AIM OF THE MANUAL

11. This Manual is intended to serve four purposes:

a) to advise and aid countries in compiling and analysing statistics on inputs to R and D;
b) to stimulate countries which have begun work in this field to continue systematically and on an increased scale to develop the internal analysis of their national science effort;
c) to act as a framework for international comparisons and for comparisons with other economic data. National practices

will, of course, continue to vary but the variations may be further reduced and at least become measurable in terms of international standards;

d) to provide the definitions from which deviations for special purposes can be explicitly made.

12. The Manual is designed to be useful both at national and at international levels and every attempt has been made to reach definitions that are relevant and acceptable to a large number of countries. It is recognized, however, that R and D activities are so varied, dynamic and therefore difficult to define, that definitive standards can never be reached. In surveying resource inputs an element of arbitrariness will necessarily be involved in the decisions on how to classify institutes or activities. The purpose of the Manual is to minimize the arbitrary character of such decisions by making the accepted criteria as clear as possible.

1. 3. SCOPE AND LIMITATIONS OF THE MANUAL

13. Ultimately it should be possible to write a Manual for the measurement of all scientific and technical activities including research and experimental development, higher education and scientific services. However, this edition of the Manual deals only with resources devoted to research and experimental development in the natural sciences (including the medical and agricultural sciences), engineering and technology and the social sciences and humanities. The Manual discusses, to some extent, but does not include standards for the measurement of:

a) other scientific and technical or technological activities;[1]
b) the output of R and D.

14. The structure of the Manual itself is as follows:

a) Chapters II and III form the theoretical basis for measuring resources devoted to R and D and comprise definitions, conventions and the main sectoral and functional classifications which, taken together, delimit the R and D area of the economy.
b) Chapters IV and V contain more detailed classifications within the R and D area and recommendations concerning actual measures of R and D and methods of measuring.
c) Chapter VI draws attention to some problems of relating R and D data to other economic variables and of making international comparisons of R and D expenditure.

1. See Chapter II, paragraph 36.

There are also six appendices dealing with the following topics:

I. Some problems of measurement of R and D in the social sciences and humanities;

II. Additional material on classification by socio-economic objectives;

III. Guidelines for distinguishing R and D activities from non-R and D activities in post-graduate studies as recommended by the Nordic Manual on resources devoted to Higher Education "Resursstatistik för universitet och högskolor";

IV. The measurement of the output of R and D and the balance of technological payments;

V. Efforts in the calculation of research exchange rates and deflators;

VI. Recommendations for the layout of the national R and D publications.

A bibliography is included after the appendices for the reader who wishes to pursue particular topics in more depth.

II

BASIC DEFINITIONS AND CONVENTIONS

2.1. THE BASIC CONCEPTS AND CATEGORIES OF RESEARCH AND EXPERIMENTAL DEVELOPMENT

15. Research and experimental development comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

16. Three categories of R and D may be distinguished:[1]

- basic research,
- applied research,
- experimental development.

These are defined in paragraphs 17, 20 and 23 below. In real life, R and D activities do not necessarily fall into such sequential and distinct categories. The three types of activity may sometimes be carried out in the same centre by substantially the same staff. Moreover, there may be movement in both directions. When an R and D project is at the applied research/development stage, for example, some funds may have to be spent on additional basic research that is needed before further progress can be made.

Basic Research

17. Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.

18. Basic research analyses properties, structures and relationships with a view to formulating and testing hypotheses, theories or laws.

1. This is admittedly a difficult distinction to make statistically although it is useful in discussions of the general goals or missions of both public and private R and D organisations. At the time of writing, none of the alternative sets of concepts suggested for statistical surveys have been sufficiently tested to merit inclusion here. *

19. The results of basic research are not generally sold but are usually published in scientific journals or circulated to interested colleagues. Occasionally, basic research may be "classified" for security reasons.

20. Basic research is usually undertaken by scientists who may set their own goals and to a large extent organise their own work. However, in some instances basic research may be primarily oriented or directed towards some broad fields of general interest. Such research is sometimes called "oriented basic research".

Applied Research

21. Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.

22. Applied research is undertaken either to determine possible uses for the findings of basic research or to determine new methods or ways of achieving some specific and pre-determined objectives. It involves the consideration of the available knowledge and its extension in order to solve particular problems. In the Business Enterprise sector the distinction between basic and applied research will often be marked by the creation of a new project to explore any promising results of a basic research programme.

23. The results of applied research are intended primarily to be valid for a single or limited number of products, operations, methods and systems. Applied research develops ideas into operational form. The knowledge or information derived from it is often patented but may also be kept secret.

Experimental Development

24. Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience, that is directed to producing new materials, products and devices, to installing new processes, systems and services, and to improving substantially those already produced or installed.

25. In the social sciences and humanities, experimental development may be defined as the process of translating knowledge gained through research into operational programmes, including demonstration projects for testing and evaluation.

26. The distinction between R and D and production activities in the natural sciences and technology or, in the case of the social sciences and humanities, between R and D and policy developments, is often complex and obscure. It is important, however, that a distinction be made to ensure as true a measure of the level of R and D activity as

possible. In the Business Enterprise sector the boundary will often be marked by a management decision to enter into production (see paragraph 39) whilst in the social sciences and humanities the boundary can be identified as the application of given methodology to particular issues. Paragraphs 27 and 28 respectively illustrate the general difference between basic and applied research and experimental development in the natural sciences and engineering and in the social sciences and humanities.

Examples

27. In the natural sciences and technology

1. The study of a given class of polymerization reactions under various conditions, of the yield of products, and of their chemical and physical properties, is basic research. The attempt to optimize one of these reactions with respect to the production of polymers with given physical or mechanical properties (making it of particular utility) is applied research. Experimental development then consists of the "scaling up" of the process optimized at the laboratory level and the investigation and evaluation of potential methods of production of the polymer and perhaps of articles to be made from it.

2. The study of the absorption of electro-magnetic radiation by a crystal in order to obtain information on its electron band structure is basic research. The study of the absorption of electro-magnetic radiation by this material under varying conditions (for instance temperature, impurities, concentration, etc.) in order to obtain some given properties of radiation detection (sensitivity, rapidity, etc.) is applied research. The preparation of a device using this material in order to obtain better detectors of radiation than those already existing (in the considered spectral range) is experimental development.

3. The determination of the amino-acid sequence of an anti-body molecule would be basic research. Such investigations undertaken in an effort to distinguish between anti-bodies of various diseases would be applied research. Experimental development would then consist of devising a method for synthesizing the anti-body for a particular disease, based on the knowledge of its structure, and clinically testing the effectiveness of the synthesized anti-body on patients who have agreed to accept experimental advanced treatment.

28. In the social sciences and humanities

1. Theoretical investigation of the factors determining regional variations in economic growth is basic research; however,

such an investigation performed for the purpose of developing government policy would be applied research. The development of operational models based upon laws revealed through research for the modification of regional disparities would be experimental development.

2. Analysis of the environmental determinants of learning ability is basic research. The analysis of the environmental determinants of learning ability for the purpose of evaluating education programmes designed to compensate for environmental handicaps is applied research. The development of means of determining which educational programme would be used for particular classes of children would be experimental development.

3. The study of a hitherto unknown language to establish its structure and grammar is basic research. Analysis of regional or other variations in the use of a language to determine the influence of geographical or social variables on the development of a language is applied research. (It is particularly difficult to find meaningful examples of experimental development in the humanities.)

29. During R and D surveys respondents may have great practical difficulties in applying these theoretical distinctions to the wide range of projects in progress in their organisation. As surveying agencies are not always in a position to check the responses they receive and are usually obliged to accept them as such, it is of the utmost importance that they provide the institutions surveyed with the maximum of explanation and guidance to complement the formal definitions and to secure a maximum of uniformity in the basic data of R and D statistics.

30. There are four important tools available to achieve this objective:

a) explanatory notes,
b) hypothetical examples,
c) guidance to individual respondents,
d) documentation on treatment of different cases.

For obvious reasons this Manual deals exclusively with (a) and (b). However, this basis of formal definition and distinction has to be complemented with information of types (c) and (d). In order to secure consistency in the guidance given by the surveying agencies, it is essential to develop a documentation on how difficult borderline cases have been solved. This documentation can also serve as a valuable source of examples for (b) and could help countries to develop more uniform classification practices.

2. 2. THE BOUNDARIES OF RESEARCH AND EXPERIMENTAL DEVELOPMENT ACTIVITIES

31. For surveys purposes R and D must be distinguished from a wide range of related activities with a scientific and technological base. These other activities are very closely linked to R and D through flows of information and in terms of operations, institutions and personnel, but they should, as far as possible, be excluded when measuring R and D.

32. The criterion for distinguishing R and D from non-R and D activities is the presence in R and D of an appreciable element of novelty.

33. This is shown in the following examples:

1. In the field of medicine, routine autopsy on the causes of death is simply the practice of medical care and not research; but special investigation of a particular mortality in order to establish the side effects of certain cancer treatments is research. Similarly, routine tests, carried out for doctors, such as blood and bacteriological tests, are not research but a special programme of blood tests in connection with the introduction of a new drug is applied research.

2. The keeping of daily records of temperatures or of atmospheric pressure is not research but the operation of a weather forecasting service or general data collection. The investigation of new methods of measuring temperature is research, as are the study and development of new systems and techniques for interpreting the data.

3. The construction and operation of a pilot plant should be classed as experimental development as long as it is intended to produce new technical data. If, on completion of the experimental phase, the pilot plant is used as a unit of production, the activity is no longer part of experimental development even if the title "pilot plant" is retained and repair work is handled by R and D staff.

4. R and D activities in the mechanical engineering industry often have a close connection with design and drawing work. Usually there are no special R and D departments in small and medium sized companies in this industry and R and D problems are mostly dealt with under the general heading "design and drawing". If calculations, designs, workshop - drawings and operating instructions are made for the setting-up and operating of pilot plants and prototypes, they should be included in experimental development. If they are carried out for the preparation, execution and

maintenance of production - (for example, jigs, machine-tools) standardization, or to promote the sale of products, (e. g. offers, leaflets, spare parts catalogues) they should be excluded from experimental development.

5. Many social scientists perform work in which they bring the established methodologies and facts of the social sciences to bear upon a particular problem, but which cannot be classified as research. The following are examples of work which might come in this category and are not R and D: interpretative commentary on the probable economic effects of a change in the tax structure, using existing economic data; forecasting future changes in the pattern of the demand for social services within a given area arising from an altered demographic structure; operations research (OR) as a contribution to decision-making, e. g. planning the optimal distribution system for a factory; the use of standard techniques in applied psychology to select and classify industrial and military personnel, students, etc. , and to test children with reading or other disabilities.

2. 3. ACTIVITIES TO BE EXCLUDED FROM R AND D

34. The activities to be excluded from R and D fall into two major groups:

a) Activities closely related to R and D and generally referred to in this Manual as "other scientific and technological activities".
b) Industrial production and distribution of goods and services and the various allied technical services in the business enterprise sector and in the economy at large.

Also excluded are activities using the disciplines of the social sciences such as market research.

35. In addition to the guidance given in the remainder of 2. 3. , further criteria for distinguishing R and D from related activities are given in Section 5. 3. 1.

2. 3. 1. Other scientific and technological activities

36. We are not concerned here with the problems of measuring these activities but with the conventions to be used to exclude them from the assessment of R and D activities. In this connection, it will be useful separately to identify and measure such routine activities as, for instance, the counting of seeds and consultations on agronomy in the activities of an agricultural research station, and the practice of health care which is indispensable to research and to the teaching of clinical medicine.

The following activities should be excluded from the measurement of R and D.

a) Education

All education and training of manpower in the natural sciences, engineering, medicine, agriculture, the social sciences and the humanities in universities and special institutions of higher and post-secondary education. However, the research training of (post) graduate students is an integral part of research carried out at universities, to be considered, wherever possible, as a part of research (see also paragraph 109a).

b) Scientific and technical information services

The specialized activities of:

- collecting
- coding
- recording
- classifying
- disseminating
- translating
- analysing
- evaluating

by

- scientific and technical personnel
- bibliographic services
- patent services
- scientific and technical information extension and advisory services
- scientific conferences

except where conducted solely or primarily for the purpose of R and D support. This means, for example, that the preparation of the original report of R and D findings should be included in R and D.

c) General purpose data collection

Undertaken generally by government agencies to record natural, biological or social phenomena that are of general public interest or that only the government has the resources to record. Examples are routine topographical mapping, routine geological, hydrological, oceanographic and meteorological surveying, astronomical observations. Data collection conducted solely or primarily as part of the R and D process is included in R and D (e. g. data on the paths and characteristics of particles in a nuclear reactor). The same reasoning applies to the processing and interpretation of the data.
The social sciences in particular are very dependent on the accurate record of facts relating to society in the form of censuses, sample surveys, etc. When these are specially collected or processed for the purpose of scientific research the cost should be attributed to research and should cover the planning, systematizing, etc. of the data. But data collected for other or general purposes such as quarterly sampling of unemployment, should be excluded even if exploited for research, costs. Market surveys are excluded.

d) Testing and standardization

Refers to the maintenance of national standards, the calibration of secondary standards, and routine testing and analysis of materials, components, products, processes, soils, atmospheres, etc.

e) Feasibility studies

Investigation of proposed engineering projects using existing techniques in order to provide additional information before deciding on implementation; in the social sciences, feasibility studies are investigations of the socio-economic characteristics and implications of specific situations (e. g. a study of the viability of a petro-chemical complex in a certain region). However, feasibility studies on research projects are part of R and D.

f) Specialized medical care

Refers to routine investigation and normal application of specialized medical knowledge. There may, however, be an element of R and D in what is usually called "advanced medical care".

g) Patent and licence work

All administrative and legal work connected with patents and licences. However, patent work and research connected with R and D projects are R and D.

h) Policy related studies

Policy in this context refers not only to national policy but also to policy at the regional and local levels, as well as that of business enterprises in the pursuit of their economic activity. Policy related studies cover a range of activities such as the analysis and assessment of the existing programmes, policies and operations of government departments and other institutions; the work of units concerned with the continuing analysis and monitoring of external phenomena (e. g. defence and security analysis); and the work of legislative commissions of inquiry concerned with general government or departmental policy or operations. In the case of policy-related and operational studies it will often prove difficult to distinguish between research and development and related activities, since research and research-like activities are often undertaken within the framework of such studies. In such cases reference should be made to the supplementary criteria in section 5. 3. 1.

37. In certain cases the theoretical criteria for distinguishing between R and D related activities are particularly difficult to apply and national practice may vary. Space exploration and mining and prospecting

are two areas where large amounts of resources are involved and so any such variations will have important effects on the international comparability of the resulting R and D data. For this reason the following conventions apply for international comparisons.

a) Space exploration

Routine space exploration should be included in R and D.

b) Mining and prospecting

There is often a linguistic confusion between "research" for new or substantially improved resources (food, energy, etc.) and the "search" for existing reserves of (known) natural resources which complicates the issue when discussing the distinction between R and D and surveying and prospecting.

In theory in order to establish accurate R and D data, the following activities should be identified, measured and summed:

1. The development of new surveying methods and techniques.
2. Surveying undertaken as an integral part of a research project on geological phenomena.
3. Research on geological phenomena per se undertaken as a subsidiary part of surveying and prospecting programmes.

In practice, the third of these presents a number of problems. It is difficult to frame a precise definition which would be meaningful for respondents to national surveys. The sums involved are probably relatively small in practice but a misreading by respondents might lead to large amounts of "search" resources being counted as R and D.

For this reason, for the present and by convention, only the following activities should be included in R and D:

i) The development of new or substantially improved methods and equipment for data acquisition and for the processing and study of the data collected, and for the interpretation of these data.

ii) Surveying undertaken as an integral part of a research project on geological phenomena per se including data acquisition, processing and interpretation undertaken for primarily scientific purposes. By convention shallow stratographic bar holes are included in this heading.

It follows that the surveying and prospecting activities of commercial companies will be almost entirely excluded from R and D. For example, the sinking of exploratory oil wells and other exploration whose aim is to decide a question such as the evaluation of the resources of a deposit should be considered as general purpose data-collection.

38. It is sometimes difficult to identify the share of an institute's activities which are "other scientific and technological activities" and which, therefore, should be excluded from R and D. In survey practice, this task is facilitated by certain "rules of thumb". Three typical illustrations of the use of these may be cited:

a) In institutions of higher education, research and teaching are always very closely linked, as most academic staff do both and many buildings, as well as much equipment, serve both purposes. In the absence of complete and accurate information, measurement of the share of R and D is generally based on estimates of the proportion of working time devoted to this activity by university staff. This is a very important estimate, especially in the social sciences and humanities where a particularly high proportion of research is carried out in the universities.

b) Institutions or units of institutions or of firms whose principal activity is R and D, often have secondary, non-R and D activities (e. g. scientific and technical information, testing, control, analysis, etc.). Insofar as a secondary activity is undertaken primarily in the interests of R and D, it should be included in R and D activities; if the secondary activity is designed essentially to meet needs other than R and D, it should be excluded from R and D.

   Example

   The activities of a scientific and technical information service or of a research laboratory library, maintained predominantly for the benefit of the research workers in the laboratory, should be included in R and D. The activities of a firm's documentation centre open to all the firm's staff should be excluded from R and D even if it shares the same premises as the company research unit. Similarly, the activities of central university libraries should be excluded from R and D.

   These criteria apply only to the cases where it is necessary to exclude the activities of an institution or a department in their entirety. Where more detailed accounting methods are used, it may be possible to impute part of the cost of the excluded activities as R and D overheads. Whereas the preparation of scientific and technical publications is, generally speaking, excluded, the preparation of the original report of research findings should be included in R and D.

c) Institutions whose main purpose is an R and D related scientific activity often undertake some research in connection with this activity. Such research should be isolated and included when measuring R and D.

Example

Public bodies and consumer organisations often run laboratories where the main purpose is testing and standardization. The staff of these laboratories may also spend time devising new or substantially improved methods of testing. Such activities should be included in R and D.

2. 3. 2. Boundaries between experimental development and production or technical services

2. 3. 2. 1. Introduction

39. Possibily the greatest source of error in measuring R and D lies in the difficulty of locating the cut-off point between experimental development and the technical services and production activities that follow. Errors at this point are particularly significant because although the costs of experimental development are often many times higher than the cost of research per se the costs usually of production are higher still. In the Business Enterprise sector the problem is essentially how to distinguish between experimental development and production. Industry R and D is undertaken with a view to "technological innovation", i. e. to the successful marketing of new services or manufactured products or to the commercial use of new technical processes. Care must be taken to exclude activities which, though undoubtedly a part of the technological innovation process, rarely involve any R and D, e. g. design engineering; patent filing and licensing; "tooling up", market research, etc. Similar difficulties may arise in distinguishing public technology-based services such as inspection and control and related research, as for example, in the area of foods and drugs.

40. A precise definition of the cut-off point between experimental development and production cannot be stated in such a way that it is applicable to all industrial situations - instead, it would be necessary to establish a series of conventions or criteria by type of industry. However, the basic rule laid down by the NSF provides a practical basis for the exercise of judgement in difficult cases. Slightly expanded, it states:

> "If the primary objective is to make further technical improvements on the product or process, then the work comes within the definition of R and D. If, on the other hand, the product, process or approach is substantially set and the primary objective is to develop markets, to do pre-production planning or to get a production or control system working smoothly, then the work is no longer R and D".

2. 3. 2. 2. Special borderline cases

41. This section deals with some typical applications of the NSF criterion.

Prototypes

42. A prototype is an original model on which something new is patterned and of which all things of the same type are representations or copies. It is a basic model possessing the essential characteristics of the intended product. Applying the NSF criterion, the design, construction and testing of prototypes normally fall within the scope of R and D. This applies whether only one or several prototypes are made and whether consecutively or simultaneously. But when any necessary modifications to the prototype(s) have been made and testing has been satisfactorily completed, the boundary of R and D has been reached. The construction of several copies of a prototype to meet a temporary commercial, military or medical need after successful testing of the original, even if undertaken by R and D staff, is not part of R and D.

Pilot plant

43. The construction and operation of a pilot plant is a part of R and D as long as the principal purposes are to obtain experience and to compile engineering and other data to be used in:

- evaluating hypotheses;
- writing new product formulae;
- establishing new finished product specifications;
- designing special equipment and structures required by a new process;
- preparing operating instructions or manuals on the process.

But if, as soon as this experimental phase is over, a pilot plant switches to operating as a normal commercial production unit, the activity can no longer be considered R and D even though it may still be described as "pilot plant". As long as the primary purpose in operating a pilot plant is non-commercial, it makes no difference in principle if part or all of the output happens to be sold. Receipts from this source should not be deducted from the cost of R and D activity. However, as soon as pilot plant begins to operate as a normal production unit, the effect is more or less the same as the sale of a pilot plant. [1]

Trial production, trouble-shooting and engineering follow-through

44. After a prototype, with any necessary modifications, has been satisfactorily tested, the costs of the first trial production runs should

1. See also paragraph 124.

not be attributed to R and D since the primary objective is no longer to make further improvements to the product but to get the production process going. The first units of a trial production run for a mass production series should not be considered as R and D prototypes, even if they are loosely described as such. Normally, the costs of trial product runs of "experimental production", including tooling-up for full-scale production (tool making and tool try-out), are not to be included in R and D.

45. After a new product or process has been turned over to production units, there will still be technical problems to be solved, some of which may demand further R and D. Such "feed-back" R and D should be included.

46. Trouble-shooting occasionally brings out the need for further R and D but more frequently it involves the detection of faults in equipment or processes and results in minor modifications of standard equipment and processes. It should not, therefore, be included in R and D.

Table 1. CHART OF BORDELINE CASES AND THEIR TREATMENT

ITEM	TREATMENT	REMARKS
Prototypes	Include in R and D	As long as the primary objective is to make further improvements.
Pilot plant	Include in R and D	So long as the primary purpose is R and D. If it is, subsequently, used as a production unit or is sold, deduct the sales price from the capital account of the original year of investment.
Design and drawing	Divide	Include design required during R and D. Exclude design for production process.
Trial production and tooling up	Exclude	Except "feed-back" R and D.
After sales service and "trouble-shooting"	Exclude	Except "feed-back" R and D.
Patent and licence work	Exclude	All administrative and legal work connected with patents and licences.
Routine tests	Exclude	Even if undertaken by R and D staff.
Data collection	Divide	- Include when an integral part of research (usually social science research). - Exclude information activities and the collection of broad-purpose data.
Public inspection, control, enforcement of standards, regulations	Exclude	

III

MAIN SECTORAL AND FUNCTIONAL CLASSIFICATIONS OF R AND D DATA

3. 1. INTRODUCTION

47. The distinction already discussed between basic research, applied research and experimental development is one important breakdown. However, in order to understand more fully the R and D process and its role in society it is necessary to examine R and D in terms of the funding and performing organisations and the purpose and nature of the R and D programmes themselves. The relevant classifications are, to some extent, inter-related. Classification in terms of organisational sectors, e. g. general government, enterprises, must be viewed in terms of the statistical unit from which information is collected. Classification by purpose is linked to this sectoral analysis; there is no single "purpose" nomenclature suitable for all sectors, since government programmes are naturally viewed in terms of socio-economic objectives whilst R and D in the business enterprise sector is more usefully viewed against product groups. Similarly, although in principle the nature of R and D programmes can be described for all sectors in terms of "fields of science" classification, such a classification is not generally practicable for all sectors. In this chapter the following major classifications will be examined:

- Classification of the institutional units (institutes, enterprises, etc.) which perform or finance R and D according to their principal activities by:
  1. Sector,
  2. Sub-sector.
- Distribution of the R and D activities in each unit surveyed among:
  1. Product field,
  2. Field of science,
  3. Socio-economic objective.

The sub-classifications of R and D expenditure by cost-type, and of R and D manpower by occupation and/or qualification are dealt with in Chapter IV as are the methods of measuring flows between sectors.

3. 1. 1. Statistical units

48. Problems arise in connection with the statistical units which provide the data for R and D surveys, in particular whether the data should be collected at institute/enterprise level or at establishment-type level. It is impossible to make a recommendation since there is a lack of uniformity in organisational practices both between countries and between sectors within the same country.

49. Surveying authorities must choose the approach they find most useful. For example, in the Business Enterprise sector, large and complex companies might be broken down into convenient operating divisions with each division acting as a statistical unit. It is imperative that specific information on the unit surveyed should be given in any published tables so that the reader can evaluate the basis on which the data had been collected. [1]

3. 1. 2. The distinction between "institutional" and "functional" classifications

50. In the "institutional" approach the whole of the R and D resources of the unit surveyed are allocated to one class or sub-class according to the main activity of the unit concerned. The advantage of this approach is that R and D data is collected within the same framework as regular economic statistics which makes for ease of surveying and facilitates comparisons between R and D and other economic data. The main disadvantage is that it does not exactly describe R and D activities of the unit which may not always all be directly related to the "official" activity.

51. In the functional approach the classification is made on the basis of the R and D activities reported by the unit. Sometimes such classifications are applied at the level of the whole unit surveyed but more often they involve breaking down the resources devoted to R and D by the unit between the different functional classes. The functional approach, thus, gives much more detailed and internationally comparable results than the institutional approach. However, functional data is less easy to collect because it involves more work for the respondent.

52. For the above reasons it is usual to use "institutional" basic classifications in national (and international) R and D surveys which facilitate the survey process combined with "functional" cross-classifications in order to obtain more detailed and comparable R and D data.

1. For the effect of the unit classified on extramural expenditures see Section 4. 3. 2.

3. 2. INSTITUTIONAL CLASSIFICATIONS

53. In order to facilitate the collection of data, the description of institutional flows of R and D funds and the analysis and interpretation of R and D data, institutional units (institutes, enterprises, or establishments, etc.) should be grouped into sectors of the economy, following as closely as possible existing standard classifications of economic activities.

3. 2. 1. Classification by sector

54. The organisation of R and D surveys on a sector basis offers a number of substantial practical advantages:

a) Different questionnaires and survey methods can be used for each sector to take into account the different "mixes" of activities, different accounting systems or different response possibilities of the organisations.

b) When measuring expenditure, the sectoral approach offers the most reliable way of building up national aggregates.

c) Sectoring offers a framework for the analysis of flows of funds to (and from) the R and D funding and performing agencies.

d) Since each sector has its own characteristics and its own blend of R and D, this classification also throws some light on differences between the level and direction of R and D in different countries.

e) Insofar as the sectors chosen are based on the framework of an existing standard classification, it may be possible to relate R and D to other statistical series, thus facilitating the interpretation of the role of R and D in economic development and the formulation of science policy.

55. The System of National Accounts* (SNA) states that "in any national accounting system transactors are necessarily grouped ... but they need not be grouped in the same way in all parts of the system, and, indeed, it is not desirable that they should be". The SNA gives two slightly different systems of sectoring, one based on the productive activity of each establishment and the second on the financial activity at a more aggregate level.

56. The following definitions are based largely on the SNA productive activity approach with the difference that Higher Education has been established as a separate sector and households have been merged with Private Non-Profit. Other slight changes have been made and are noted.

57. In view of the diverse ways in which most contemporary institutions have developed, the definitions of the sectors that follow cannot

be logically precise because, like the SNA from which they are partly drawn, they are based on a combination of sometimes conflicting criteria such as function, aim, economic behaviour, sources of funds and legal status.

58. Thus, it will not always be clear in which sector a given institute should be classified and an arbitrary decision may have to be made. Institutions may lie on the borderline between two sectors or the conceptual distinction may be clear but established legal and administrative affiliations or political considerations may prevent the application of this conceptual distinction in practice.

59. When two countries classify institutions with the same or similar functions in different sectors, the survey results will not be internationally comparable. Such divergencies are probably unavoidable as R and D surveys are primarily undertaken to serve national purposes. For international surveys, however, data should be collected and submitted in as much detail as possible in order to leave room for re-arrangement for international comparisons.

60. Four domestic sectors are identified:

1. Business Enterprise,
2. General Government,
3. Private Non-Profit,
4. Higher Education.

A definition is also given of:

5. Abroad.

3. 2. 1. 1. The Business Enterprise Sector

61. This sector includes:

1. All firms, organisations and institutions whose primary activity is the production of goods or services for sale to the general public at a price intended approximately to cover at least the cost of production.
2. The private non-profit institutes mainly serving them.

62. The core of the sector is made up of private enterprises whether or not they distribute profit. Amongst these enterprises may be found some firms for whom R and D is the main activity (commercial R and D institutes and laboratories).

63. In addition, it includes government departments, establishments and similar units mainly engaged in selling the kind of goods and services which are often produced by business enterprises, though as a matter of policy the price set for these may not approximate to the full cost of production. In order to qualify as "sales" in this context, the charges should be related to the amount (quality and quantity) of

the goods and services furnished and the decision to purchase them should be voluntary. Examples: Nationalized mining and manufacturing units, electricity production and distribution, water supply services, railways, post and telecommunication services, broadcasting, etc.

Institutes Serving Business Enterprises

64. According to the SNA these bodies should be included in the Business Enterprise sector as long as they are not wholly or mainly both financed and controlled by organs of government. A full description of these institutes will be found in SNA. *

65. There has, in the past, been some controversy about how to classify agricultural (or industrial) research institutes established by government and either administered by government departments or linked to universities and private non-profit institutions.

SNA offers no specific guidance on agricultural research establishments. According to general SNA theory they can only be included in the business enterprise sector if, even though mainly financed by government:

i) they principally provide services designed to increase the efficiency and earning power of agricultural (or industrial) business establishments;
ii) they are not effectively government controlled.

However, further reading of the more descriptive part of SNA 5. 14 suggests that in order for an institute to be included in this sector, the business units it serves must have a substantial say in the running of its affairs. It is, thus, suggested that where such agricultural (and industrial) research units are not government controlled, they should be left in the sector by which they are administered unless business enterprises play a direct role in financing and directing their programmes. Where the R and D activities in such institutes play an important role in national science policy, they should be considered as a separate sub-sector and reports to international organisations should be as detailed as possible to allow re-arrangement of the data for the purpose of international comparisons.

3. 2. 1. 2. The Government Sector

66. This sector includes:

Organisations which furnish but do not normally sell to the community those services which cannot otherwise conveniently or economically be provided and which act as the administrative agency for the economic and social policy of the community.

67. All units of government (other than public enterprises and institutes of higher education) which fit the above description, irrespective of their treatment in the government or the level at which they operate (national, provincial, state, local), are included in this sector. These units and organisations engage in a wide range of activities, for example, administration, defence, maintenance of law and order, health, educational, cultural, recreational and other services, and promotion of economic growth and technological development. Also included are private non-profit institutes and social security arrangements which, by virtue of their relationship with the government, are clearly the instruments of government economic, social or scientific policy. The following types of organisations should be included as well:

a) Non-profit organisations which primarily serve government, i. e. bodies which are not established with the aim of earning a profit and which are mainly engaged in research and similar activities with regard to publically administered functions.
b) Non-profit bodies entirely or mainly both financed and controlled by government except those dispensing higher education.

The government sector may be sub-divided to show private non-profit institutes dependent on government separately, and these should be specified.

68. The definition of this sector is based in general on the SNA definition of producers of government services. The main difference is that publicly controlled institutes of higher education are excluded.

3. 2. 1. 3. The Private Non-Profit Sector

69. This sector includes:

> Most private organisations which are not established primarily with the aim of earning a profit. They are maintained by fees, dues and donations from members and sponsors, by grants from government and enterprises, and may also obtain revenue from the direct sale of some of their products and services, as, for instance, publications and public lecture programmes.

70. The following types of private non-profit organisations should, however, be excluded from this sector:

a) Those mainly rendering services to enterprises;
b) Those which primarily serve government;
c) Those entirely or mainly financed and controlled by government;
d) Those offering higher education services or controlled by institutes of higher education.

71. What distinguishes the organisations in this sector from business enterprises is not so much that they are non-profit but the aim of their activity. An independent private research institute selling R and D

through R and D contracts, which may be non-profit in the sense that any surplus is ploughed back into the organisation to be used for research projects of the institute's own selection, is a business enterprise.

72. This sector consists primarily of voluntary associations of individuals who have banded together in order to carry out specific activities. Typical examples of associations belonging to this category are voluntary scientific societies, philanthropic research institutions and voluntary health agencies.

73. This definition is based on the SNA except that it excludes non-profit higher education institutes. In addition, as a convention, all R and D activities of the general public (households) should be included in this sector. Their role in the performance of R and D is extremely small (individual inventors working in their own time and with their own facilities) but they do act as a source of funds for R and D, for example, by making donations to medical foundations.

3. 2. 1. 4. The Higher Education Sector

74. This sector includes:

> All universities, colleges of technology and other institutes of post-secondary education whatever their source of finance or legal status. It also includes all research institutes, experimental stations and clinics operating under the direct control of or administered by or associated with higher education establishments.

75. Higher education, which is not a separate SNA sector, has been separately identified here in view of the important role played by institutes of higher education in the performance of R and D. It is drawn from the SNA sectors of government and private non-profit.

76. For international comparisons, it would be desirable to have information for universities and colleges separated from that of associated institutes.

3. 2. 1. 5. Abroad

77. All organisations with R and D activities operating on domestic territory can be divided between the four sectors mentioned above. When examining flows of funds, it is necessary to include a fifth sector - Abroad.

78. Abroad consists of:

> Institutions on all territory outside the political frontiers of a country except that:
>
> i) vehicles, ships, aircraft and space satellites operated by domestic organisations and testing grounds leased or

acquired by a government and/or private organisations in other countries' territory are not to be considered abroad.
ii) the facilities of international organisations situated within the political frontiers of the reporting country are to be considered abroad.

79. Table 2 (following page) summarizes the various aspects of an organisation to be considered when deciding in which sector it should be classified.

3. 2. 2. Classification by sub-sector

80. It is general practice in national and international surveys of resources devoted to R and D to sub-divide the R and D activities of each sector with each unit surveyed being attributed to a single sub-class. These sub-sectors are then crossed with various other classifications outlined in Chapters II, III. 3 and IV.

81. One possible approach is to use the same standard classification for all four sectors, for instance the International Standard Industrial Classification* (ISIC). Although this has been done in a few countries it is not generally accepted practice. The use of separate institutional classifications for the various sectors is more usual. This mixed approach is, thus, recommended in the present edition of the Manual.

3. 2. 2. 1. Standard Sub-classification for the Business Enterprise sector - Industry Group

82. The basic classification for a breakdown in the business enterprise sector is usually a national variant of the International Standard Industrial Classification* (ISIC). Here the breakdown is according to the main industrial activity of the unit classified which may be either a whole firm or an establishment.

83. Table 3 (p. 42) shows a re-arrangement of ISIC which is suitable for analysing R and D activities in the business enterprise sector. In general, three digit classes have been adopted for "manufacturing" industries. The chemical, electricial and transport equipment industries have, however, been subdivided in order to identify separately drugs, electronics and aeronautics. Despite the new revision of the ISIC, the nomenclature of which is far more detailed than that of the 1958 version, certain industrial activities with a strong science base cannot be readily allocated to any one industry. A particular case is "atomic energy devices" which has been classified in the "machinery industry group". The table shows considerable detail for the services industries in order to draw attention to the possibility that these industries may undertake some R and D in the social sciences and humanities. It is not expected that the results will merit them being separately reported in national and international publications.

Table 2. USEFUL INDICATIONS FOR SECTORING

	FUNCTION	ECONOMIC BEHAVIOUR	LEGAL STATUS	REMARKS
Business Enterprise	To produce goods and services for sale to general public	Market prices intended to cover cost of production (profit or non-profit) or prices which vary according to quantity and quality purchased	Private or public organisations	Includes enterprises organised on a co-operative basis and non-profit institutions mainly serving enterprises
Private Non-profit Institutions	Generally to provide goods and services for their members and special client groups or to raise money for other institutes	Main income: fees from members and clients, grants	Private or quasi-public organisations	Excludes: 1. institutions mainly serving and/or controlled by business enterprises or government. 2. universities and associated institutes
General Government	To organise for the community those common services which cannot otherwise conveniently or economically be provided	Main income: taxes via government budgets	Public organisations	Excludes enterprises and institutions for higher education. Includes PNP organisations controlled by and/or serving government
Higher Education	To provide formal post-secondary education	Main income: fees, government subsidy or allocation, private gifts and grants, income from endowment	Public or private organisations	In SNA, institutions of higher education are distributed over the other three sectors above

Table 3. INTERNATIONAL STANDARD INDUSTRIAL CLASSIFICATION (ISIC) ARRANGED FOR PURPOSES OF R AND D STATISTICS

INDUSTRY GROUPS	ISIC	COMPONENT INDUSTRIES
Agriculture	1	Agriculture, forestry, fishing
Mining	2	Mining industries
Electrical	3831/3833/3839 3832	Electrical machinery Electronic components and accessories and telecommunication equipment
Chemicals	351/352 (except 3522 and 3523) 3522 and 3523 351/354 and 22	Chemical n. e. c. (including plastics materials + artificial fibres) Drugs Petroleum products
Aircraft	3845	Aircraft, hovercraft and space vehicles
Chemical-related	31 32 355/356	Food, drink and tobacco Textiles, footwear and leather Rubber and plastic products
Transport equipment (except aircraft)	3843 3841 3842, 3844, 3849	Motor vehicles Shipbuilding Other transport equipment
Basic metals	371 372 381	Ferrous metals Non-ferrous metals Fabricated metal goods
Machinery (except electrical)	382 385	Machinery (Atomic energy devices) Instruments
Other manufacturing Industries	33 341 342 323, 324 36 39	Wood, cork, furniture Paper Printing Leather Stone, clay, glass Manufacturing n. e. c.
Non-manufacturing Industries	4 5 6 71 72 810 820 8323/8324/8325 9310/9320/9340/9420 8 n. e. c. 9 n. e. c.	Electricity, gas and water Construction Wholesale and retail trade and restaurants and hotels Transportation Communications Financial institutions Insurance (Commercial research institutions (Advertising services Education services, research and scientific institutes, welfare institutions, libraries, museums, botanical and zoological gardens, and other cultural services n. e. c. All other

3. 2. 2. 2. Standard Sub-Classification for the Government Sector

84. In most countries the basic sub-classification in the government sector is by ministry or agency. However, the pattern of ministerial responsibilities varies considerably between countries.

85. In some countries an overall classification of government activities and agencies by "programme" has been established for budgetary purposes. In such cases R and D units in the government sector are classified according to their principal overall function (which may be broader or narrower than the mission of the ministry concerned).

86. The standard international classification for use within the government sector is that quoted in Table 5. 3 of the System of National Accounts which is also used by Working Party 2 of the OECD Economic Policy Committee for studies of total government expenditures. (See Annex II.) Unfortunately it is not, in its present form, very suitable for use with R and D data. For the present no standard sub-classification is recommended for the government sector.

3. 2. 2. 3. Standard Sub-Classification for the Private Non-Profit Sector

87. The standard international classification for the Private Non-Profit sector is that given in SNA, Table 5. 4. However, this is not very relevant to R and D. Given the small size of the Private Non-Profit sector a standard sub-classification is rarely needed. If such a breakdown is made the same sub-classification should be used as in the Higher Education sector.

3. 2. 2. 4. Standard Sub-classification for the Higher Education Sector

88. R and D activities in the Higher Education sector are generally broken down by broad field of science at institutional level which means that university faculties or research institutes are classified as a whole, rather than their individual projects.

89. A broad field of science classification could theoretically be drawn from ISCED* (see also paragraph 110) but a more suitable classification has been devised for UNESCO R and D surveys and is recommended for use (see Table 4).

3. 3. FUNCTIONAL CLASSIFICATION OF R AND D

90. A breakdown of R and D activities by sector and sub-sector gives useful information to the science planner; however, when making detailed analyses, it is necessary to use systems of classification which reveal the orientation of R and D activities. For the purpose of international comparison such functional classifications are far more significant than those based on institutions.

Table 4. UNESCO CLASSIFICATION BY SCIENTIFIC FIELDS

PRINCIPAL FIELDS	SUB-DIVISION OF PRINCIPAL FIELDS
A. Natural sciences	1. Mathematics 2. Physics, mechanics, electronics, astronomy 3. Chemistry, physical chemistry 4. Biology, botany, zoology, bio-chemistry, bio-physics 5. Geology and earth sciences, meteorology, geophysics 6. Other
B. Engineering	1. Metallurgy, mining 2. Mechanical engineering 3. Construction, civil engineering 4. Electrical engineering 5. Aeronautical engineering 6. Chemical engineering, fuel and petroleum technology 7. Textile engineering 8. Geodesy 9. General technology and applied science 10. Other
C. Medical sciences	1. Medicine 2. Dentistry 3. Pharmacy 4. Other
D. Agriculture	1. Agronomy, rural science 2. Forestry, horticulture 3. Dairying, animal husbandry 4. Veterinary science 5. Other
E. Social sciences	1. Political science, diplomacy 2. Economics, commerce, banking 3. Sociology, ethnology 4. Other
F. Humanities and Fine Arts	1. Humanities 2. Fine Arts 3. Education 4. Other

91. Although it may be possible to define functional classifications which could be applied to R and D activities in all four sectors, for practical purposes it is more useful to discuss classifications in two groups:

a) for use in the Business Enterprise sector;
b) for use in the General Government, Private Non-Profit and Higher Education sectors.

92. The most practical classification for the Business Enterprise sector is by product field. For the Higher Education, Private Non-Profit and Government sectors a classification is generally feasible by field of science.

93. A further functional approach to the analysis of R and D efforts is the classification by socio-economic objective, in the Government sector or at national level.

3. 3. 1. Classification by product field

94. In the classification by product field, the R and D activity of each enterprise or establishment is broken down according to the product field to which it is relevant. In theory, only applied research and experimental development work can be distributed by product field. As, however, the basic research performed in industry may be oriented towards some area of commercial interest to the performing company, it might be possible in some cases to classify a firm's R and D as a whole by product field.

95. The main international classification by product, the Standard International Trade Classification* is, as its name suggests, trade rather than industry oriented. This, combined with the fact that processes such as mineral extraction, for example, do not fit in this classification, makes it rather inconvenient for R and D purposes. For the moment a reasonable approach seems to be to use the ISIC also for this classification of industry's R and D by product field. The following example may illustrate the different use of the ISIC in classifying by industry group and product field respectively.

Example:

A firm (establishment) belonging to the electrical machinery industry has performed R and D on plastics. When classifying by industry group, i. e. the industry group where this R and D has been performed, the R and D resources will be allocated to the "electrical machinery industry". In classifying by product field, i. e. in the actual product field in which R and D has been performed, these resources will be classified as "chemical".

3. 3. 2. Detailed functional classification by field of science

96. The purpose of a detailed field of science classification is to reveal the object or focus of R and D activities measured in terms of expenditure or of the occupational field in which R and D manpower actually work.[1] Although extremely difficult to obtain, such a classification is of great importance to science policy makers.

97. Such a classification is most easily applied in the Higher Education and Private Non-Profit sectors. Sometimes the units surveyed in the Government sector may also be able to break down their R and D activities by detailed field of science but this has very rarely been attempted in the Business Enterprise sector.

98. Unfortunately at the time of writing no up-to-date detailed standard international classification of detailed fields of science for R and D activities is available, as the review of the UNESCO draft International Standard Nomenclature for Fields of Science and Technology was still in progress.

99. As it seemed rather risky to quote a classification which might subsequently be extensively modified, this edition of the Manual does not include a recommended list of detailed fields of science. A number of publications quoting detailed national classifications currently in use are cited in the bibliography. *

3. 3. 3. Classification by socio-economic objectives

100. The aim of classifying R and D data by socio-economic objective is to assist Government policy formulation. Consequently the categories should be broad, and regardless of which of the approaches outlined below is selected, the results are expected to be interpreted as measures of the resources allocated to each purpose.

101. There are a number of approaches to classification by socio-economic objective. Two of these seem particularly well suited to the needs and practicalities of R and D statistics, viz.:

a) according to the purpose of the programme or project concerned seen from the point of view of the funder. This approach is most easily applied to government R and D funds (including the general public funds of the university sector) and is, probably, at present the most widely used and, thus, the most suitable for adoption for international comparisons.

b) according to the general content of the R and D programme or project seen from the point of view of the performer. This approach is most easily applied to R and D performed in the

1. The educational background of the R and D labour force can also be classified by field of science but the proper classification in this case is ISCED (see paragraph 89) which provides the necessary link between science and educational policy.

government and private non-profit sectors, though individual countries have applied it in the higher education and even the business enterprise sectors. This approach has, as yet, been adopted by relatively few Member countries.

102. The collection by purpose is the more fundamental from the viewpoint of government policy, whereas the collection by content lends itself more readily to finer subdivision, although at very fine subdivisions the classification becomes a list of specialized fields of science. Only at the major level of subdivision will the two methods give comparable results, and even then there could be significant differences. It is therefore important that all results should state clearly the basis of collection, and that they should be dealt with separately in international comparisons.

103. The allocation of R and D expenditure to socio-economic objectives should be made at that level which permits the most accurate reflection of the purposes of the funder or the actual R and D performed, depending on which of the two approaches of paragraph 101 has been selected. The actual reporting level chosen will depend on the practical possibilities of a particular situation and on the method of planning, organising and executing research programmes.

104. For the time being, both approaches will be followed, using the classification, indicated in paragraph 105. These twelve categories of objectives have been drawn up primarily for use in analysis of government R and D funds. The classification is experimental in the sense that it will be modified in the light of practical experience to apply to all sectors. It is also evolutionary in that it will be changed over time to reflect changes in the concerns of governments. The descriptive text for each category of objectives is indicative rather than complete. In order to assist the Secretariat in analysis and to make it possible to provide more complete listing of the scope of the individual objectives, Member countries should report their objectives by major sub-categories, especially those relevant to policy.

105. This classification scheme draws heavily on the objective lists of the Nordforsk and the European Economic Community. In general, it reflects the overall purposes for which funds have been committed to R and D programmes rather than the fields of science involved. Civil space research is an exception. It has been retained although it is no longer a specific science policy objective because for the moment it cannot be deleted without greatly altering the distribution among the other objectives to which it would be assigned.

Classification by socio-economic objectives

a) Development of agriculture, forestry and fishing

This group covers all R and D primarily intended to develop and support these activities (ISIC, group 1), including for

example relevant work on chemicals and mechanization. It excludes R and D in favour of the food processing and packaging industries which should be included in objective 2.

b) Promotion of industrial development

This chapter includes R and D programmes whose primary objective is to support the development of industry. The core of this class will consist of R and D programmes in favour of manufacturing industry (ISIC group 3) but it also contains R and D in favour of the construction industry (ISIC, group 5), the wholesale and retail trade, restaurants and hotels (ISIC, group 6), banking, insurance and other commercial services (ISIC group 8) or in favour of industry in general.
It does not include R and D performed by industry (principally financed from public funds) in support of other objectives, for example in the fields of space, defence, transportation and telecommunications, although these obviously have an important secondary effect on the development of the industries concerned. If R and D is supported for a communal project it should be excluded from this class and included under the relevant objective. For example, the development of a new type of rolling stock as part of a re-organisation of the nation's railways should be classified under "transport". Re-development of similar rolling stock in view of export sales belongs under the present heading. Similarly R and D in support of tourism as a cultural activity should be included under "objective(8)", but R and D mainly intended to improve the commercial prospects of the hotel and tourism industry should be included here.

c) Production and rational use of energy

All R and D activities aimed at the supply, production, conservation and distribution of all forms of energy except R and D on means of propulsion for vehicles and rockets. R and D on water as a source of energy should be included. R and D on nuclear energy should be included but reported separately. Those countries where all nuclear R and D is funded through an integrated national programme which cannot be sub-divided should report the total sum giving as many details as possible on the non-energetic R and D projects included.

d) Transport and telecommunications

This chapter includes:
- R and D directed towards better and safer transportation systems including traffic safety (except when an integral part of urban and rural planning);

- R and D on all telecommunication services (except satellites) as well as R and D on the planning and organisation of networks.

e) Urban and rural planning

R and D referring to the total planning of urban and rural areas, better housing and improvements to the community environment (e. g. siting of hospitals, sound insulation, etc.). The intention here is the integrated planning that attempts to co-ordinate various elements and create a "total environment".

f) Protection of the environment

This group covers R and D directed towards an "undestroyed" physical environment. It includes all R and D on pollution: causes; diffusion and conversion; effects on man and the environment. It covers pollution in or due to: air, water, soil and sub-strata, noise, solid waste disposal and radiation. It excludes R and D designed to prevent pollution in those activities which might cause pollution; this should be assigned to the class relevant to that activity.

g) Health (excluding pollution)

R and D programmes directed towards the protection and improvement of human health. It includes R and D on food hygiene and nutrition, and also R and D on radiation used for medical purposes, biochemical engineering, medical information, rationalization of treatment and pharmacology (including testing medicines and breeding of laboratory animals for scientific purposes), as well as research relating to epidemiology, prevention of industrial diseases and drug addiction.

h) Social development and services

R and D related to social and cultural problems includes, for example, social security, social services, social relations, culture, recreation and leisure, law and order, consumer protection, working conditions, labour relations, manpower development, public administration, national economy, peace and other international objectives. This group should be sub-classified in as much detail as possible using whatever classification respondents think relevant.

i) Exploration and exploitation of the earth and atmosphere

This heading covers exploration and exploitation of the earth's crust and mantle, seas, oceans and the atmosphere. It does not include the study of pollution, the study of soils for agricultural purposes, or fishing. It includes R and D on meteorology (except when conducted by satellite).

j) General advancement of knowledge

This class includes all R and D which contributes to the general advancement of knowledge and which cannot be attributed to a specific objective.

i) Purposes of government R and D funding

When reporting data for total public support for R and D by "purpose" this class should include, by convention, all R and D financed from general purpose grants from ministries of education although in some countries many of these programmes may be relevant to other objectives. This convention has been adopted because of the problems of obtaining suitable data and thus of comparability. Member countries should provide the most detailed possible breakdown of the contents of this class by field of science and/or where they are able to do so, by objective.

ii) "General content" of R and D by performer

When reporting data on general content of R and D performed in the higher education sector, this convention no longer applies and any such programmes should be distributed by objective.

k) Civil space

This class covers all civil R and D concerning space. These activities have been grouped together here because in several OECD Member countries civil space is still an objective in its own right. They might equally well have been broken down between the relevant objectives such as advancement of knowledge (e. g. astronomy) or specific applications (e. g. telecommunications satellites).

l) Defence

Defence includes all R and D programmes undertaken primarily for military reasons regardless of their content or whether they have secondary civil applications. It includes nuclear and space R and D undertaken for military purposes. It does not include civil R and D financed by ministries of defence, for instance on meteorology or telecommunications.

IV

MEASUREMENT AND CLASSIFICATION OF R AND D MANPOWER AND EXPENDITURE DEVOTED TO R AND D

4. 1. INTRODUCTION

106. The two principal methods of input measurement are:

a) measures of manpower employed on R and D;
b) measures of expenditure on R and D.

Expenditures and manpower should be surveyed simultaneously and along the same lines so that analyses can cover both and so that it is possible to calculate ratios between R and D expenditure and R and D scientists and engineers for a country as a whole and for each sector surveyed. If different agencies are responsible for the collection of expenditure and manpower data, close co-operation is essential.

4. 2. MANPOWER EMPLOYED ON R AND D

107. All manpower employed directly on R and D regardless of level of responsibility should be included together with administrators and managers of R and D and those providing direct services such as clerical staff. Those providing an indirect service such as canteen staff, janitors and cleaners, should be excluded from the measurement of manpower, although their wages should be included as an overhead in the expenditure data. If possible, calculations should be made in terms of "full-time equivalence", rather than physical persons (see "need for estimates and adjustments", paragraphs 145 and 153).

4. 2. 1. Categories of R and D manpower

108. It is desirable to classify manpower working in R and D both by occupation and by formal qualification. Whereas it is often easier at national level to collect information by formal qualification, this is not always very meaningful as it may not correspond to the actual employment of manpower and, owing to the different patterns of formal education, it does not lend itself to international comparisons.

4. 2. 1. 1. Classification by occupation

109. The standard international classification in this field is the International Standard Classification of Occupations (ILO-1968). This does not have a separate class for R and D workers outside the natural sciences and places teachers in a separate group. It can, however, be adapted to suit some aspects of an R and D survey. The main definitions of function which follow are specially framed for R and D surveys. A list of suggested ISCO classes to be included in each OECD function is given in Table 5 on the following page).

a) Researchers (R and D scientists and engineers)

> Persons actually engaged in the conception and/or creation of new knowledge, products, processes, methods and systems.

Their professional title may vary from one country to another and even from one sector to another. Executives and directors responsible for the administration of R and D activities should also be included in this category, as well as (post-) graduate students properly contributing to research (see also paragraph 36a). Identification of the latter may be very difficult for some countries and to facilitate international comparability they should be measured and recorded separately.

b) Technicians

> Technicians perform auxiliary technical tasks connected with R and D normally under the direction and supervision of a researcher (R and D scientist or engineer).

Their tasks include:
- assisting with or (under supervision) performing experiments, tests and analyses;
- preparing materials and equipment for experiments, tests and analyses;
- taking records, making calculations and preparing charts and graphs;
- maintaining and operating advanced machinery and equipment;
- in social science R and D, survey interviewers may often be used to collect data, e. g. when sample surveys are being carried out. Although there is no appropriate ISCO class, survey interviewers should be included under the functional heading of technicians.

c) Other supporting staff

> Skilled and unskilled craftsmen, secretarial and clerical staff working on or directly associated with R and D activity.

Table 5. SUGGESTED RELATION BETWEEN OECD FUNCTION AND ISCO CLASSES

OECD CLASS	ISCO CLASSES	ISCO NUMBER
Researchers (R and D scientists and engineers)	Chemists, physicists, physical scientists n. e. c.	011, 012, 013
	Biologists, medical scientists and related scientists, bacteriologists and related scientists, agronomists and related scientists	051, 052, 053
	Statisticians, mathematicians and actuaries, systems analysts	081, 082, 083
	Economists	090
	Lawyers, jurists, n. e. c.	121, 129
	Sociologists, psychologists, anthropologists, geographers, historians and political scientists	192
	Librarians, archivists and curators	191
	Civil, electrical, mechanical, chemical, metallurgical, mining and engineers n. e. c.	022-029 incl.
	University and higher education teachers	131
	Administrators and managerial workers	Major group 2
Technicians	Physical and life science technicians	014 and 054
	Surveyors, draughtsmen, civil, electrical, mechanical, chemical, metallurgical, mining and other engineering technicians	031-039 incl.
	Statistical and mathematical technicians, including computer programmers	084
	(Survey interviewers)	(none)
Other supporting staff	Agricultural, service and production and related workers	Major groups 7, 8, 9
	Clerical workers and related workers	Major group 3

Manpower providing an indirect service, such as canteen staff, janitors, etc., should be excluded. Their wages should be treated as an overhead in the expenditure data.

4. 2. 1. 2. Classification by formal qualification

110. The International Standard Classification of Education ISCED* offering a breakdown by levels of programmes of education which provides the essential major elements of a classification by highest qualification received is thus the Standard International Classification in this area.

ISCED comprises 8 degrees or levels of education and 21 areas of study. Only the four highest degrees are relevant to the analysis of manpower working on R and D by formal qualification. The four classes can be defined as follows:

a) Holders of university degrees

Includes holders of degrees earned at universities proper and also at specialized institutes of university status. ISCED levels six (first university levels) and seven (post-graduate levels).

Examples: Universitäten, Technische Hochschulen (Germany).
Facultés, "grandes écoles" (France).
Universiteiten, Technische Hogescholen, Landbouw Hogeschool (Netherlands).
4-year colleges granting B. A. or B. Sc. (United States).

Includes graduates in all fields including social sciences and humanities. Post-graduate research students should be included in this category but they should be measured and recorded separately.

b) Holders of other post-secondary diplomas (not equivalent to a university degree)

Covers holders of ISCED level 5 diplomas. These diplomas are awarded after high level practical studies which are often of shorter duration than university programmes.

Examples: Graduates of Fachhochschulen (Germany).
Instituts universitaires de technologie, diplômés d'études supérieures techniques (France).
Hogere Technische Scholen, Hogere Landbouw Scholen (Netherlands).
Ecoles techniques supérieures (Belgium).
Higher National Certificate and Higher National Diploma (United Kingdom).
Höhere Technische Lehranstalten (Austria).

Studies are typically specialized in subject matter presented at a level that requires the equivalent of full second level education for their mastery, and they provide an education of a more "practical" orientation than those of the universities. Many of the programmes are part-time, evening, sandwich, courses and refresher courses.

c) Holders of diplomas of secondary education

Covers holders of ISCED level 3 diplomas.
This class includes lower technical diplomas of secondary level obtained outside the academic secondary school system.

Examples: Graduates of Technikerschulen (Germany).
Middlebare Technische Scholen (Netherlands).
Ecoles industrielles supérieures (Belgium).
Ordinary National Diploma and Ordinary National Certificate (United Kingdom).
Diploma from a Technical Secondary School (United States).

d) Other qualifications

Includes all those with secondary, or incomplete secondary qualifications or with education not falling under any of the above categories.

4. 2. 1. 3. Joint occupational and qualification approach

111. Table 6 shows a matrix of R and D manpower, broken down both by occupation and by formal qualification.

Table 6. R AND D MANPOWER

QUALIFICATION / OCCUPATION	UNIVERSITY		OTHER POST-SECONDARY	SECONDARY	OTHER	TOTAL
	POST GRADUATE	OTHER				
Researchers						
Technicians						
Other supporting staff						
Total						

112. While it is probable that most of those occupied as scientists or engineers will have a university degree, they may also include, however, holders of higher technical diplomas, persons with incomplete university training and self-trained persons who have proved their capabilities in a given job.

113. Similarly, many of those occupied as technicians will have higher or lower technical diplomas. In very new fields, however, there may also be some university graduates working at technician tasks which, when the processes are standardized, will be performed by non-graduates (e. g. computer programmers). In countries which did not provide much standard technical training until recently, there will be many technicians with no formal qualification (although they may have had incomplete post-secondary education and/or on-the-job training).

114. The estimation of full-time equivalents is rather impracticable for the cross-classification. Instead one should always distinguish between scientists and engineers full-time and scientists, and engineers part-time in R and D.

4. 2. 2. Other characteristics of R and D manpower

115. There are further characteristics of R and D manpower and particularly of scientists, engineers and technicians which may be of interest, notably:

a) age;
b) sex;
c) fields of qualification (scientific or technical specialization); the use of ISCED is recommended;
d) level of university degree (post-graduate, etc.);
e) year of university graduation;
f) foreign-born persons: country where secondary school and where higher education was completed.

116. It is not suggested that these characteristics should be regularly included in R and D questionnaires. They may, perhaps, be better treated in overall surveys of national stocks of scientific and technical personnel; but it should be kept in mind that such cross-qualifications may be important for science policy reasons.

4. 3. R AND D EXPENDITURE

117. Sums allocated to R and D can be spent either:
- inside (intramural expenditure), or
- outside (extramural expenditure)

a firm, ministry or public agency, private non-profit institution or university. Both expenditure categories will be discussed (see also graph A).

4. 3. 1. Intramural R and D expenditure

118. Intramural expenditure includes all funds used for the performance of R and D within a particular organisation or sector of the economy, whatever the source of finance.

119. It includes both current and capital expenditure which each consists of a number of various sub-classes:

Current expenditure

Current expenditure is made up of:

a) Wages, salaries and all related elements of labour costs (or "fringe benefits") such as bonus payments, holiday pay, contributions to pension funds, payroll taxes and welfare expenditure. This class may be broken down into expenditures made in respect of scientists and engineers and those in respect of other R and D personnel. Even if (post-) graduate research students are not included in the manpower figures, all known funds used to support their R and D should be reported.

b) Materials and equipment, other than major items of equipment, including books, journals, reference material, subscriptions to libraries, scientific societies and so forth, whether incurred for individual research workers or for the research organisation as a whole. Including also the replacement of office furniture and fittings, as well as the imputed or actual cost of small prototypes or models made outside the research organisation.

c) Water and fuel, including gas and electricity.

d) Maintenance and repair of buildings and equipment. Rent, rates and cleaning.

e) Administrative expenses and share of overhead costs in the case of research departments or institutes sharing premises or facilities with other parts of a large organisation. Including office expenses, telephone and telegraph, transport, travel, entertainment, printing and duplicating services, canteen facilities, storage expenses, accounting costs, insurance.

f) Purchase of services (e. g. cost of computer time).

Depreciation

In the scheme of measurement current expenditure on R and D excludes actual or imputed provisions for depreciation.

120. Normally, it will not be necessary to ask respondents in each sector to give an annual breakdown of their current expenditure into

the above six or more sub-divisions and a combined figure will usually suffice. It may, however, be useful to obtain a detailed breakdown of current expenditure on an occasional basis, first of all in order to provide data for comparison of R and D costs between different sectors, industries and organisations within a country and secondly, to provide the means for constructing indices of R and D costs. Such indices are essential for comparisons and analysis of expenditure over time and between countries (see also Chapter VI).

Capital expenditure

121. It covers:

Annual gross capital expenditure actually incurred by performers, irrespective of the method of finance, the period over which this may be written off, or whether the expenditure is for replacement or an addition to assets.

122. Capital expenditure on R and D includes:

a) the acquisition of land (although this is not a capital expenditure in terms of the SNA);
b) expenditures on buildings, fixed assets and plant, including major improvements, modifications, repairs and renovations as well as legal fees resulting from the purchase of real estate;
c) the acquisition of major instruments and equipment.

The sale or transfer of fixed assets should be shown separately.

123. In measuring actual capital expenditure (i. e. as charged on the capital account), small tools and instruments and minor improvements to existing buildings will normally be excluded, as in most accounting systems these items are normally carried on current expenditure accounts. The boundary between "minor" and "major" items varies slightly between countries, according to taxation practices and between different firms and organisations in the same country according to accounting practices. But these differences are rarely significant and it is neither necessary nor practical to insist on any rigid standard for this purpose.

124. A special difficulty arises when a pilot plant switches to operating as a normal commercial production unit or is being sold (see also paragraph 43). In either case, the receipts - imputed or real - have to be considered as dis-investments in R and D and thus in accordance with the SNA they should be deducted retrospectively from gross investments in R and D in the year of original payment. In practice this is possible only where the construction costs of the pilot plant have been put on the capital account. To avoid inconsistencies in the return, these transactions (dis-investments) should be recorded separately. Similar difficulties arise in the social sciences where, for instance,

buildings might be provided for research purposes and then revert to other uses. Whenever it is known initially that the buildings are to be devoted principally to other purposes, only the net expenditure attributable to the research should be counted against it. This may be considered as an alternative to the method of dis-investment.

125. All depreciation provisions for building, plant and equipment, whether real or imputed should be excluded. This solution is proposed for three reasons:

a) The actual sums set aside for depreciation are useless for purposes of international comparison because of differences in tax laws;

b) In the general government sector, no provision is normally made for depreciation of fixed assets. Consequently, even within a country, comparisons between sectors cannot be made unless depreciation provisions are excluded, and aggregates for a national series cannot be compiled unless the sector totals are put on a comparable basis;

c) It is useful to know whether the pattern of capital expenditure for R and D purposes follows that for business investment in general.

126. Thus, although for particular sectors it may be useful to collect figures on actual or imputed provisions for depreciation, it is desirable that these be separately recorded.

4. 3. 2. Extramural flows of funds

127. Essentially the term "extramural" denotes a flow of R and D funds from one organisation or sector to another.

Extramural flows can be identified in two ways:

1. As "extramural expenditures" which are the sums an organisation (or sector) reports having paid to another organisation (or sector) for the performance of R and D.

2. As R and D supported by "extramural source of funds" which are the sums an organisation (or sector) reports having received from another organisation (or sector) for the performance of R and D.

Such payments can take the form of contracts, grants or donations and they can be made in cash or in kind (e. g. equipment made available to the performer).

128. It is, of course, as important to the science policy maker to know who supports R and D as who performs it and every effort should be made to trace these flows of R and D funds. For various reasons

the performer-based "source of funds" approach, which involves tracing the funds back from the reporting performer to the original source, is preferable.

129. When making a breakdown by source of funds, only those funds received for the performance of R and D should be considered as coming from outside the unit. Funds received from outside as payment for other sales or services (e. g. profit on sales of serum, journals, etc.) count as the institute's own funds as do funds received from the sale of patents or licences.

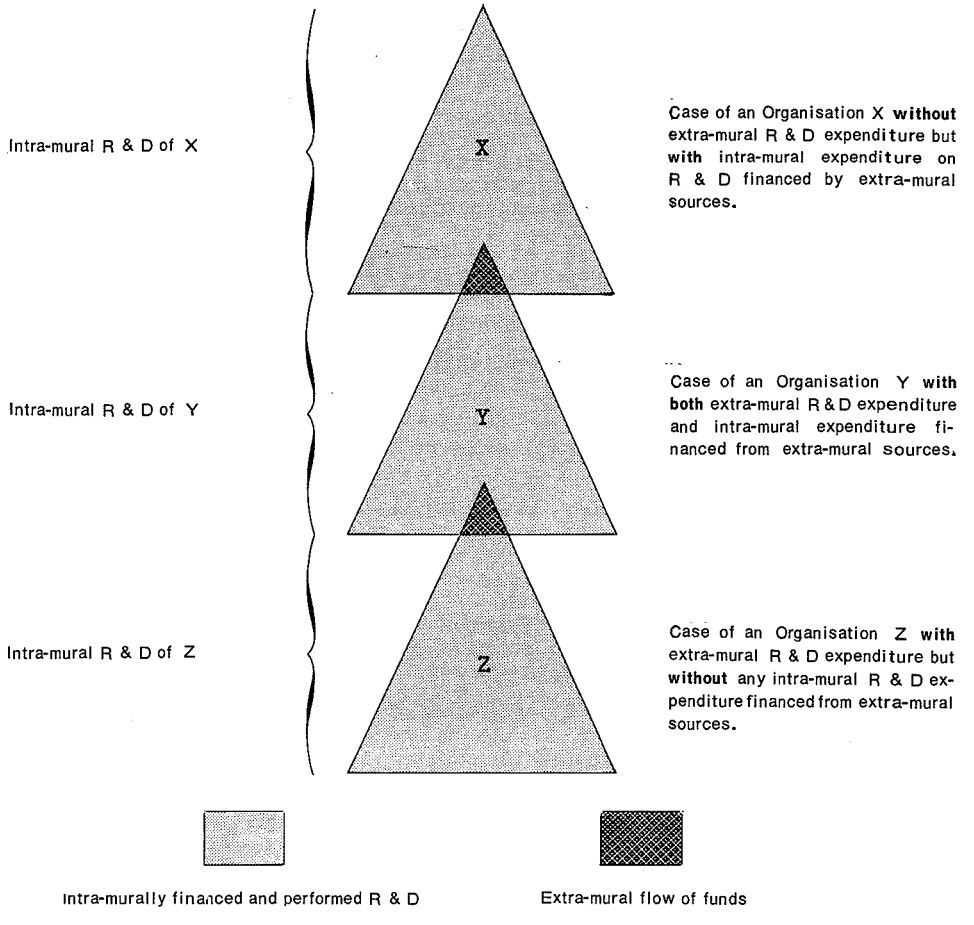
130. As already noted in paragraph 48 the amount of extramural flow of funds reported will be affected by any variations in the type of statistical unit on which the data is based. This particularly concerns flows between organisations within the same sector. For instance, government departments may well charge one another for the performance of R and D but this will usually be considered as intramural to the Government sector. Similarly a business enterprise may, for accounting reasons, charge for the R and D done by one of its establishments for another, but consider the work to be intramural as far as the enterprise is concerned. The decision on where to draw the boundary is an arbitrary one and the important point again is to comment fully in any published tables.

131. Further problems arise when the money passes through several organisations. This can occur when R and D is sub-contracted as is often the case in the Business Enterprise sector. The performer should indicate, as far as possible, the original source that provided the funds for R and D; intermediary non-performing organisations within some countries play an important part in the financing of R and D by distributing among performers grants received from several different sources but not "earmarked" for specific projects. Well known examples are the Stifterverband für die Deutsche Wissenschaft and the Deutsche Forschungsgemeinschaft in Germany. In such cases it is acceptable to regard these organisations as the source although it is preferable to attempt to retrace the funds to their original source.

132. For analytical purposes, however, extramural expenditure data may sometimes provide information which cannot be obtained from performers' reports of sources of funds. All organisations involved in R and D should be asked to report their extramural expenditures to "abroad" and, where government finances a large share of national R and D, it is useful to draw on data from budgets, legislative appropriations and ministerial programmes since these data offer an advanced view of the likely use of government funds by other sectors and are available long before survey reports on the actual use of these funds are turned in.

Graph A

DIAGRAMMATIC PRESENTATION OF THE CONVENTIONS UNDERLYING THE SURVEY CONCEPTS OF INTRA-MURAL AND EXTRA-MURAL R & D



Each triangle represents the total outlays on R & D of any organisation performing and financing this kind of activity. The upper angle represents the extra-mural R & D expenditure, the rest of the triangle the intra-mural expenditures. Part of these intra-mural expenditures are financed from extra-mural sources (dark shaded triangle at the basis) or, to put it in another way, represents the extra-mural expenditure on R & D of another organisation, etc.

4. 3. 3. National aggregates and matrices concerning performers and sources of R and D funds

133. If data is collected from respondents in each sector of the economy on their intramural R and D expenditure during a given period broken down by source of funds, aggregates can be made for each sector and for the country as a whole without double-counting. The major national R and D aggregate is:

Gross Domestic Expenditure on Research and Experimental Development (GERD)

GERD is total intramural expenditure for R and D performed on national territory during a given period.

It includes R and D performed on the national territory funded from abroad, but excludes payments to abroad for the performance of R and D (and R and D performance of international organisations within the country).

134. On the basis of the data on intramural performance of R and D collected in the different sectors, matrices can be constructed that show the role of each sector in the performance and financing of GERD (see Table 7 on p. 63). Flows within the sectors do not appear in this table. The sum of R and D financed by and performed within the Business Enterprise sector, for example, includes both performers' own funds and funds received from other business enterprises that were used in the performance of R and D during the survey year (see also graph A).

135. Another interesting aggregate at national level is the sum of expenditure for R and D supported by a country excluding R and D financed from abroad and performed within the country but including payments for R and D performed abroad. The latter has to be based on the relevant extramural expenditures reported by financing organisations.

4. 4. CROSS-CLASSIFICATIONS

136. For various reasons it is not possible to classify current and/or capital expenditures by all the systems described in Chapter II (type of R and D), Chapter III (sector; industry group; field of science; socio-economic objective). For instance, it is almost impossible to acquire complete data on capital expenditure for basic research since the fixed assets in question may be used for applied research as well. Table 8 (see p. 64) summarizes the practical possibilities of classifying R and D at the present state of the art.

Table 7. GROSS EXPENDITURE ON R AND D WITHIN A COUNTRY

SOURCE OF FUNDS BY SECTOR	SECTOR OF PERFORMANCE				TOTAL
	BUSINESS ENTERPRISE	GENERAL GOVERNMENT	PRIVATE NON-PROFIT	HIGHER EDUCATION	
Business Enterprise					Total financed by the Business Enterprise sector
General Government					Total financed by the General Government sector
Private Non-Profit					Total financed by the Private Non-Profit sector
Higher Education					Total financed by the Higher Education sector
Abroad					Total financed by Abroad
Total	Total performed in the Business Enterprise sector	Total performed in the General Government sector	Total performed in the Private Non-Profit sector	Total performed in the Higher Education sector	GERD

Table 8. CHART OF THE PRACTICAL POSSIBILITIES OF CLASSIFIED R AND D EXPENDITURE

Expenditure Categories	Relevant classsifications																			
	Chapter II				Chapter III															
	Functional classification				Sub-sector				Functional classification											
	Type of R and D				Industry Group				Product Field				Detailed Field of Science				Socio-economic Objective			
	Basic Research	Applied Research	Expenditure Development	Total	Basic Research	Applied Research	Expenditure Development	Total	Basic Research	Applied Research	Expenditure Development	Total	Basic Research	Applied Research	Expenditure Development	Total	Basic Research	Applied Research	Expenditure Development	Total
Current expenditure	← Possible →				← Possible →				Not or rarely possible	← Sometimes possible →		Not or rarely possible	← Possible →		← Less possible →		Only possible as one total			
Capital expenditure	← Not or rarely possible →			Possible	← Not or rarely possible →			Possible	← Not or rarely possible →			Sometimes possible	← Not or rarely possible →			Sometimes possible				

4.5. CLASSIFICATION BY SIZE

137. In addition to the classifications already considered, the analysis of R and D activities can be significantly improved by data on structural size. To facilitate international comparisons, such data should be given in a uniform manner, using the same size classifications. The size classifications mentioned hereafter are recommended for the manpower data of the Business Enterprise sector. These manpower data may concern:

a) the total number of employees (head count);
b) the number of employees engaged in R and D (full-time equivalent);
c) the number of scientists and engineers employed in all activities (head count);
d) the number of scientists and engineers engaged in R and D (full-time equivalent).

Whenever possible the elaborated version should be used.

SIZE CLASSIFICATION OF MANPOWER DATA
(B.E. SECTOR)

COMPRESSED VERSION		ELABORATED VERSION	
I	less than 50	Ia	less than 25
		Ib	25 - 49
II	50 - 99	II	50 - 99
III	100 - 499	IIIa	100 - 249
		IIIb	250 - 499
IV	500 - 999	IV	500 - 999
V	1,000 - 4,999	Va	1,000 - 1,999
		Vb	2,000 - 4,999
VI	5,000 or more	VIa	5,000 - 9,999
		VIb	10,000 or more

138. In the case of R and D units in the General Government, Private Non-Profit and Higher Education sectors the following classification of manpower data is recommended for the groups b) to d) as mentioned in paragraph 137. For group a) paragraph 137, size classification should be made with respect to the elaborated version above. In practice there will be some difficulty in classifying university institutes.

SIZE CLASSIFICATION OF MANPOWER DATA

(General Government and PNP sector, Higher Education sector, full-time equivalent)

I	0 - 9
II	10 - 24
III	25 - 49
IV	50 - 99
V	100 - 199
VI	200 and above.

139. For the analysis of R and D resources in the Business Enterprise sector it is recommended that the data should be classified by size of total employment of the unit classified as shown in Table 9. If possible, classifications should be made at establishment level. When this is not possible the firm should state explicitly on which level of the unit the classification is based.

Table 9

ENTERPRISE SIZE BY TOTAL EMPLOYMENT	NUMBER OF ENTER-PRISES	R AND D EXPENDITURE IN NATIONAL CURRENCY			R AND D MANPOWER	
		CURRENT EXPEN-DITURE	CAPITAL EXPEN-DITURE	TOTAL	SCIEN-TISTS AND ENGINEERS	TOTAL
(size groups)						
Total						

140. For the General Government, Private Non-Profit and Higher Education sectors the data should be given in the same way as in Table 9. However, in the first column the size classification should be by total R and D manpower and in the second column the number of the appropriate institutional units should be given.

V

METHODS OF MEASURING R AND D AND THE NEED FOR ESTIMATES AND ADJUSTMENTS

5.1. METHODS OF COMPILING R AND D DATA

141. There is no satisfactory substitute for a special survey. Whilst a certain amount of information about recent trends in resources devoted to R and D can be obtained from regular publications, such as government "science" budgets or annual reports of science councils, such data give only an approximate measure of R and D efforts, firstly because the concept of "R and D" may vary considerably from the Frascati definition or may change over time and secondly, because it is extremely difficult to track down flows of funds from financial statements without incurring double counting.

142. A survey stands or falls by its questionnaire which should be clearly and logically set out, contain the minimum number of questions supplemented by definitions, examples and any special instructions relevant to the sector and country involved.

143. The extent to which follow-up procedures are used will depend on the level and quality of response, the number of units surveyed and the resources available to the surveying authority. It is rarely possible to make personal contact with all the units surveyed. One possibility is to plan a follow-up programme for a number of enquiries, aiming to visit all the main units over a given period. Another is to limit the follow-up to a sub-sample, checking a few organisations very thoroughly. This does not, of course, preclude making personal contact with respondents who require guidance or who submit unsatisfactory returns.

5.2. IDENTIFYING SURVEY RESPONDENTS

144. If the social sciences and/or humanities are being surveyed in the Business Enterprise sector, it is important to note that there may be significant research efforts going on in certain sub-categories which report relatively little R and D in the natural sciences. These include the distributive trades; insurance; banking and other financial institutions; advertising and other business services; miscellaneous

services such as hotels and catering, television and radio outside the government sector.

5.3. THE NEED FOR ESTIMATES AND ADJUSTMENTS

145. The measurement of R and D activities involves a good deal of estimation. It is impossible to make detailed recommendations which would apply in every case. Both the criteria that have been proposed and actual practice leave a good deal to the survey authorities. The latter will be the final judges in deciding if definitions have been properly understood and respondents (performers and financers) have used the same methods for estimating.

5.3.1. Estimates to be made by the respondents

146. There are many institutional links between R and D and other scientific activities. University departments, besides being units of higher education, are also performers of R and D and may be engaged in a number of other scientific activities as well. Industrial R and D departments often also perform such functions as technical sales service, production control, and routine testing while, on the other hand, some development work is carried on in production units. Thus, R and D is not just what R and D units do. It is both less and more than this since it is unlikely that all the institutes surveyed have only one activity. R and D cannot be measured by adding together the statistical records of the institutions.

147. The measurement of R and D may involve three stages:

a) Identification and measurement of total activity of all specialized research units;
b) Subtraction from this total of that portion of their activity which is non-R and D;
c) Addition to this total of any R and D activity performed outside research units - for instance in production units, education departments and hospitals. In the business enterprise sector, considerable attention should be given to the case of small and medium size firms which are often unable to assess their R and D activities which are not separately budgeted.

148. Wherever a unit's activity is divided between two or more major functions, the respondent should be asked to exclude non-R and D activity. Excluded from research are the gathering of data, such as statistics of production or distribution; sales projections; the routine application of personnel testing and placement techniques; market studies using established techniques; and other established operating activities. Data collection undertaken specifically for a social science research project, however, should be included. All activities directly

related to social science research projects, such as data processing, table and chart preparation, and typing, should be included. In particular an estimate of overheads attributable to social science research and development should be included in the same way as for the natural sciences and engineering. Activities which are minor in relation to the main body of work of the unit may, for practical reasons, be ignored as long as the resulting distortion is likely to be slight (see supplementing criteria for separating R and D from other scientific activities, Table 10).

5.3.1.1. Expenditure estimates

149. The respondent should report the aggregate full cost of the organisation's R and D projects. To get this figure he will often have to do a substantial amount of estimating and adjusting since:

- in most organisations, accounting systems are geared to organisation units rather than to activities;
- even where organisational units are narrowly specialized, the R and D unit may share certain facilities with other units;
- some cost items may be carried on different budgets;
- only the expenditures actually incurred during the reporting period should be reported; often this means dividing the total expenditure on a particular project between two or more years;
- personnel may divide their time between R and D and other activities.

150. A number of organisations in the Business Enterprise sector (e.g. market research agencies, consultants) may be engaged in carrying out social science research or related activities for other organisations in the same sector. It is, therefore, particularly important to avoid double-counting by distinguishing between "own funds" of organisations and funds received from other organisations.

151. As far as current expenditure is concerned, the necessary adjustments will often have to be made on the basis of the distribution of man-hours between the different activities. It should be emphasized in the instructions that the percentages should be applied not only to salaries and wages but to all other items of current cost, including a share of overheads.

152. In the case of capital expenditures, shared facilities present some special problems. When a university building, equipment or instruments are used exclusively either for research or for testing, then the expenditure can be allocated accordingly, but where equipment, instruments or buildings are used for both research and teaching then the proportion of utilization should be estimated approximately according to man-hours (or machine-hours). When this is not practicable, the expenditure should be allocated according to the predominant use. Similar considerations apply in other institutions where capital equipment

Table 10

Supplementary Criteria for Separating R and D from Related Activities

The following assessment questions taken in sequence will usually be helpful in separating R and D from related activities.

1. What is new or innovative about this project?
   a) Is it seeking previously undiscovered phenomena, structures or relationships?
   b) Does it apply available knowledge or techniques in a new way?
   c) Is there a significant chance that it will result in new (extended or deeper) understanding of phenomena, relationships, or manipulative principles, of interest to more than one organisation?

2. Is this activity planned, with defined objectives, and systematic methods?
   a) What are the objectives?
   b) What methods are being used?

3. Is there an intention to report the work in an aim-method-results type format for use by others?

4. What are the reasons for carrying out this activity?
   a) What are the motives for the persons responsible for commissioning the work?
   b) What are the main purposes of the project?

5. How general are the findings or results of the activity likely to be?
   a) Are the results likely to be relevant to a large number of organisations or to society in general?
   b) If the results are specifically applicable to one organisation, will any other organisation be able to repeat similar work more quickly and/or more cheaply in the light of these results?

6. Does the project fall more naturally into one of the given classes of related activities?

In practice not all of these questions will be applicable to each case, but in answering those which are applicable an assessor will usually form a clear opinion on whether the activity under consideration should be classified as R and D.

is shared with non-R and D users. Care should be taken not to overlook capital items carried on a different budget. In some countries, for instance, all building expenditures of government agencies are carried on the budget of the Ministry of Public Works.

5.3.1.2. R and D manpower estimates

153. The number of man-hours devoted to each function within an R and D unit should, whenever possible, be converted into "full-time equivalence" when measuring R and D in terms of manpower.

Example:

An industrial research department employs 80 scientists and engineers who work full-time on R and D plus 15 others who spend a third of their time on technical services and only two-thirds on R and D. The "full-time equivalent" employment of scientists and engineers on R and D is:

$$80 + (15 \times 2/3) = 90.$$

154. Difficulties may arise in assessing "full-time equivalence" of research workers in the social sciences and humanities. This is because of the relatively high proportion of such workers who hold posts in the Higher Education sector (especially in the universities), and who divide their time between teaching, administration and research. In this connection, sample-surveys of time-budgets of staff in universities and other institutions of higher education may help to determine the proportion of time spent on research. In addition to collecting manpower data in terms "of full-time equivalence", it is desirable to obtain data on the numbers of persons mainly or substantially engaged in social science and humanities research.

5.3.2. Estimates and adjustments by the surveying agency

155. Even if the optimal questionnaire has been used and has been supplemented by efficient follow-up activities, the surveying agency may find gaps and inconsistencies in the data when compiling sectoral and national totals.

156. The reports on one and the same transaction made by the financing organisation and by the performer are likely to differ because of varying reference periods, book-keeping practices, methods of estimation and interpretations of concepts. A government agency may report funding action under legislative appropriations for a fiscal year, whereas a firm under contract may report funds actually spent over a calendar year. The financing organisation may consider the whole of a contract as "development" whereas the performer correctly reports only that portion of the work that carries an element of novelty. On the other hand, the performer may have omitted the estimated money value of support received in kind.

157. There are thus sources of errors on both sides but, as a rule, the performer is in a much better position to make the estimates and adjustments. There are other practical reasons for relying primarily on reports by performers of their intramural expenditure rather than on financers' reports of extramural expenditure. Insofar as they finance R and D out of their own funds, performers have to be surveyed anyway. Sources of funds located abroad cannot be surveyed. The performer approach keeps the risk of double-counting to a minimum because a given sum of money cannot be financially spent on R and D by more than one performer at a time. It has the additional value of yielding intramural expenditure which can be related to figures on full-time equivalents of researchers.

158. A special problem is posed when institutions in the Higher Education sector are unwilling or unable to estimate a breakdown of expenditure between teaching and R and D. In such cases rough estimates should be made (if possible) after consultation with experts in the field, on the basis of the university accounts.

159. Another difficulty is that whilst it is theoretically necessary for all respondents to give the original source of their funds, many may not be in a position to do so. A particular case of this occurs in the Higher Education sector. Universities generally draw on three types of funds to finance their research activities:

i) R and D contracts and ear-marked grants received from government and other outside sources. These should be credited to their original source.

ii) Income from endowments, shareholdings, property plus receipts from the sale of non-R and D services such as fees from individual students, subscriptions to journals, sales of serum or agricultural produce. These are clearly the universities' "own funds".

iii) The general grant they receive from the Ministry of Education or from the corresponding provincial or local authorities in support of their overall research/teaching activities. In this case there is a conflict between the principle of tracing the original source and that of using the performers' report. In the first approach one argues that, as government is the original source and has intended at least part of the funds concerned to be devoted to R and D, the R and D content of these "General University Funds" should be credited to government as a source of funds. Using the second approach one argues that as it is the universities which decide how much money should be committed to R and D out of a pool which contains both "own funds" as narrowly defined in (ii) above and General University Funds, the sums concerned should be credited to "Higher Education" as a

"source of funds". The choice of an approach depends on whether the actual mechanisms for committing money to R and D in the country concerned are more like the first or the second situation, and no clear recommendation can be given. It is however, important that the amount devoted to R and D should be declared separately even if this means making an estimate, so that it can be reclassified for the purposes of General University Funds international comparison.

160. Because of these difficulties in measuring R and D activities in the Higher Education sector and the variation in approaches used in the various Member countries, it would be useful for the purposes of international comparison if data were also collected on total manpower and total expenditure on all activities in the sector.

161. There may be other cases where for pressing internal reasons national definitions and classifications of R and D vary from those used or recommended in this Manual. For instance, the coverage of R and D in fiscal laws and in the regulations for government aid for scientific and technological activities in industry may be rather wide and include some activities which are strictly speaking innovation or prospecting. Where data based on these national definitions is used for science policy purposes inside the country, it is imperative that every effort should be made to bring the data in line with the present Manual when making international comparisons even if this means making estimates of the difference.

VI

RELATION OF R AND D DATA WITH OTHER ECONOMIC VARIABLES AND INTERNATIONAL COMPARISON OF R AND D EXPENDITURE

6.1. COMPARING R AND D DATA WITH OTHER ECONOMIC VARIABLES

162. Insofar as R and D plays a major role in the scientific and technological advance of a country it also affects the economic growth potential. The science-policy maker needs, therefore, R and D data which can be compared with other types of statistics in order to examine the relationship with other economic variables. It is for this reason that the standards laid down in this Manual have, as far as possible, been based on accepted international classifications and especially on the System of National Accounts.

163. Wherever appropriate in this Manual, differences between OECD and SNA definitions have been noted. However, the following are the most important and are worth repeating:

a) The creation in the Manual of a separate Higher Education sector, whereas in the SNA institutions of higher education may be included in the other sectors;

b) The exclusion of depreciation from current expenditure whereas the SNA states that it is included;

c) The inclusion of acquisition of "land" as capital expenditure whereas it is considered as a tangible non-reproducible asset in the SNA.

164. Comparisons with figures on industrial production should be made on the basis of the International Standard Industrial Classification. In comparing R and D expenditure with international trade data, it should be remembered that the latter are based on a classification by product or product group.

165. Certain ratios such as:

- R and D expenditure/Gross Domestic Product or
- R and D expenditure/value added

should be used with circumspection. When making inter-industry group comparisons the influence of such factors as indirect taxation

and depreciation on these two economic variables should not be forgotten. Indeed, indirect taxes, which differ greatly from industry to industry, tend to increase the value added in each industry. The wage rates in effect in the different branches of economic activity (agriculture, mining, manufacturing) have a similar effect. On the other hand, the subsidies granted to certain branches for economic or social reasons enable producers and manufacturers to lower their sales price and as a consequence, reduce the value added. To cancel out the influence of indirect taxation and subsidies, value at factor cost rather than at market price is generally used. Lastly, depreciation, calculated at different rates in different industries, contributes to the distortion of comparisons.

6.2. THE RESEARCH EXCHANGE RATE AND DEFLATORS

166. In order to make meaningful comparisons over time and between countries of R and D expenditure it is necessary to derive constant price series of R and D expenditure and to express such sums in a common currency (such as the United States dollar).

167. In general, official statistics suitable for these purposes are not pertinent to R and D activities. Thus the official exchange rate is based on external trade and money markets and does not necessarily reflect the domestic price level of countries nor the real cost of R and D activity, this dichotomy being most significant when comparing North America with European countries and Europe with Japan. Similarly, an index of manufacturers' wholesale prices is unlikely to reflect the particular commodities used in the R and D process.

Information required

168. In order to calculate useful "research exchange rates" and "research deflators" it is necessary to have information on the specification, prices and quantity of items entering into:

a) labour costs;
b) other current expenditure;
c) capital expenditure.

Since this kind of information is almost unavailable it is extremely hard to calculate these indices; this is discussed further in Annex IV.

Conclusion

169. If progress is to be made on these fronts, a real effort will be needed in the following areas:

a) refinement in the collection of the national R and D data;

b) collection of general price data, for instance on wage levels, fuel and power, etc.;

c) special surveys of prices and at least a sample of quantities of materials and equipment in the various fields of R and D in Member countries.

ANNEXES

Annex I

SOME PROBLEMS OF MEASUREMENT OF R AND D IN THE SOCIAL SCIENCES AND THE HUMANITIES

1. The social sciences and humanities are included in this Manual for the first time; this annex indicates some of the problems involved in the measurement and classification of R and D in these activities. Since it is unlikely, certainly in the early years, that as good a quality of information will be obtained for the social sciences and humanities as for the natural sciences, respondents are asked to identify information on the social sciences and humanities separately and to specify the sectors to which the information refers.

Distinguishing between the social sciences and the humanities

2. Research in the social sciences and humanities may be thought of as including those activities concerned with the social, economic and institutional aspects of society, with man's place in society and with the forms of his knowledge and communication. As a guide to the distinction between the social sciences and the humanities, the former are concerned with "law-seeking" disciplines (sociology, economics) while the latter include the analytical criticism of creative, literary and artistic activities (although excluding the activities themselves). The distinction between the two will often be difficult to make, as many social science disciplines have strong humanist traditions, while the humanities are increasingly using the social science approach.

Borderline between the natural sciences and the social sciences and humanities

3. There may also be some problems in drawing a boundary line between R and D in the natural sciences and in the social sciences and humanities. Geography, psychology and anthropology are examples of three fields of science where such problems may occur. Their resolution is left to national authorities. In some countries it may be possible for the surveying authorities to lay down comprehensive guidelines; elsewhere it may be better to leave the problem of allocation to the respondent.

Identifying research and non-research activities

4. "General purpose" data collection is particularly important to social science research, since without it many aspects of this research

could not be performed. However, unless it is collected primarily for research purposes it should not be classified as a research activity. Insofar as data collection involves identifiable aspects whose objective is to facilitate research, a commensurable proportion of the costs of such data collection should be counted as research expenditure and should be included.

5. Policy-related and operational studies are an important category of related activities in the social sciences - e.g. interpretative commentary on the likely effects of a change in the tax structure, based on existing economic data. However, this work will rarely satisfy the research criterion and should normally be excluded. In some instances it will nevertheless be difficult to differentiate between related activities of this kind and R and D proper; the criterion here should be whether the work relies solely on existing facts and methodologies to help in the solution of a particular problem, or whether it is creative work undertaken on a systematic basis to increase the stock of knowledge. This problem will be particularly important in the business enterprise sector, where the majority of such activities as market research and operational research will be no more than the routine application of existing techniques to a variety of practical problems. Nonetheless, the departmental title could lead to the whole cost of the department being included by respondents as research; it is therefore suggested that survey forms emphasize this problem and give guidance on the proper treatment of such activities.

Identifying survey respondents

6. The relative importance of the various economic sectors will be quite different in the social sciences and humanities than in the natural sciences. Notably, central and local government, and the private non-profit sector will be more important, while within the business enterprise sector emphasis will switch to non-manufacturing bodies such as the distributive trades and financial institutions.

7. Furthermore, while the scientific R and D within an enterprise can often be clearly recognized in terms of its structure, social science research may be widely diffused. It is unlikely that any one individual will either be responsible for or aware of all the social science research carried out. Survey respondents should therefore be encouraged to consider the whole range of an enterprise's activities before replying, possibly by the inclusion of an "aide-memoire".

Measurement of expenditure and manpower

8. One aspect of the problems of identifying the cost of research in the social sciences and humanities deserves special attention. Compared with scientific R and D, a much higher proportion of research expenditure consists of the salaries of research workers

(perhaps up to 80%); also in most countries a higher proportion of social science and humanities research will be performed within the universities. These two factors taken together mean that it is particularly important to get accurate estimates of the proportion of the time of university staff spent on research.

9. In measuring the manpower employed on social science and humanities research there may be some difficulty in assessing the full-time equivalence of research workers due to the increased importance of university staff. In this connection, sample surveys of time-budgets of staff in institutions of higher education may help to determine the proportion of time spent on research.

The distinction between basic research, applied research and experimental development

10. The assignment of research in the social sciences and humanities to the categories of basic and applied research may sometimes involve a judgment about the purposes of the research. The funder is more likely to allocate the activity to a practical goal, while the performer will often view it as fundamental or basic research in order to gain "peer recognition". In these situations, the view of the funder should prevail. Furthermore, some research projects may genuinely straddle both categories - for instance, study of the variables affecting the educational attainments of children drawn from different social and ethnic groups may be seen as both basic and applied research. It is unlikely that a split of social science and humanities research into these two categories can be achieved in any consistent sense across different institutions and countries; hence the results of such a distinction should be treated with caution.

11. For most of the social sciences and humanities the concept of experimental development is very difficult to imagine. Although certain aspects of the social sciences and humanities do involve this concept, for the most part it has little or no meaning. This is particularly true of the humanities. The reason for this lies in the "output" of these disciplines which is an increased understanding of social phenomena and their relationships. Although this understanding may well have implications on government, managerial, organisational and operational policies, the linkage between the two is often complex and indirect and it would be misleading to identify such policies as the outcome of the research programme. However, despite this difficulty attempts should be continued to identify the experimental development portion of social science and humanities research where applicable, although it will be necessary to exercise extreme caution in interpreting the results of such a classification.

Annex II

ADDITIONAL MATERIAL ON CLASSIFICATION BY SOCIO-ECONOMIC OBJECTIVES

This annex includes three tables:

II. 1. The broad correspondence between the OECD R and D objectives classification and the revised version of the EEC Nomenclature for the analysis and comparison of science programmes and budgets (NASB).

II. 2. Broad correspondence between the classifications of R and D by socio-economic objectives developed by NORDFORSK and OECD.

II. 3. Classification used by Working Party 2 of the OECD Economic Policy Committee for its Pilot Study on Public Expenditures and their Classification.

Table II.1. THE BROAD CORRESPONDENCE BETWEEN THE OECD R AND D OBJECTIVES CLASSIFICATION AND THE REVISED VERSION OF THE EEC NOMENCLATURE FOR THE ANALYSIS AND COMPARISON OF SCIENCE PROGRAMMES AND BUDGETS (NASB)

OECD	NASB 1975
1. Agriculture, Forestry and Fishing	5. Promotion of Agricultural Productivity and Technology
2. Promotion of Industrial Development	6. Promotion of Industrial Productivity and Technology
3. Production and Rational Use of Energy	4. Production, Distribution and Rational Use of Energy
4. Transport and Telecommunications	2.4 Transport Systems 2.5 Telecommunications Systems
5. Urban and rural planning	2. Planning of the Human Environment excluding 2.4 (Transport and 2.5 Telecommunications)
6. Protection of the Environment	3.3 Research on Pollution
7. Health (except pollution)	3. Protection and improvement of human health excluding 3.3 (Research on pollution)
8. Social Development and Services	7. Social Studies
9. Exploration and Exploitation of the Earth and Atmosphere	1. Exploration and Utilization of the Earth and its Atmosphere
10. General Advancement of Knowledge	10. General Promotion of Knowledge
11. Civil Space	8. Space
12. Defence	9. Defence

Table II.2. BROAD CORRESPONDENCE BETWEEN THE CLASSIFICATION OF R AND D BY SOCIO-ECONOMIC OBJECTIVES DEVELOPED BY NORDFORSK AND OECD

NORDFORSK[1]	OECD	COMMENTS
1. Agriculture, forestry, hunting and fishing	1. Development of agriculture, forestry and fishing	Hunting is mentioned explicitly in the NF-classification[2]
2. Mining, manufacturing and crafts, construction	2. Promotion of industrial development	In the NF-classification construction includes building of roads, harbours, etc.
3. Other lines of business		
4. Production and distribution of energy	3. Production and rational use of energy	In the NF-classification R and D on water supply is included
5. Transport and telecommunications	4. Transport and telecommunications	
6. Living conditions and physical planning	5. Urban and rural planning	
7. Abatement of pollution and protection of the environment	6. Protection of the environment	
8. Prevention and combating of disease	7. Health (except pollution)	
9. Social conditions	8. Social development and services	
10. Culture, massmedia, leisure, education		
11. Working conditions		
12. Economic planning and public administration, etc.		
13. Exploration and exploitation of the earth and atmosphere	9. Exploration and exploitation of the earth and atmosphere	
14. General advancement of knowledge	10. General advancement of knowledge	
15. Space	11. Civil space	This chapter is in the NF-classification subdivided in positions so that the R and D relative to other objectives are classified according to its main purpose (space) and according to its secondary purpose (e.g. telecommunication 15.5)
16. Defence	12. Defence	The NF-classification like the OECD classification includes space R and D undertaken for military purposes

1. This classification is, at the time of writing (September 1975), in draft form.
2. NORDFORSK Classification.

Table II.3. CLASSIFICATION USED BY WORKING PARTY 2 OF THE OECD ECONOMIC POLICY COMMITTEE FOR ITS PILOT STUDY ON PUBLIC EXPENDITURES AND THEIR CLASSIFICATION

PURPOSE

1. General public services
   - 1.1. General and financial administration n.e.c.
   - 1.2. External affairs
     - 1.2.a. International development aid
     - 1.2.b. Other external affairs
   - 1.3. Law and order and safety
     - 1.3.a. Administration and regulation n.e.c. and research
     - 1.3.b. Police duties
     - 1.3.c. Legal affairs, prisons, etc.
     - 1.3.d. Fire protection
   - 1.4. General research n.e.c.
     - 1.4.a. Space research n.e.c.
     - 1.4.b. Other general research n.e.c.

2. Defence
   - 2.a. Military defence
   - 2.b. Civil defence
   - 2.c. Research on defence

3. Education
   - 3.1. General administration and regulation n.e.c. and research on education
   - 3.2. Schools, universities and other educational facilities
     - 3.2.a. Pre-primary and primary/secondary education
       - 3.2.a.I. Education proper and subsidiary services n.e.c.
       - 3.2.a.II. Support of students
     - 3.2.b. Universities and colleges
       - 3.2.b.I. Education proper and subsidiary services n.e.c.
       - 3.2.b.II. Support of students
     - 3.2.c. Other forms of education
       - 3.2.c.I. Education proper and subsidiary services n.e.c.
       - 3.2.c.II. Support of students →

Table II.3. (Cont'd)

PURPOSE
3.3. Subsidiary services
3.3.a. Pre-primary and primary/secondary education
3.3.b. Universities and colleges
3.3.c. Other forms of education
4. Health
4.1. General administration and regulation n.e.c. and research
4.1.a. Administration and regulation n.e.c.
4.1.b. Health and research
4.2. Hospitals and clinics
4.3. Individual health services
4.3.a. Individual doctors, dentists, etc., and drugs and appliances prescribed by them
4.3.b. Other
5. Social Security and Welfare
5.1. Social Security and Assistance
5.1.a. General administration and regulation n.e.c. and research
5.1.b. Compensation for temporary loss of income due to sickness
5.1.c. Old age and survivors benefits; payments upon decease
5.1.c.I. Schemes for government employees
5.1.c.II. Other schemes
5.1.d. Compensation for loss of income due to temporary disablement
5.1.e. Benefits to permanently disabled
5.1.f. Unemployment benefits
5.1.g. Family and child allowance
5.1.h. Maternity allowances
5.1.i. Other public assistance to persons
5.2. Welfare Service
5.2.a. General administration and regulation n.e.c. and research
5.2.b. Care of the disabled and mentally defective
5.2.c. Care of the aged
5.2.d. Child care
5.2.e. Other welfare services

→

Table II.3. (Cont'd)

PURPOSE

6. Housing and community amenities

- 6.1. Housing
  - 6.1.a. Income related schemes
  - 6.1.b. Other
- 6.2. Community development
- 6.3. Sanitary services
  - 6.3.a. General administration and regulation n.e.c. and research
  - 6.3.b. Collection of garbage and refuse and street cleaning
  - 6.3.c. Sewerage disposal
  - 6.3.d. Measurement and prevention of air pollution
  - 6.3.e. Other sanitary services

7. Other Community and Social Services

- 7.1. Recreational and related cultural services
  - 7.1.a. Parks, playgrounds and similar facilities
  - 7.1.b. Libraries, museums, theatres and like institutions
  - 7.1.c. Broadcasting and press
- 7.2. Religion and services n.e.c.

8. Economic Services

- 8.1. General administration and regulation n.e.c. and research
  - 8.1.a. General administration and regulation n.e.c.
  - 8.1.b. Research on economic services n.e.c.
  - 8.1.c. Specialized activities serving several industries
  - 8.1.d. Labour and employment programmes
  - 8.1.e. General support to industry
- 8.2. Agriculture, forestry, fishing and hunting
  - 8.2.a. General administration and regulation n.e.c.
  - 8.2.b. Research on agriculture, forestry, fishing and hunting
  - 8.2.c. Agriculture
  - 8.2.d. Forestry
  - 8.2.e. Fishing and hunting
- 8.3. Mining, manufacturing, construction
  - 8.3.a. Research
  - 8.3.b. Mining
  - 8.3.c. Manufacturing
  - 8.3.d. Construction →

Table II.3. (Cont'd)

PURPOSE

8.4. Electricity, gas, steam and water
- 8.4.a. Electricity
  - 8.4.a.I. Research
    - 8.4.a.I.A Research on atomic energy
    - 8.4.a.I.B Research on other sources of electrical energy
  - 8.4.a.II. Other
- 8.4.b. Gas
  - 8.4.b.I. Research
  - 8.4.b.II. Other
- 8.4.c. Steam and heat
  - 8.4.c.I. Research
  - 8.4.c.II. Other
- 8.4.d. Water supply
  - 8.4.d.I. Research
  - 8.4.d.II. Other water supply
    - 8.4.d.II.A Control of water pollution
    - 8.4.d.II.B Other

8.5. Roads
- 8.5.a. Interurban roads
- 8.5.b. Intra-urban roads

8.6. Inland and coastal waterways

8.7. Other transportation and communication
- 8.7.a. Research on transportation
- 8.7.b. Road transport
- 8.7.c. Water transport
  - 8.7.c.I. Inland transport
  - 8.7.c.II. Sea transport
- 8.7.d. Air transport
  - 8.7.d.I. Infrastructure
  - 8.7.d.II. Transportation
- 8.7.e. Railways
- 8.7.f. Mixed urban transportation systems
- 8.7.g. Other transportation n.e.c.
- 8.7.h. Communication
  - 8.7.h.I. Research on communication
  - 8.7.h.II Other

8.8. Other economic services n.e.c.
- 8.8.a. Tourism, commerce, etc.
- 8.8.b. Retailing and consumer interest
  - 8.8.b.I. Exit programmes
  - 8.8.b.II. Other →

Table II.3. (Cont'd)

PURPOSE
8.8.c. Multipurpose projects, land conservation and similar
8.8.c.I. Multipurpose flood control, irrigation, etc.
8.8.c.II. Land conservation and reclamation
8.8.d. Other economic services n.e.c.
9. Other Purposes
9.1. Public debt transactions
9.2. Transfers of a general character to other government organs*
9.3. Outlays in connection with disasters and other calamities
9.4. Other purposes n.e.c.

* Not applicable for General Government.

Annex III

METHOD TO DISTINGUISH R AND D ACTIVITIES FROM NON-R AND D ACTIVITIES IN THE HIGHER EDUCATION SECTOR (SECOND AND THIRD LEVELS OF EDUCATION)

Recommendations included in the Nordic Manual on Statistics of Resources devoted to Higher Education (Resursstatistik för Universitet och Högskolor)

The borderline between research and teaching is particularly hard to establish in the case of education at ISCED level 7 (training of researchers). This problem concerns both the activities of teachers and those of students at level 7. Such students are often attached to or directly employed by the establishment concerned and have contracts, or are bound by a similar engagement, which oblige them to do some teaching at lower levels but which permit them to continue their studies and to do research.

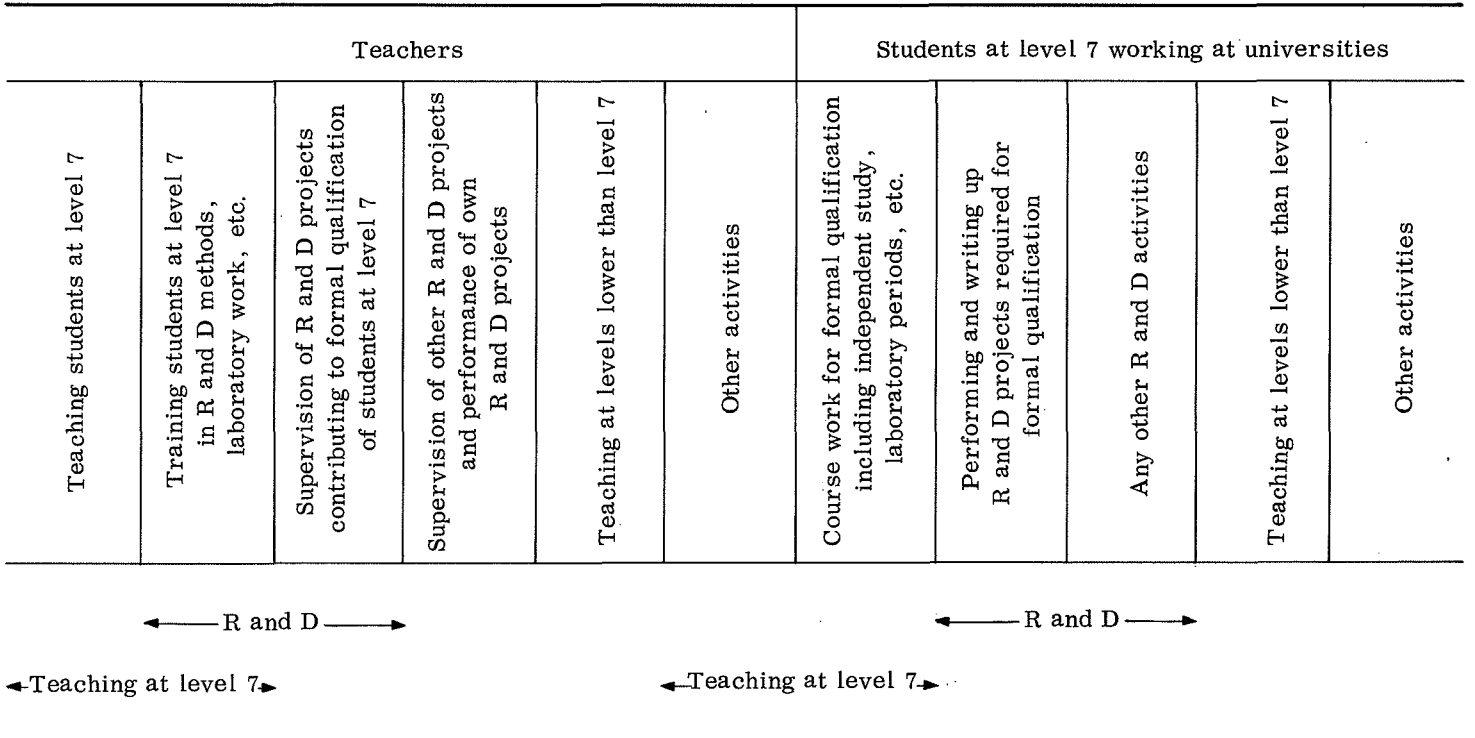
In several Member countries, parts of the curricula for level 7 studies are highly structured, involving, for instance, study schemes, set courses, compulsory laboratory work, etc. Here, the teacher is disseminating education and training in research methods. Typical activities for students under this heading are attending compulsory courses, studying the literature on the subject concerned, learning research methodology, etc. These activities do not fulfil the criterion of novelty specified in the definition of R and D.

In addition, in order to obtain a final qualification at level 7, the student is generally also expected to prove his competence by undertaking a relatively independent study or project and by presenting its results. As a general rule, these studies contain the elements of novelty required for R and D projects. The relevant activities of students should therefore be attributed to R and D. It follows that, as such projects are classified as R and D, any supervision by the teacher should also be considered as R and D.

In addition to R and D performed within the framework of courses of education at level 7, it is obviously possible for both teachers and students to be engaged in other R and D projects.

The borderlines between research and education at level 7 are illustrated in the following diagram (next page).

BORDERLINES BETWEEN R AND D AND EDUCATION/TRAINING AT LEVEL 7



Source: Resursstatistik för Universitet och Högskolor.

The practical problems of drawing the borderline between research and education at level 7 will sometimes appear insurmountable. This is, in particular, true for those parts of such courses which are not at all structured or only to a limited extent. In such cases, it might be suggested that all such education at level 7 should be included in R and D.

Annex IV

MEASUREMENT OF THE OUTPUT OF R AND D AND THE BALANCE OF TECHNOLOGICAL PAYMENTS

1 The measurement of the output of R and D is not treated in this Manual. There is, in fact, no accepted system of measuring the results of research either at national or at international level, nor does it, at the present time, seem possible to frame such a system The most that can be hoped for is that in 10-20 years' time some form of statistics on output will be available. There is, however, one measure which, though quite separate from R and D data, may give some indication of the technological situation of a country at international level, that is the balance of technological payments.

2. Payments for patents, licences and technical know-how are a separate category which should be clearly distinguished from all R and D extra-mural and intra-mural expenditure Although they are a separate category and often neglected, they are extremely important. It is evident that no single country can lead simultaneously in all spheres of R and D. Nor can any business enterprise be permanently ahead of all its competitors Each country (or enterprise) will wish to "import" some of the results of R and D already performed elsewhere. This applies with particular force to small countries (or enterprises), where size is itself a limiting factor, and also to underdeveloped countries and technologically backward industries, but it is also true of the largest countries such as the United States and USSR.

3. Consequently, it is desirable to obtain some measure, however imperfect, of the transfers of research results and technical know-how from one country to another. Some rough indication of the magnitude of the "Balance of Technological Payments" for any individual country can be obtained by collecting information on patent, licence and "know-how" expenditure. These statistics have two advantages. Firstly, they are "weighted" by the valuation placed by the world market on a particular patent or licence, even though the market is very imperfect. Only inventions of some economic significance will be the subject of licensing arrangements. Secondly, they include expenditure on inventions and developments which are not patented for a variety of reasons. This expenditure takes the form of payments for "technical know-how" and there is very little doubt that it is increasing rapidly.

4. For all these reasons a measure of this flow of funds at international level is desirable. There are, however, serious defects in those statistics relating to the transfers between associated companies. In some cases these are paid for in the normal way as market transactions but in other cases there are probably delayed, fictitious payments or even inflated payments.

5. In some cases statistics on payments and receipts for patents, licences and know-how to and from abroad are obtained quite independently of R and D surveys, for example, as a type of invisible transaction from balance of payments statistics or by patent offices. If these statistics are sufficiently comprehensive, it may not be necessary to include these questions within the framework of an R and D survey. But in most cases it will be necessary, as it is desirable to obtain the figures with the same sector and industrial breakdown as R and D statistics.

Annex V

EFFORTS IN THE CALCULATION OF RESEARCH EXCHANGE RATES AND DEFLATORS

A. Exchange Rates

1. Pioneering efforts in calculating R and D exchange rates were made by Professor C. Freeman in the early 1960s. The statistical method used by Professor Freeman was essentially similar to those involved in international comparisons of national products which were developed at the OEEC in the 1950s. The costs of the items in a typical basket of goods of country A was calculated at the prices of country B and their sum compared with the original cost in country A. Similarly, the typical basket of goods in country B was compared at its price in A and its price at home. The two resulting ratios were averaged and the ratio applied to the official exchange rate to give "purchasing power equivalent" for the field in question.

2. This method has two linked disadvantages. The first is that it yields two results and, therefore, it might be useful to see some method of averaging. It is a matter of discussion whether the arithmetic mean, the geometric or a combination of the two should be used. Secondly, the method is not transitive. Countries can only properly be compared in pairs. If we calculate a "purchasing power equivalent" between country A and country B and country B and country C, we cannot, properly speaking, use these results to draw any comparison between country A and country C. In practice, then, we cannot use the calculations directly to find a ratio between countries A and C but must repeat the operation in each instance.

3. Since these pioneering efforts a new approach has been used by Macdonald. The main change is that he adopts the idea of an average basket of goods (based on the arithmetic average of quantities consumed by the countries concerned of the various items included in the R and D basket). He calculates sub-exchange rates for three types of expenditure (labour costs, other current costs and capital expenditures) and then takes a weighted average of these to find overall R and D exchange rates. The disadvantage of this approach is that it requires rather precise details about the actual "quantities" of inputs in the individual countries in order to calculate the "average basket of R and D goods". In the case of labour costs, actual R and D manpower data are available. However, Macdonald is obliged to use some approximations or substitute data for the other types of cost when weighting to find the overall exchange rates.

4. A further method has been devised for the OECD drawing on these previous studies and using data presently available. This method can be summarized as follows: sixteen sub-classes of GERD are chosen as follows:

SECTOR	LABOUR COST	OTHER CURRENT COSTS	MACHINERY AND EQUIPMENT	LAND AND BUILDINGS
Business Enterprise	1	2	3	4
General Government	5	6	7	8
PNP	9	10	11	12
Higher Education .	13	14	15	16

For each of these 16 sub-classes, a "standard all-OECD basket of goods" is established (in terms of quantities - e. g. number of scientists and engineers or tons of machinery). This basket may be exhaustive (as in the case of manpower) or be based on a sample only (e. g. other current expenditure). The unit prices of all the items included in the 16 baskets in all the countries are also collected and a series of sub-exchange rates are calculated between countries for each of the 16 sub-classes.

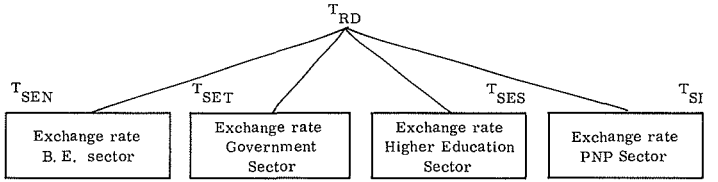
5. In principle these 16 sub-exchange rates should be aggregated on the basis of standard "all-OECD" consumption in the various classes (measured in quantity). As this cannot be done, the results are weighted using the avarage "all-OECD" pattern of R and D expenditure as collected in the ISY's (this average is measured as the percentage distribution by sector and cost type in each country. Each individual country has the same weight in the "all-OECD" result.)

6. The example on pages 101-106 illustrates this latter method. In this example, some estimates have had to be made because of the paucity of the data. These estimates were designed so that any possible errors would always be in the same direction. The resulting exchange rates are, therefore, half-way between official and real R and D rates. More extensive surveys are the only means of further improving R and D exchange rates. In calculating these exchange rates, each sector has been taken separately and its exchange rate determined on a sub-rate basis. This structure is shown in the accompanying diagrams. In this example each country corresponds to one level of the graph tree; the example illustrates how the upper level rate is calculated once the lower level sub-rates are known. The means of applying the index chosen are shown on pages 103-104 and various methods of approximating the data on page 105.

CALCULATION OF R AND D EXCHANGE RATE (CALLED T_{RD}) BETWEEN FRANCE AND GERMANY IN 1969

An experimental study based on 3 countries: France, Germany and Japan

This T_{RD} exchange rate will be calculated using 4 subrates corresponding to 4 sectors of expenditure:



T_{RD} stands for: R and D exchange rate between France and Germany in 1969

T_{SEN} stands for: R and D exchange rate of the Business Enterprise Sector between France and Germany in 1969

T_{SET} stands for: R and D exchange rate of the Government Sector between France and Germany in 1969

T_{SES} stands for: R and D exchange rate of the Higher Education Sector between France and Germany in 1969

T_{SI} stands for: R and D exchange rate of the Private Non-Profit Sector between France and Germany in 1969

T_{RD} is calculated from T_{SEN}, T_{SET}, T_{SES} and T_{SI} as well as from the table below which shows an average shape of expenditure in the four sectors in the three countries:

As a percentage

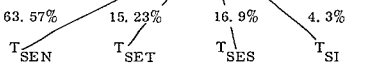
	B.E. SECTOR	GOVERNMENT SECTOR	HIGHER EDUCATION SECTOR	PNP SECTOR	TOTAL
France	$f_1\%$	$f_2\%$	$f_3\%$	$f_4\%$	100
Germany	$a_1\%$	$a_2\%$	$a_3\%$	$a_4\%$	100
Japan	$j_1\%$	$j_2\%$	$j_3\%$	$j_4\%$	100
Average	$\frac{f_1+a_1+j_1}{3} = a\%$	$\frac{f_2+a_2+j_2}{3} = b\%$	$\frac{f_3+a_3+j_3}{3} = c\%$	$\frac{f_4+a_4+j_4}{3} = d\%$	100

This gives $T_{RD} = a\% \times T_{SEN} + b\% \times T_{SET} + c\% \ T_{SES} + d\% \ T_{SI}$.

We must now determine T_{SEN}, T_{SET}, T_{SES} and T_{SI}.

CALCULATIONS

$$T_{RD} = 0.6357 \ T_{SEN} + 0.1523 \ T_{SET} + 0.169 \ T_{SES} + 0.043 \ T_{SI}$$



ISY 1969 Data Published in 1972

As a percentage

	B.E. SECTOR	GOVERNMENT SECTOR	HIGHER EDUCATION SECTOR	PNP SECTOR	TOTAL
France	55. 53	29. 24	14. 23	1. 00	100
Germany	68. 19	4. 47	17. 47	9. 87	100
Japan	67. 00	12. 00	19. 00	2. 00	100
Average	63. 57	15. 23	16. 90	4. 30	100

The R and D exchange rate between France and Germany is then obtained as follows:

$$T_{RD} = 63.57\% \times T_{SEN} + 15.23\% \times T_{SET} + 16.9\% \ T_{SES} + 4.3\% \ T_{SI}$$

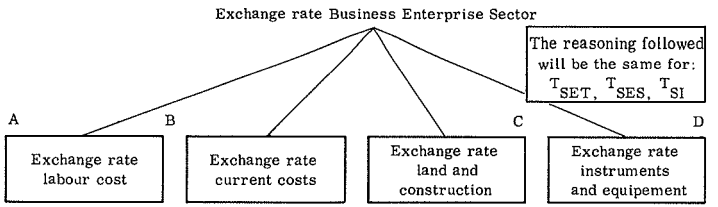
therefore

$$T_{RD} = 0.6357 \ T_{SEN} + 0.1523 \ T_{SET} + 0.169 \ T_{SES} + 0.043 \ T_{SI}$$

All data used at this stage of calculation are real

We must now proceed to determine T_{SEN}, T_{SET}, T_{SES} and T_{SI}.

DETERMINATION OF T_{SEN}



T_{SEN} stands for R and D exchange rate of Business Enterprise Sector between France and Germany

A stands for R and D exchange rate of labour cost between France and Germany

B stands for R and D exchange rate of current costs between France and Germany

C stands for R and D exchange rate of land and construction between France and Germany

D stands for R and D exchange rate of building and equipment between France and Germany

T_{SEN} is calculated from A, B, C and D as well as from the table below which shows an average shape of expenditure in the three countries studied in our experimental example:

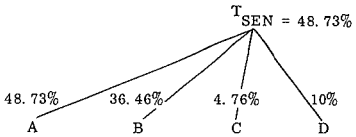
As a percentage

BUSINESS ENTERPRISE SECTOR	MANPOWER	CURRENT COSTS	LAND AND CONSTRUCTION	INSTRUMENTS AND EQUIPMENT	TOTAL
France	$F_1 1\%$	$F_2 2\%$	$F_3 3\%$	$F_4 4\%$	100 budget Ent. F.
Germany	$G_1 1\%$	$G_2 2\%$	$G_3 3\%$	$G_4 4\%$	100 budget Ent. G.
Japan	$J_1 1\%$	$J_2 2\%$	$J_3 3\%$	$J_4 4\%$	100 budget Ent. J.
Average	$\frac{F_1+G_1+J_1}{3} = a\%$	$\frac{F_2+G_2+J_2}{3} = b\%$	$\frac{F_3+G_3+J_3}{3} = c\%$	$\frac{F_4+G_4+J_4}{3} = d\%$	100%

Thus the R and D exchange rate of the Business Enterprise Sector for France and Germany is:

$$T_{SEN} = a\% \times A + b\% \times B + c\% \times C + d\% \times D$$

CALCULATIONS



OECD 1969 R and D Statistics published in 1972

As a percentage

BUSINESS ENTERPRISE SECTOR	MANPOWER	CURRENT COSTS	LAND AND CONSTRUCTION	INSTRUMENTS AND EQUIPMENT	TOTAL
France	55.2	34.7	4.6	5.5	100
Germany	50.5	35.7	5.0	8.8	100
Japan	40.5	39.0	4.7	15.7	100
Average	48.73	36.46	4.76	10.0	100

Thus, the rate of exchange is obtained in the following manner:

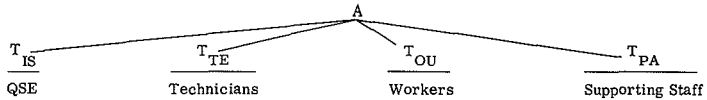
$$T_{SEN} = \underline{48.73\% \times A + 36.46\% \times B + 4.76\% \times C + 10\% \times D}$$

We can thus determine A, B, C and D.

All data used at this stage of calculation are known.

CALCULATION OF A = EXCHANGE RATE OF "LABOUR COST" BETWEEN FRANCE AND GERMANY

It should be pointed out that statistics show a strong percentage of labour cost (almost 50%) in the total costs.
The accuracy of the global T_{RD} exchange rate will largely be a function of this sub-rate.
This labour cost exchange rate is a function of 4 sub-rates:



T_{IS} stands for the sub-rate of exchange in QSE in France and Germany

T_{TE} stands for the sub-rate of exchange of technicians in France and Germany

T_{OU} stands for the sub-rate of exchange of workers in France and Germany

T_{PA} stands for the sub-rate of exchange of supporting staff in France and Germany

A is calculated from T_{IS}, T_{TE}, T_{OU} and T_{PA}, as well as from the table below, which shows an average shape of quantities of each category of staff employed in the countries studied:

As a percentage

	QSE	TECHNICIANS	WORKERS	SUPPORTING STAFF	TOTAL
France	$c_1\%$	$c_2\%$	$c_3\%$	$c_4\%$	100
Germany	$d_1\%$	$d_2\%$	$d_3\%$	$d_4\%$	100
Japan	$e_1\%$	$e_2\%$	$e_3\%$	$e_4\%$	100
Average	$\frac{c_1+d_1+e_1}{3} = a'\%$	$\frac{c_2+d_2+e_2}{3} = b'\%$	$\frac{c_3+d_3+e_3}{3} = c'\%$	$\frac{c_4+d_4+e_4}{3} = d'\%$	100

Now, since we deal with quantities, we must use, according to Chapter II, an average weight index system in order to determine A:

$$A = \frac{\text{QSE average consumption} \times \text{German QSE price in DM} + \text{Technician's average consumption} \times \text{German technician price in DM} + \text{Worker's average consumption} \times \text{German worker price in DM} + \text{Supporting Staff average consumption} \times \text{etc.}}{\text{QSE average consumption} \times \text{French QSE price in FF} + \text{Technician's average consumption} \times \text{French technician price in FF} + \text{Worker's average consumption} \times \text{French worker price in FF} + \text{Supporting Staff average consumption} \times \text{etc.}}$$

$$= \frac{a' P^{IS}_{Ger} + b' P^{TE}_{Ger} + c' P^{OU}_{Ger} + d' P^{PA}_{Ger}}{a' P^{IS}_{Fr} + b' P^{TE}_{Fr} + c' P^{OU}_{Fr} + d' P^{PA}_{Fr}} = \frac{0.3031\, P^{IS}_{Ger} + 0.3276\, P^{TE}_{Ger} + 0.2658\, P^{OU}_{Ger} + 0.1040\, P^{PA}_{Ger}}{0.3031\, P^{IS}_{Fr} + 0.3276\, P^{TE}_{Fr} + 0.2658\, P^{OU}_{Fr} + 0.1040\, P^{PA}_{Fr}}$$

CALCULATION

$$A = \frac{\sum_i q^i_a\, p^i \quad \text{Germany}}{\sum_i q^i_a\, p^i \quad \text{France}}$$

i = QSE, technicians, workers, other supporting staff

As a percentage

	QSE	TECHNICIANS	WORKERS	SUPPORTING STAFF	TOTAL
France	27.27	42.27	21.70	8.76	100%
Germany	28.52	29.72	33.31	8.45	100%
Japan	35.16	26.31	24.74	10.95	100%
Average	30.31	32.76	26.58	10.40	100%

DETERMINATION OF THE ELEMENTS NEEDED FOR THE CALCULATION OF A

We know the average quantity of QSE:

France = c_1% of QSE

Germany = d_1% of QSE

Japan = e_1% of QSE

Average quantity of QSE used in the calculations = $\frac{c_1 + d_1 + e_1}{3}$

The same reasoning is applied for technicians, workers and other supporting staff.

Determination of the average cost per year of a French QSE:

$$= \frac{\text{total cost of QSE's}}{\text{number of French QSE's}}$$

The same reasoning is applied for technicians, workers and other supporting staff.

The same reasoning is applied for Germany and Japan.

We can now calculate A:

$$A = \frac{\sum_i q_a^i \, p^i \quad \text{Germany}}{\sum_i q_a^i \, p^i \quad \text{France}}$$

There is an evident need of determining accurately the average salary of a QSE, technician, worker, etc.

DETERMINATION OF AVERAGE QUANTITIES

We have already seen that the average a = 30.31% QSE

b = 32.76% technicians

c = 26.58% workers

d = 10.40% supporting staff

Calculation of average yearly cost of QSE:

Since no data concerning the global cost for each category of staff are available (we only know the global cost for all staff put together) we have calculated average salaries by using scale factors:

For France : Cost of one QSE = 3 times the cost of one worker = 3 times the cost of one supporting staff

Cost of one technician = 2 times the cost of one worker

For Germany: Cost of one QSE = 2.8 times the cost of one worker = 2.8 times the cost of one supporting staff

Cost of one technician = 1.8 times the cost of one worker

For Japan : Cost of one QSE = 2 times the cost of one worker = 2 times the cost of one supporting staff

Cost of one technician = 2 times the cost of one worker.

Thus, the average salary of one worker is: in France = 20,661 Francs
in Germany = 11,730 DM
in Japan = 626,053 Yen

For the remaining categories of staff we only have to multiply this by the corresponding scale co-efficient.

We can now calculate A:

$$A = \frac{0.3031 \times 2.8 \times 11730 + 0.3276 \times 1.8 \times 11730 + 0.3698 \times 11730}{0.3031 = 3 \times 20661 + 0.3276 \times 2 \times 20661 + 0.3698 \times 20661} = \frac{21207}{39964} = \underline{0.5306}$$

CALCULATION OF B = EXCHANGE RATE OF CATEGORY "OTHER CURRENT COSTS"

Exactly as for staff categories, we should split up B in sub-classes of current costs. However, we find that in practice it is not possible to establish an exhaustive list of all current costs with the average price of a unit of a particular type of current cost as well as with quantities consumed.

* It is, therefore, necessary to select, for the different countries studied, a list of significant current costs (costs, quantities and unit prices) together with the percentages of those costs as regards the total selected current costs. We then follow the same method as previsouly.
* We could also think of calculating a ratio such as:

$$\frac{\text{current costs}}{\text{number of QSE}}, \qquad \frac{\text{current costs}}{\text{number of technicians}}, \qquad \text{etc.}$$

* For this category we can apply the official exchange rates.

This is what we have done in the first approach, bearing in mind the lack of time to collect data.

CALCULATIONS

Of the three suggestions, we provisionally adopted the following:

Official exchange rate: 1 DM = 1.75 FF

Thus, $B = \frac{1}{1.75} = 0.57$

CALCULATION OF C AND D = EXCHANGE RATES FOR CAPITAL EXPENDITURES

The problem is the same as for B.

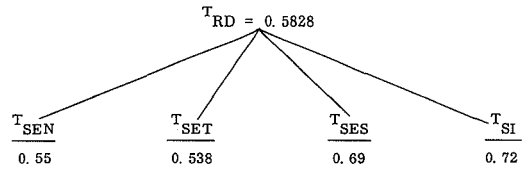
* In this case, however, if one does not wish to make a specific survey, official exchange rates are more appropriate since the capital expenditures are more closely related to the international market than to the internal price levels.
* Nevertheless, a survey can be undertaken on the domestic consumption of countries regarding certain capital expenditures; national data on production or imports can be used.
* Other ratios such as $\frac{\text{capital expenditures}}{\text{number of QSE}}$ can be used also, as before.

Of the three suggestions, we provisionally adopted the following:

Official exchange rate : B = C = D = 0.57

SUMMARY OF CALCULATIONS TO DETERMINE R AND D EXCHANGE RATES

Germany/France

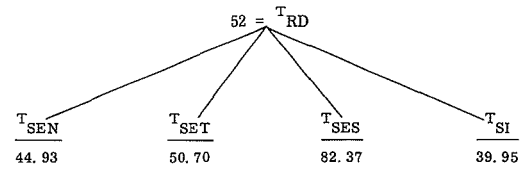


T official exchange rate = 0. 57

ratio: $\frac{T_{RD\ calculated}}{official\ T} = \frac{0.5828}{0.57} = 1.02$

Conclusion: The official exchange rate is broadly comparable to the R and D exchange rate calculated so far as France is concerned.

Japan/France



T official exchange rate = 63

ratio: $\frac{T_{RD\ calculated}}{official\ T} = \frac{52}{63} = 0.83$

Conclusion: The official exchange rate is 1 Yen = 0. 0159 FF

The calculated exchange rate: 1 Yen = 0. 0192 FF

In 1969 using the official exchange rate, Japan's R and D efforts were underestimated by at least 21% minimum, bearing in mind that we had to use some estimates when data were lacking.

We can easily find the exchange rate between Japan/Germany, etc. In fact we know that there is a transitivity between sub-rates A, B, C, D, studied earlier.

Therefore: $T_{A\ Japan/Germany} = T_{A\ Japan/France} \times T_{A\ France/Germany} = \frac{T_{A\ Japan/France}}{T_{A\ Germany/France}}$, etc. because there is reversibility.

B. Deflators

7. Little work has so far been published on the derivation of R and D deflators although the technical aspects of such work present few problems. At the time of the second revision of the Frascati Manual it was agreed that the following comments should serve as a guide to future work on this front:

1. Deflators should be produced for homogeneous sectors of the economy, whether or not these correspond with the existing sectoral approach;
2. They should be of Laspeyres form;
3. In view of the relative importance of manpower in R and D activities (almost 50% of expenditure) they should receive special attention;
4. Practical characteristics of this work should take precedence over theoretical niceties;
5. The best possible use should be made of existing sources of information.

Annex VI

RECOMMENDATIONS FOR THE LAYOUT OF THE NATIONAL R AND D PUBLICATIONS

1. It is obvious that, when preparing national R and D publications, the primary consideration will be to publish data of a type and in the layout which will be of most interest to the national reader. However, national publications are often used as a source of international comparisons and, in order to avoid misuse of data, it is recommended that publications in Member countries should contain the following in one of the official OECD languages:

a) details on the definitions and coverage of the data;

b) a summary text of main results;

c) a glossary of table headings and table text columns;

d) translations of the footnotes to the tables.

Preferably items c) and d) should be published in the tables.

Definitions and Coverage of the R and D Statistics

2. In analysis, it is indispensable to have information on:

a) coverage and accuracy of the R and D statistics;

b) deviations (if any) in definitions and concepts from the standards laid down in the Manual. When this information is available, misleading comparisons can be avoided and the risk of false conclusions diminished considerably.

3. A. For each sector, specify as far as possible the following:

A. 1. Sector definition

1. Specify deviations from the Manual and indicate their quantitative importance.
2. Indicate if deviations described in 1. are consistent with national "national accounts" practices or not.
3. Specify important borderline cases and indicate their quantitative importance.

A. 2. Sources of information

1. Survey (specify whether by mail and/or by personal interview; add copy of national questionnaire);

2. Indirect information (specify sources)
   Example: Government budget data.

Note: Where both indirect and survey information are used in a sector, indicate the proportion of the sector covered by each.

A. 3. Coverage

1. Total survey;

2. Cut-off total survey (specify cut-off point and indicate magnitude of coverage);

3. Sample survey;

4. Indirect information (indicate magnitude of coverage).

Note: Specify for each of 1. to 3. the relevant data on:

a) sample design;

b) response data and estimation method(s) including method of imputation for non-response.

B. For each group of variables, specify insofar as possible the following:

B. 1. Deviation from the definitions in the Manual

Example: classification by industrial branch.

B. 2. Data mainly taken from:

1. Accounts of respondents (expenditure);

2. Budgets of respondents (planned expenditure);

3. Other information supplied by the respondents;

4. Other external sources (specify).

B. 3. Estimates made by collecting agency

1. Imputation of missing data (specify method);

2. Adjustment of data to homogeneous time period.

C. Editing techniques

It may also be useful to indicate which of the following editing techniques have been used:

1. Cross-checks of sector classification of units with the national accounts classification.

2. Checks on internal consistency of reported data a) cross-wise, and b) length-wise.

3. Cross-checks of transfer data between financing and performing units.

4. Checks of R and D with other information (specify).

   Example: Wage rates and wage changes according to R and D statistics compared to general wage statistics. R and D capital investments compared to total investment by enterprise.

4. Summary and Glossary

The usefulness of national publications to foreign consumers of R and D statistics is - as a rule - seriously limited by language difficulties. For this reason a summary and a glossary in one of the official OECD languages would be most useful. Furthermore, a summary is often of considerable value to domestic users.

BIBLIOGRAPHY

BACKGROUND OF THE MANUAL

Brief history and origins of the present Manual

The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of Research and Development. DAS/PD/62.47(3rd revision), OECD, Paris, 1962.

C. Freeman/A. Young, The R and D Effort in Western Europe, North America and the Soviet Union: An experimental international comparison of research expenditure and manpower in 1962, OECD, Paris, 1965.

International Statistical Year for Research and Development: A study of the resources devoted to R and D in OECD Member countries in 1963-1964. Volume I, the Overall Level and Structure of R and D efforts in OECD Member countries (1967). Volume II, Statistical Tables and Notes (1968). OECD, Paris, 1967-1968.

The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of Research and Experimental Development. DAS/SPR/70.40. OECD, Paris, 1970.

EFFORTS OF OTHER INTERNATIONAL ORGANISATIONS

UNESCO

Considerations on the international standardization of science statistics (UNESCO, COM-72/CONF. 15/4, Paris, 1972). English only.

The European Economic Communities

Yearly Reports on public expenditure on R and D in the Community Countries; Analysis by objectives.

67-70 : Etudes et enquêtes statistiques 2/70
67-71 : Etudes et enquêtes statistiques 2/71
68-72 : Etudes et enquêtes statistiques 1/72
69-73 : Statistical Studies and Surveys 1/74
73-74 : Statistical Studies and Surveys 1/75

Nomenclature for the Analysis and Comparison of Science Programmes and Budgets (NASB) 1975 version. European Communities - EUROSTAT 200/75.

NORDFORSK (The Scandinavian Council for Applied Research)

NORDFORSK - Handbok för FoU-statistik. Mätning au resurser för forsknings - och utvesklingsverksamhet. Stockholm, 1974.

In Scandinavian only

BIBLIOGRAPHIE

HISTORIQUE DU MANUEL

Bref rappel historique et origines du Manuel

La mesure des activités scientifiques et techniques: Méthode type proposée pour les enquêtes sur la recherche et le développement. DAS/PD/62.47(3ème révision), OCDE, Paris, 1962.

C. Freeman/A. Young. L'effort de R-D en Europe Occidentale, Amérique du Nord et Union soviétique : Un essai de comparaison internationale des dépenses et des effectifs consacrés à la recherche en 1962, OCDE, Paris, 1965.

Année statistique internationale sur la Recherche et le Développement : Une étude sur les ressources consacrées à la R-D dans les pays Membres de l'OCDE en 1963-1964. Volume I, Ampleur et structure de l'effort global de R-D dans les pays Membres de l'OCDE (1967). Volume II, Tableaux statistiques et notes explicatives (1968). OCDE, Paris, 1967-1968.

La mesure des activités scientifiques et techniques : Méthode type proposée pour les enquêtes sur la recherche et le développement expérimental. DAS/SPR/70.40. OCDE, Paris, 1970.

EFFORTS ENTREPRIS PAR D'AUTRES ORGANISATIONS INTERNATIONALES

UNESCO

Anglais seulement.

Les Communautés Economiques Européennes

Rapports annuels sur le financement public de R-D dans les pays de la Communauté. Analyse par objectivs.

67-70 : Etudes et enquêtes statistiques 2/70
67-71 : Etudes et enquêtes statistiques 2/71
68-72 : Etudes et enquêtes statistiques 1/72
69-73 : Etudes et enquêtes statistiques 1/74
73-74 : Etudes et enquêtes statistiques 1/75

Nomenclature pour l'analyse et la comparaison des programmes et budgets de la science (NABS) version 1975. Communautés Européennes - EUROSTAT 200/75.

NORDFORSK (Le conseil scandinave pour la recherche appliquée)

En scandinave seulement

Nordic Manual for R and D Statistics: Selected chapters in English (draft translation) including Chapter 3: Definitions and delimitations of the R and D activity; Chapter 4: Classification systems and classification principles; Chapter 5: Manpower in R and D and Chapter 6: Expenditure/Financing.

Manuel scandinave sur les statistiques de R-D : Chapitres uniquement en français (traduction provisoire) Chapitre 3 : Définitions et délimitations des activités de R-D ; Chapitre 4 : Systèmes de classification et principes de classification.

CHAPTER I: RELEVANCE OF R AND D STATISTICS AND AIM AND SCOPE OF THE MANUAL

CHAPITRE I : L'UTILISATION DES STATISTIQUES DE R-D, BUTS ET CONTENU DU MANUEL

The measurement of scientific activities in the social sciences and the humanities (UNESCO, CSR-S-1, Paris, 1971).

La mesure des activités scientifiques dans les sciences sociales et humaines (UNESCO CSR-S-1, Paris, 1971).

1.1. Relevance of statistics of research and experimental development

1.1. L'utilisation des statistiques de recherche et développement expérimental

1.2. Aim of the Manual

1.2. Buts du Manuel

1.3. Scope and limitations of the Manual

1.3. Contenu et limites du Manuel

The measurement of scientific and technological activities (UNESCO, STS/15, Paris, 1969).

La mesure des activités scientifiques et techniques (UNESCO, STS/15, Paris, 1969).

Measurement of output of research and experimental development (UNESCO, STS/16, Paris, 1970).

Mesure de l'output de la recherche et du développement expérimental (UNESCO, STS/16, Paris, 1970).

Western Interstate Commission for Higher Education, "Outputs of Higher Education: Their Identification, Measurement and Evaluation", Papers from a seminar held at Washington, D. C., May 3-5, conducted by WICHE, edited by Ben Lawrence, George Weathersby and Virginia W. Patterson, Boulder, Colorado 80302, July 1970. Price $ 3.50.

Anglais seulement

CHAPTER II: BASIC DEFINITIONS AND CONVENTIONS

CHAPITRE II : DEFINITIONS ET CONVENTIONS DE BASE

The measurement of scientific and technological activities (UNESCO, STS/15, Paris, 1969).

La mesure des activités scientifiques et techniques (UNESCO, STS/15, Paris, 1969).

NORDFORSK - Handbok für FoU-statistik. Mätning au resurser för Forsknings - och utvesklingsverksamhet. Stockholm, 1974. Chapter 3.

Nordic Manual for R and D statistics - Chapter 3 "Definitions and delimitations of the R and D activity" (draft translation).

Manuel scandinave sur les statistiques de R-D - Chapitre 3 "Définitions et délimitations des activités de R-D" (traduction provisoire).

2.1. Basic concepts and categories of research and experimental development

2.1. Concepts de base et catégories de recherche et développement expérimental

Falk, Charles E., "Dynamics and Forecasts of R and D Funding", Technological Forecasting and Social Change, 1974.

Brown, Alfred E., "New Definitions for Industrial R and D", Research Management, September 1972.

Rothschild Lord, "Forty-five varieties of Research (and Development)" - Nature, Vol. 239, October 13th, 1972.

Anglais seulement

2.2. Boundaries of research and experimental development activities

2.3. Activities to be excluded from R and D

2.3.1. Other scientific and technological activities

The quantitative measurement of scientific and technological activities related to research and experimental development (UNESCO, CSR-S-2, Paris, 1975).

2.3.2. Boundaries between experimental development and production or technical services

Selected statistics on technological innovation in industry catalogue 13.555 occasional, Statistics Canada.

CHAPTER III: MAIN SECTORAL AND FUNCTIONAL CLASSIFICATIONS OF R AND D DATA

3.1. Introduction

NORDFORSK - Handbok för FoU-statistik. Mätning au resurser för forsknings - och utvesklingsverksamhet. Stockholm, 1974. Chapter 4.

Nordic Manual for R and D statistics - Chapter 4 "Classification Systems and Classification Principles" (draft translation).

3.1.1. Statistical units

NORDFORSK - op. cit., Chapter 4.2.1. - 4.2.4.

Nordic Manual - op. cit. Chapter 4.2.1. - 4.2.4. (draft translation).

3.1.2. The distinction between "institutional" and "functional" classifications

3.2. Institutional classifications

3.2.1. Classification by sector

"A System of National Accounts" (United Nations, 1968) Chapter V - The Transactors of the System.

3.2.1.1. The Business enterprise sector

"A System of National Accounts", op. cit., par. 5.7. -5.12.

3.2.1.2. The Government sector

"A System of National Accounts", op. cit., par. 5.24. -5.30.

3.2.1.3. The Private-non-profit sector

"A System of National Accounts", op. cit., par. 5.35. -5.39.

3.2.1.4. The Higher Education sector

3.2.1.5. Abroad

"A System of National Accounts", op. cit., par. 5.100-5.102.

2.2. Frontières des activités de recherche et de développement expérimental

2.3. Activités exclues des activités de R-D

2.3.1. Autres activités scientifiques et techniques

La mesure quantitative des activités scientifiques et techniques connexes à la recherche et au développement expérimental (UNESCO, CSR-S-2, Paris, 1975).

2.3.2. Frontières entre développement expérimental et production ou services techniques

Certaines statistiques sur l'innovation technologique dans l'industrie, catalogue 13.555 hors série, Statistique Canada.

CHAPITRE III: PRINCIPALES CLASSIFICATIONS DES DONNEES DE R-D PAR SECTEURS ET FONCTIONS

3.1. Introduction

Manuel scandinave sur les statistiques de R-D - Chapitre 4 "Systèmes de classification et principes de classification" (traduction provisoire).

3.1.1. Unités statistiques

Manuel scandinave - op. cit. Chapitre 4.2.1. - 4.2.4. (traduction provisoire).

3.1.2. La distinction entre les classifications "institutionnelles" et "fonctionnelles"

3.2. Classifications institutionnelles

3.2.1. Classification par secteurs

"Système de Comptabilité nationale" (Nations Unies, 1968) Chapitre V - Les agents du système.

3.2.1.1. Le secteur des entreprises

"Système de Comptabilité nationale", op. cit., par. 5.7. -5.12.

3.2.1.2. Le secteur de l'Etat

"Système de Comptabilité nationale", op. cit., par. 5.24. -5.30.

3.2.1.3. Le secteur des institutions privées sans but lucratif

"Système de Comptabilité nationale", op. cit., par. 5.35. -5.39.

3.2.1.4. Le secteur de l'enseignement supérieur

3.2.1.5. L'Etranger

"Système de Comptabilité nationale", op. cit., par. 5.100-5.102.

3.2.2. Classification by sub-sector

3.2.2.1. Standard Sub-Classification for the Business Enterprise sector

The International Standard Industrial Classification (ISIC). Statistical Papers Series M No. 4 Rev. 2, United Nations, 1968.

3.2.2.2. Standard Sub-classification for the Government sector

"A system of National Accounts", op. cit., Table 5.3.

Pilot study on public expenditure and their classification. Working Party No. 2 of the Economic Policy Committee, OECD, Paris, 1974.

3.2.2.3. Standard Sub-classification for the PNP sector

"A System of National Accounts", op. cit., Table 5.4.

3.3. Functional Classification of R and D

3.3.1. Classification by product field

Classification of Commodities by Industrial Origin, Dept. of Economic and Social Affairs, Statistical Ofc. of the UN, Statistical Papers, Series M, No. 43, New York, 1966.

3.3.2. Detailed functional classification by field of science

International Standard Nomenclature for Fields of Science and Technology - UNESCO (work in progress).

International Standard Classification of Education (ISCED) UNESCO - COM-74/ISCED/3, Paris, 1974.

3.3.3. Classification by socio-economic objectives

Changing priorities for Government R and D. An experimental study of trends in the objectives of Government R and D funding in 12 OECD Member countries, 1961-1972. Chapter II "The problems of comparing national priorities for Government funded R and D". OECD, Paris, 1975.

Research and Development: Public Financing of R and D in the Community countries. Analysis by objectives, op. cit., Annex I.

Nomenclature for the Analysis and comparisons of Science Programmes and Budgets (NASB) 1975 version, op. cit.

CHAPTER IV: MEASUREMENT AND CLASSIFICATION OF R AND D MANPOWER AND EXPENDITURE DEVOTED TO R AND D

4.1. Introduction

3.2.2. Classification par sous secteurs

3.2.2.1. Sous-classification type pour le secteur des entreprises

La Classification internationale type par industrie (CITI). Etudes statistiques - Série M n° 4, Rev. 2, Nations Unies, 1968.

3.2.2.2. Sous-classification type pour le secteur de l'Etat

"Système de Comptabilité Nationale", op. cit., Tableau 5.3.

Etude pilote sur les dépenses publiques et leur classification. Groupe de Travail n° 2 du Comité de Politique économique, OCDE, Paris, 1974.

3.2.2.3. Sous-classification type pour le secteur des ISBL

"Système de Comptabilité nationale", op. cit., Tableau 5.4.

3.3. Classification fonctionnelle des activités de R-D

3.3.1. Classification par groupes de produits

La Classification type pour le commerce international, Ministère des Affaires économiques et sociales, Bureau statistique des Nations Unies, Série Statistique M, n° 43, Nations Unies, New York, 1966.

3.3.2. Classification fonctionnelle détaillée par disciplines scientifiques

Nomenclature type par disciplines scientifiques et technologiques - UNESCO (en cours).

Classification internationale type de l'éducation (CITE) - UNESCO COM-74/CITE/3, Paris, 1974.

3.3.3. Classification par objectifs socio-économiques

Evolution des priorités de la recherche publique. Etude expérimentale des changements intervenus dans les objectifs des gouvernements dans 12 pays Membres de l'OCDE de 1961 à 1972. Chapitre II "Les problèmes de la comparaison des priorités nationales dans le financement public de la R-D". OCDE, Paris, 1975.

Recherche et développement : Financement public de la R-D dans les pays de la Communauté. Analyse par objectifs, op. cit., Annexe I.

Nomenclature pour l'Analyse et la comparaison des programmes et budgets de la science (NABS), version 1975, op. cit.

CHAPITRE IV : MESURE ET CLASSIFICATION DES RESSOURCES CONSACREES A LA R-D : PERSONNEL ET DEPENSES

4.1. Introduction

4. 2. Manpower employed on R and D

Nordic Manual for R and D Statistics: Chapter 5 "Manpower in R and D" (draft translation).

4. 2. 1. Categories of R and D manpower

4. 2. 1. 1. Classification by occupation

International Standard Classification of Occupations (ILO, 1968).

Pilot Study of the Feasibility of Collecting Detailed Occupational Data for Engineers Employed by Industry. Washington, DC: Department of Labor, Bureau of Labor Statistics, 1965.

4. 2. 1. 2. Classification by qualification

International Standard Classification of Education (ISCED), UNESCO COM-74/ISCED/3. Paris, 1974.

The Invisible University, Postdoctoral Education in the United States. R. B. Curtis. Washington, DC: National Academy of Sciences, Oct. 1969.

Classification of Educational Systems in OECD Member countries (series). OECD, Paris, 1972.

4. 2. 2. Other characteristics of R and D manpower

"Manpower Requirements for National Objectives in the 1970's" by Leonard A. Lecht, Center for Priority Analysis, National Planning Association, Washington, DC. Prepared for the US Department of Labor Manpower Administration.

"Projections of Science and Engineering Doctorate Supply and Utilization, 1980 and 1985", National Science Foundation, NSF 75-301.

Survey of Science Information Manpower in Engineering and the Natural Sciences. Columbus: Battelle Memorial Institute, November 1966.

Assessing the Impact of Changes in National Priorities for the Utilization of Scientists and Engineers. Washington, DC: National Planning Association, Feb. 1974.

"Undergraduate and Graduate Study in Scientific Fields", H. S. Astin and A. S. Bisconti. American Council on Education Research Reports, Vol. 8, No. 3, Aug. 1973.

"Trends in the Characteristics of Engineering College Students, 1961-1965", Alexander W. Astin, American Council on Education Research Reports, Vol. 1, No. 4, 1966. (Also in Proceedings of the Sixth Annual Forum of the Association for Institutional Research, May 1967, 99-104.)

Estimating Manpower Needs in Engineering by Analysis of Personnel Transactions. Los Angeles : Univ. of California, 1969.

4. 2. Personnel affecté à la R-D

NORDFORSK - Handbok för FoU-statistik. Chapter 5.

Manuel scandinave sur les statistiques de R-D : pas de traduction du chapitre 5 en français.

4. 2. 1. Catégories de personnel de R-D

4. 2. 1. 1. Classification par fonction

Classification internationale type des professions (BIT, 1968).

Pas de traduction française.

4. 2. 1. 2. Classification par qualification formelle

Classification internationale type de l'éducation (CITE), UNESCO COM-74/CITE/3 Paris, 1974.

Pas de traduction française.

Classification des systèmes d'enseignement dans les pays Membres de l'OCDE (série). OCDE, Paris, 1972.

4. 2. 2. Autres caractéristiques du personnel de R-D

En anglais seulement.

Symposium on Manpower Theory, The Journal of Human Resources, Vol. II, No. 2, Spring 1967.

Factors Influencing Engineering Enrollment, Washington, DC. American Society for Engineering Education, 1965.

Scientific and Technical Careers: Factors Influencing Development During the Educational Years. P. R. Rever, Iowa City: The American College Testing Program, July 1973.

"The Backgrounds and Early Careers of Engineering Doctorate Recipients", Joan Creager. Washington, DC: National Academy of Sciences, May 1968. (Also in Journal of Engineering Education, November, 1968.)

A preliminary Analysis of Interspecialty Mobility of Technical/Professional Manpower Resources, SRI R and D Studies Series. Menlo Park: Stanford Research Institute, September 1967.

En anglais seulement.

4. 3. R and D expenditure

Manual for surveying national scientific and technological potential (UNESCO, NS/SPS/15, Paris, 1970).

Nordic Manual for R and D Statistics: Chapter 6 "Expenditure/Financing" (draft translation).

4. 3. Dépenses de R-D

Manuel d'inventaire du potentiel scientifique et technique national (UNESCO, SC/SP/15, Paris, 1969).

Manuel scandinave sur les statistiques de R-D : pas de traduction du chapitre 6 en français.

NORDFORSK - Handbok för FoU-statistik. Chapter 6.

4. 3. 1. Intramural R and D expenditure

4. 3. 2. Extramural flows of funds

4. 3. 3. National aggregates and matrices concerning performers and sources of R and D funds

4. 3. 1. Dépenses intramuros de R-D

4. 3. 2. Flux financiers extramuros

4. 3. 3. Agrégats nationaux et tableaux concernant les exécutants et sources de financement des travaux de R-D

4. 4. Cross-classification

4. 5. Classification by size

4. 4. Classification croisée

4. 5. Classification par dimension

CHAPTER V: METHODS OF MEASURING R AND D AND THE NEED FOR ESTIMATES AND ADJUSTMENTS

CHAPITRE V : METHODES DE MESURE DES RESSOURCES DE R-D ET NECESSITE DE FAIRE DES ESTIMATIONS ET DES AJUSTEMENTS

5. 1. Methods of compiling R and D data

"Methodology of Statistics on Research and Development", National Science Foundation, NSF 59-36.

Anglais seulement.

Only in Scandinavian

NORDFORSK - Handbok för FoU-statistik. Chapter 7 (The performance of R and D surveys)

En scandinave seulement.

5. 2. Identifying survey respondents

5. 2. Identification des répondants aux enquêtes

5.3. The need for estimates and adjustments

5.3.1. Estimates to be made by the respondents

Financial Accounting Standards Board. Statement of Financial Accounting Standards No. 2, "Accounting for Research and Development Costs", October 1974.

Bierman, Harold Jr., and Dukes, Roland E., "Accounting for Research and Development Costs", The Journal of Accountacy. April 1975.

Firmin, Peter A., Goodman, Seymour S., Hendricks, Thomas E., and Linn, James J., Final Report on "University Cost Structure and Behaviour", Tulane University, New Orleans, Louisiana 70118, August 31, 1967.

French, Wendell, Final report on the project, "To Devise and Test Simplified Adequate Systems of Measuring and Reporting Financial, Manpower, Facilities, Research, and Other Activities in Colleges and Universities", University of Washington, Seattle, Washington, June 1965. And supplement to the final report, "The Academic Manpower Administration System at the University of Washington: Toward a Generalized Theory".

McCarthy, Joseph L. and Deener, David R., "The Costs and Benefits of Graduate Education : A Commentary with Recommendations", The Council of Graduate School in the United States, Washington, DC, March 1972.

National Science Foundation, "Systems for Measuring and Reporting the Resources and Activities of Colleges and Universities", NSF 67-15, 1967, National Science Foundation, Washington, DC 20550.

The Committee of Vice-Chancellors and Principals of the Universities of the United Kingdom : Report of an Enquiry into the Use of Academic Staff Time. London 1972.

The Netherlands Central Bureau of Statistics - Dr. W. F. M. de Vries, 08575-71-s-7 "The Measurement of R and D in universities".

5.3.2. Estimates and adjustments by surveying agency

5.3. Nécessité de faire des estimations et des ajustements

5.3.1. Estimations qui doivent être faites par les organismes interrogés

En anglais seulement.

5.3.2. Ajustements qui doivent être faits par l'organisme enquêteur

Resursstatistik för Universitet och Högskolor (Statistics Resources for Universities and "High Schools"). Nordisk Statistisk Sekretariat, Tekniske Rapporter NR 10 (Copenhagen, 1974).

CHAPTER VI: RELATION OF R AND D DATA WITH OTHER ECONOMIC VARIABLES AND INTERNATIONAL COMPARISON OF R AND D EXPENDITURE

6.1. Comparing R and D data with other economic variables

Conference Eur. Stats/WG 33/15 UNESCO/COM/72/CONF/15/5, 26 October 1972 "The Integration of Research and Experimental Development Statistics with General Economic and Manpower Statistics", A. Lönnqvist.

6.2. R and D exchange rate and deflators (See Annex IV)

CHAPITRE VI : RAPPROCHEMENTS ENTRE LES STATISTIQUES DE R-D ET D'AUTRES STATISTIQUES ECONOMIQUES ET COMPARAISON INTERNATIONALE DES DEPENSES DE R-D

6.1. Comparaison des statistiques de R-D avec d'autres statistiques économiques

6.2. Le taux de change recherche et les déflateurs (voir Annexe IV)

ANNEX I : SOME PROBLEMS OF MEASUREMENT OF R AND D IN THE SOCIAL SCIENCES AND HUMANITIES

The measurement of scientific activities in the social sciences and the humanities (UNESCO, CSR-S-1, Paris, 1971).

OECD DAS/SPR/70. 40 Addendum: The measurement of scientific and technical activities. Notes on a Proposed Standard Practice for Surveys of Research in the Social Sciences and Humanities.

Federal Government activities in the human sciences - Statistics Canada.

ANNEX II : ADDITIONAL MATERIAL ON CLASSIFICATION BY SOCIO-ECONOMIC OBJECTIVES

ANNEX III : METHOD TO DISTINGUISH R AND D ACTIVITIES FROM NON R AND D ACTIVITIES IN THE HIGHER EDUCATION SECTOR (Second and Third Level of Education) - RECOMMENDATIONS INCLUDED IN THE NORDIC MANUAL ON STATISTICS OF RESOURCES DEVOTED TO HIGHER EDUCATION "Resursstatistik för Universitet och Högskolor"

ANNEX IV : THE MEASUREMENT OF THE OUTPUT OF R AND D AND THE BALANCE OF TECHNOLOGICAL PAYMENTS

Measurement of output of research and experimental development (UNESCO, STS/16, Paris, 1970).

ANNEX V : EFFORTS IN THE CALCULATION OF RESEARCH EXCHANGE RATES AND DEFLATORS

A. R and D exchange rates

General international comparisons of purchasing power

An international comparison of national products. Milton Gilbert and Irving Kravis - OEEC, 1954.

Comparative national products and price levels. Milton Gilbert and Associates, OEEC, 1958.

Angus Maddison. Comparative productivity levels in developed countries. Banca Nazionale del Lavoro - Quarterly Review, No. 83, Dec. 1967.

Just how misleading are official exchange rate conversions ? Paul A. David. The Economic Journal, September 1972, Chapters I and II.

ANNEXE I : QUELQUES PROBLEMES DE MESURE DE LA R-D DANS LES SCIENCES SOCIALES ET HUMAINES

La mesure des activités scientifiques dans les sciences sociales et humaines (UNESCO, CSR-S-1, Paris, 1971).

OCDE DAS/SPR/70. 40 Addendum : La mesure des activités scientifiques et techniques. Notes sur la Méthode type proposée pour les enquêtes sur la recherche dans les sciences sociales et humaines.

Activités de l'Administration fédérale en sciences humaines - Statistique Canada.

ANNEXE II : INFORMATIONS COMPLEMENTAIRES SUR LA CLASSIFICATION PAR OBJECTIFS SOCIO-ECONOMIQUES

ANNEXE III : METHODE POUR DISTINGUER LES ACTIVITES R-D DES ACTIVITES DE NON R-D DANS LE SECTEUR DE L'ENSEIGNEMENT SUPERIEUR (2ème et 3ème cycles de l'enseignement) - RECOMMANDATIONS CONTENUES DANS LE MANUEL NORDIQUE SUR LES RESSOURCES CONSACREES A L'ENSEIGNEMENT SUPERIEUR "Resursstatistik för Universitet och Högskolor"

ANNEXE IV : LA MESURE DE L'OUTPUT DE LA R-D ET LA BALANCE DES PAIEMENTS TECHNIQUES

Mesure de l'output de la R-D (UNESCO, STS/16, Paris, 1970).

ANNEXE V : EFFORTS ENTREPRIS POUR CALCULER DES TAUX DE CHANGE ET DES DEFLATEURS EN RECHERCHE

A. Taux de change recherché

Comparaisons générales internationales sur le pouvoir d'achat

Anglais seulement.

Comparaison réelle du PIB des pays de la Communauté Européenne - Parités de prix et rapports de volume 1970 - J. Mayers et autres. Analyse et prévision, Juin 1974.

Attempts to calculate R and D exchange rates

Summary of Progress Made Towards Calculating an R and D Exchange Rate - OECD (DAS/SPR/73. 80).

Research and Development: A comparison between British and American industry - National Institute Economic Review, May 1962.

C. Freeman/A. Young, The R and D effort in Western Europe, North America and the Soviet Union: An experimental international comparison of research expenditure and manpower in 1962, OECD, Paris, 1965.

The cost of basic scientific research in Europe: Department of Defense Experience - E. D. Brunner, R. H. 5275 PR - The Rand Corporation, Santa Monica, California, 1967.

Exchange rates for national expenditure on R and D. A. S. MacDonald. Economic Journal - November 1972, Chapter III.

B. R and D Deflators

R and D deflators: National experience and possible international approaches - OECD (DAS/SPR/74. 77 + annex).

The sophistication factor in science expenditure - A. V. Cohen and L. N. Ivins - Science Policy Studies No. 1 - Department of Education and Science, HMSO, 1967.

Efforts entrepris pour calculer des taux de change recherche

Résumé des efforts effectués pour calculer le taux de change en R-D, OCDE (DAS/SPR/73. 80).

Anglais seulement.

C. Freeman/A. Young. L'effort de R-D en Europe Occidentale, Amérique du Nord et Union soviétique : Un essai de comparaison internationale des dépenses et des effectifs consacrés à la recherche en 1962, OCDE, Paris, 1965.

Anglais seulement.

Anglais seulement.

B. Déflateurs de R-D

Déflateurs de R-D : Expériences nationales et approches possibles au niveau international - OCDE (DAS/SPR/74. 77 + annexe).

Anglais seulement.

Premiers éléments en vue d'une appréciation rationnelle des coûts de la recherche publique : l'indice des prix à la recherche - Jean Castex et Françoise Sevin, Le Progrès scientifique, septembre/octobre 1974.

Les moyens consacrés par la France à la Recherche et au Développement en 1969 (Annexe) - DGRST, édition spéciale du Progrès scientifique.

In Norwegian only ("Research and Development Expenditure and Manpower", 1972). "Forskinings-og Utviklingsarbeid Utgifter og personale", 1972 (pages 61-63 and 88). Norwegian Research Council for Science and the Humanities. The Agricultural Research Council of Norway. Royal Norwegian Council for Scientific and Industrial Research.

En norvégien seulement ("Recherche et Développement - Dépenses et personnel", 1972).

ANNEX VI : RECOMMENDATIONS FOR THE LAYOUT OF THE NATIONAL R AND D PUBLICATIONS

ANNEXE VI : QUELQUES RECOMMANDATIONS POUR LA PRESENTATION DES PUBLICATIONS NATIONALES DE R-D

INDEX

OECD SALES AGENTS
DEPOSITAIRES DES PUBLICATIONS DE L'OCDE

ARGENTINA – ARGENTINE
Carlos Hirsch S.R.L.,
Florida 165, BUENOS-AIRES.
☎ 33-1787-2391 Y 30-7122

AUSTRALIA – AUSTRALIE
International B.C.N. Library Suppliers Pty Ltd.,
161 Sturt St., South MELBOURNE, Vic. 3205.
☎ 69.7601
658 Pittwater Road, BROOKVALE NSW 2100.
☎ 938 2267

AUSTRIA – AUTRICHE
Gerold and Co., Graben 31, WIEN 1. ☎ 52.22.35

BELGIUM – BELGIQUE
Librairie des Sciences
Coudenberg 76-78, B 1000 BRUXELLES 1.
☎ 512-05-60

BRAZIL – BRESIL
Mestre Jou S.A., Rua Guaipá 518,
Caixa Postal 24090, 05089 SAO PAULO 10.
☎ 216-1920
Rua Senador Dantas 19 s/205-6, RIO DE
JANEIRO GB. ☎ 232-07. 32

CANADA
Publishing Centre/Centre d'édition
Supply and Services Canada/Approvisionnement et Services Canada
270 Albert Street, OTTAWA K1A 0S9, Ontario
☎ (613)992-9738

DENMARK – DANEMARK
Munksgaards Boghandel
Nørregade 6, 1165 KØBENHAVN K.
☎ (01) 12 69 70

FINLAND – FINLANDE
Akateeminen Kirjakauppa
Keskuskatu 1, 00100 HELSINKI 10. ☎ 625.901

FRANCE
Bureau des Publications de l'OCDE
2 rue André-Pascal, 75775 PARIS CEDEX 16.
☎ 524.81.67
Principaux correspondants :
13602 AIX-EN-PROVENCE : Librairie de l'Université. ☎ 26.18.08
38000 GRENOBLE : B. Arthaud. ☎ 87.25.11
31000 TOULOUSE : Privat. ☎ 21.09.26

GERMANY – ALLEMAGNE
Verlag Weltarchiv G.m.b.H.
D 2000 HAMBURG 36, Neuer Jungfernstieg 21
☎ 040-35-62-500

GREECE – GRECE
Librairie Kauffmann, 28 rue du Stade,
ATHENES 132. ☎ 322.21.60

HONG-KONG
Government Information Services,
Sales of Publications Office,
1A Garden Road,
☎ H-252281-4

ICELAND – ISLANDE
Snaebjörn Jónsson and Co., h.f.,
Hafnarstræti 4 and 9, P.O.B. 1131,
REYKJAVIK. ☎ 13133/14281/11936

INDIA – INDE
Oxford Book and Stationery Co. :
NEW DELHI, Scindia House. ☎ 47388
CALCUTTA, 17 Park Street. ☎ 24083

IRELAND – IRLANDE
Eason and Son, 40 Lower O'Connell Street,
P.O.B. 42, DUBLIN 1. ☎ 74 39 35

ISRAEL
Emanuel Brown :
35 Allenby Road, TEL AVIV. ☎ 51049/54082
also at :
9, Shlomzion Hamalka Street, JERUSALEM.
☎ 234807
48 Nahlath Benjamin Street, TEL AVIV.
☎ 53276

ITALY – ITALIE
Libreria Commissionaria Sansoni :
Via Lamarmora 45, 50121 FIRENZE. ☎ 579751
Via Bartolini 29, 20155 MILANO. ☎ 365083
Sous-dépositaires :
Editrice e Libreria Herder,
Piazza Montecitorio 120, 00186 ROMA.
☎ 674628
Libreria Hoepli, Via Hoepli 5, 20121 MILANO.
☎ 865446
Libreria Lattes, Via Garibaldi 3, 10122 TORINO.
☎ 519274
La diffusione delle edizioni OCDE è inoltre assicurata dalle migliori librerie nelle città più importanti.

JAPAN – JAPON
OECD Publications Centre,
Akasaka Park Building,
2-3-4 Akasaka,
Minato-ku
TOKYO 107. ☎ 586-2016
Maruzen Company Ltd.,
6 Tori-Nichome Nihonbashi, TOKYO 103,
P.O.B. 5050, Tokyo International 100-31.
☎ 272-7211

LEBANON – LIBAN
Documenta Scientifica/Redico
Edison Building, Bliss Street,
P.O.Box 5641, BEIRUT. ☎ 354429 – 344425

THE NETHERLANDS – PAYS-BAS
W.P. Van Stockum
Buitenhof 36, DEN HAAG. ☎ 070-65.68.08

NEW ZEALAND – NOUVELLE-ZELANDE
The Publications Manager,
Government Printing Office,
WELLINGTON : Mulgrave Street (Private Bag),
World Trade Centre, Cubacade, Cuba Street,
Rutherford House, Lambton Quay ☎ 737-320
AUCKLAND : Rutland Street (P.O.Box 5344)
☎ 32.919
CHRISTCHURCH : 130 Oxford Tce, (Private Bag)
☎ 50.331
HAMILTON : Barton Street (P.O.Box 857)
☎ 80.103
DUNEDIN : T & G Building, Princes Street
(P.O.Box 1104), ☎ 78.294

NORWAY – NORVEGE
Johan Grundt Tanums Bokhandel,
Karl Johansgate 41/43, OSLO 1. ☎ 02-332980

PAKISTAN
Mirza Book Agency, 65 Shahrah Quaid-E-Azam,
LAHORE 3. ☎ 66839

PHILIPPINES
R.M. Garcia Publishing House,
903 Quezon Blvd. Ext., QUEZON CITY,
P.O. Box 1860 – MANILA. ☎ 99.98.47

PORTUGAL
Livraria Portugal,
Rua do Carmo 70-74. LISBOA 2. ☎ 360582/3

SPAIN – ESPAGNE
Librería Mundi Prensa
Castello 37, MADRID-1. ☎ 275.46.55
Librería Bastinos
Pelayo, 52, BARCELONA 1. ☎ 222.06.00

SWEDEN – SUEDE
Fritzes Kungl. Hovbokhandel,
Fredsgatan 2, 11152 STOCKHOLM 16.
☎ 08/23 89 00

SWITZERLAND – SUISSE
Librairie Payot, 6 rue Grenus, 1211 GENEVE 11.
☎ 022-31.89.50

TAIWAN
Books and Scientific Supplies Services, Ltd.
P.O.B. 83, TAIPEI.

TURKEY – TURQUIE
Librairie Hachette,
469 Istiklal Caddesi,
Beyoglu, ISTANBUL, ☎ 44.94.70
et 14 E Ziya Gökalp Caddesi
ANKARA. ☎ 12.10.80

UNITED KINGDOM – ROYAUME-UNI
H.M. Stationery Office, P.O.B. 569, LONDON
SE1 9 NH, ☎ 01-928-6977, Ext. 410
or
49 High Holborn
LONDON WC1V 6HB (personal callers)
Branches at : EDINBURGH, BIRMINGHAM,
BRISTOL, MANCHESTER, CARDIFF,
BELFAST.

UNITED STATES OF AMERICA
OECD Publications Center, Suite 1207,
1750 Pennsylvania Ave, N.W.
WASHINGTON, D.C. 20006. ☎ (202)298-8755

VENEZUELA
Librería del Este, Avda. F. Miranda 52,
Edificio Galipán, Aptdo. 60 337, CARACAS 106.
☎ 32 23 01/33 26 04/33 24 73

YUGOSLAVIA – YOUGOSLAVIE
Jugoslovenska Knjiga, Terazije 27, P.O.B. 36,
BEOGRAD. ☎ 621-992

Les commandes provenant de pays où l'OCDE n'a pas encore désigné de dépositaire peuvent être adressées à :
OCDE, Bureau des Publications, 2 rue André-Pascal, 75775 Paris CEDEX 16
Orders and inquiries from countries where sales agents have not yet been appointed may be sent to
OECD, Publications Office, 2 rue André-Pascal, 75775 Paris CEDEX 16

OECD PUBLICATIONS, 2, rue André-Pascal, 75775 Paris Cedex 16 - No. 37 293

PRINTED IN FRANCE