Industry, Science and Technology Canada
Industrie, Sciences et Technologie Canada

Definitions of R&D — A Summary of the Frascati Manual

S&T Economic Analysis Division
Industrial Competitiveness Branch
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I Introduction

The OECD manual for the measurement of scientific and technical activities, the "Frascati Manual", was written by and for the national experts in OECD countries who collect and issue national R&D data and who submit responses to OECD biennial R&D surveys aided by the staff of the OECD Science and Technology Indicators Unit. Planners and policy analysts do not need the statistical minutiae but need to be able to refer to the appropriate definitions in the course of preparing for negotiations or briefings. This is a summary of the definitions contained in the Frascati Manual.[1] The numbers in brackets at the beginning of each paragraph refer to the corresponding paragraph in the 1981 Frascati Manual.

II R&D and Scientific and Technological Innovation

(9) Scientific and technological innovation may be considered as the transformation of an idea into a new or improved saleable product or operational process in industry and commerce or into a new approach to a social service. It thus consists of all those scientific, technical, commercial and financial steps necessary for the successful development and marketing of new or improved manufactured products, the commercial use of new or improved processes and equipment or the introduction of a new approach to a social service. R&D is only one of these steps.

(10) Besides R&D, six activities may often be distinguished in the innovation process:

- New product marketing is the set of activities necessary to the successful introduction of a new product of process into the market. Its costs are those of market research and test marketing; the non-recurring costs of establishing distribution, maintenance, and sales channels and advertising systems including the initial outlay on advertising.

- Patent work is the filing of patent applications and the carrying out of searches for prior patents in connection with the product or process being introduced or improved.

[1] The Frascati Manual is a document adopted by the OECD for policy and statistical purposes. Official definitions for governmental uses, such as taxation or national statistics, may vary. The user must always refer to the appropriate definition when measuring R&D activities. For taxation purposes in Canada, the user should refer to Revenue Canada Information Circular 86-4R2 and its related explanatory notes; for statistical purposes the user should refer to the definitions attached to Statistics Canada questionnaires.

- Financial and organizational changes may be required to finance the innovation and to permit the company to successfully exploit it. These include the non-recurring costs of financial planning, raising additional capital, corporate restructuring and retraining of sales and maintenance personnel and exclude the interest paid on borrowed funds and the foregone interest on own funds used.

- Final product or design engineering is the further modification of a product or process after the R&D phase is completed in recognition of market or manufacturing requirements. For instance, it includes the cost of industrial design for aesthetic value and of preparing production drawings, part lists and specifications.

- Tooling and industrial engineering covers all changes in production machinery and tools, in production and quality control procedures, methods and standards required to manufacture the new product or to use the new process.

- Manufacturing start-up includes the cost of retraining personnel in the new techniques or in the use of new machinery, trial production runs and the cost of items damaged because of faulty equipment, procedures and operator errors.

III Measures of R&D Input

(16) The Manual deals not only with R&D in the Natural Sciences and Engineering (NSE) which cover the physical sciences, the life sciences, including the medical and agricultural sciences, plus engineering but also the Social Sciences and Humanities (SSH).

(19) For statistical purposes, two inputs are measured: expenditures on R&D and people working in R&D. Both inputs are normally measured on an annual basis: so much spent during a year, so many person-years used during a year. Both series have their strengths and weaknesses and, in consequence, series of both kinds are necessary to secure an adequate representation of the effort devoted to R&D.

(20) The basic measure is "intramural expenditures", i.e. all expenditures for R&D performed within a statistical unit or sector of the economy. For R&D purposes both current and capital expenditures are measured. Depreciation payments are excluded.

(23) Personnel is a more concrete measure and, since labour costs normally account for 50-70 per cent of total R&D expenditures, is also a reasonable short-term indicator of efforts devoted to R&D. The measurement of the personnel engaged in R&D is also of fundamental importance in the longer term.

(28) Although R&D activities are widespread throughout the economy, they are often perceived as a national whole for science policy purposes i.e. as the "national R&D efforts". One of the aims of the Manual is, thus, to establish specifications for R&D input data which can be collected from a wide range of performers but which can also be aggregated to find meaningful national totals. The main expenditure aggregate used for international comparison is the Gross Domestic Expenditure on R&D (GERD) which covers all expenditures for R&D performed on national territory in a given year. (It includes domestically performed R&D which is financed from abroad but excluded R&D funds paid to abroad, notably to international agencies.) The corresponding personnel measure does not have a special name. It comprises total personnel working on R&D (in FTE) on national territory during a given year. International comparisons are sometimes restricted to researchers (or university graduates) because it is considered that researchers are the true core of the R&D system.

IV Basic Definitions and Conventions

a) Research and Experimental Development (R&D)

(43) Research and experimental development (R&D) 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. R&D is a term covering three activities: basic research, applied research and experimental development.

(141) The following examples illustrate the general differences between basic and applied research and experimental development in the natural sciences and engineering and in the social sciences and humanities.

(142a) 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 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.

(143a) 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.

b) The Boundaries of R&D

(58) The basic criterion for distinguishing R&D from related activities is the presence in R&D of an appreciable element of novelty or technological uncertainty.

One aspect of this criterion is that a particular project may be R&D if undertaken for one reason but if carried out for another reason will not be considered R&D. This is shown in the following examples:

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

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

c) R&D and Education and Training

(59) 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&D is generally based on estimates of the proportion of working time devoted to this activity by university staff. This is particularly true in the humanities where a particularly high proportion of research is carried out in the universities.

(62) In order to obtain a final qualification at post-graduate level, students are expected to prove their 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&D projects. The relevant activities of such students should, therefore, be attributed to R&D, any supervision by the teacher should also be considered as R&D. In addition to R&D performed within the framework of courses of postgraduate education, it is possible for both teachers and students to be engaged on other R&D projects.

d) R&D and Other Related Scientific and Technological Activities

(65) Institutions or units of institutions and firms whose principal activity is R&D often have secondary, non-R&D activities (e.g. scientific and technical information, testing, quality control, analysis). In so far as a secondary activity is undertaken primarily in the interests of R&D, it should be included in R&D activities; if the

secondary activity is designed essentially to meet needs other than R&D, it should be excluded from R&D.

- 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&D. The activities of a firm's documentation centre open to all the firm's staff if it shares the same premises as the company research unit. Similarly, the activities of central university libraries should be excluded from R&D.

- Public bodies and consumer organizations often operate 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; these activities should be included in R&D.

- Space Exploration (67) The difficulty with space exploration is that, in some respects, much space activity may now be considered routine; certainly the bulk of the costs are incurred for the purchase of goods and services which are not R&D. However, the object of all space exploration is still to increase the stock of knowledge so that it should all be included in R&D. It may be necessary to separate these activities associated with space exploration, including the development of vehicles, equipment and techniques, from those involved in the routine placing of orbiting satellites or establishment of tracking and communication stations.

- Mining and Prospecting (68) Mining and prospecting sometimes cause problems due to a linguistic confusion between "research" for new or substantially improved resources (food, energy, etc.) and the "search" for existing reserves of natural resources which blurs the distinction between R&D and surveying and prospecting.

  It follows that the surveying and prospecting activities of commercial companies will be almost entirely excluded from R&D. For example, the sinking of exploratory wells to evaluate the resources of a deposit should be considered as scientific and technological services.

e) Problems on the Borderline Between R&D and Other Industrial Activities
(69) Care must be taken to exclude activities which, though undoubtedly a part of the innovation process, rarely involve any R&D, e.g. design engineering, patent filing and licensing, "tooling up" and market research. Similar difficulties may arise in distinguishing public technology based services such as inspection and control from related R&D, as for example in the area of foods and drugs.

(70) 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 National Science Foundation (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&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&D."

(71) Some common problem areas are described below:

- Prototypes (72) 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 falls within the scope of R&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&D has been reached.

  The construction of several copies of a prototype to meet a temporary commercial, military of medical need after successful testing of the original, even if undertaken by R&D staff, is not part of R&D.

- Pilot Plants (73) The construction and operation of a pilot plant is a part of R&D as long as the principal purposes are to obtain experience and to compile engineering and other data.

  If, as soon as the experimental phase is over, a pilot plant switches to operating as a normal commercial production unit, the activity can no longer be considered R&D even though it may still be described as "pilot plant".

- Trial Production (75) After a prototype, with any necessary modifications, has been satisfactorily tested, the costs of the first trial production runs should not be attributed to R&D since the primary objective is no longer to make further improvements to the product but to get the production process going.

- Trouble-shooting (76) Trouble-shooting occasionally brings out the need for further R&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&D.

- "Feed-back" R&D (77) 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&D. Such "feedback" R&D is included.

f) Activities Excluded from R&D

(44) For survey purposes, R&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&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&D.

- Education and Training (46) All education and training of personnel 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, bona fide research by post-graduate students carried out at universities should be counted, wherever possible, as a part of R&D.

- Scientific and Technical Information Services (48) The specialized activities of collecting, coding, recording, classifying, disseminating translating, analyzing and evaluating by bibliographic services, patent services, S&T information, extension or advisory services and scientific conferences should be excluded.

- General Purpose Data Collection (49) 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&D process is included in R&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, systematising, etc. of the data. But data collected for other or general purposes such a quarterly sampling of unemployment, should be excluded even if exploited for research. Market surveys are excluded.

- Testing and Standardization (50) To the maintenance of national standards, the calibration of secondary standards and routine testing and analysis if materials, components, products, processes, soils, atmospheres, etc. should be excluded.

- Feasibility Studies (51) Investigation of proposed engineering projects using existing techniques in order to provide additional information before deciding on implementation should be excluded. 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&D.

- Specialized Medical Care (52) Routine investigation and normal application of specialized medical knowledge should be excluded. There may, however, be an element of R&D in what is usually called "advanced medical care", carried out, for example, in university hospitals.

- Patent and Licence Work (53) All administrative and legal work connected with patents and licences should be excluded. (However, patent work connected directly with R&D projects is R&D.)

- Policy Related Studies (54) Policy in this content refers not only to national policy but also to policy at the regional and local levels, as well as that of business enterprise in the pursuit of their economic activity. Policy related studies cover a range of activities such as the analysis and assessment of the existing programs, 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, and should be excluded.

V Sectoral Definitions

a) Business Enterprise

(87) This sector includes all firms, organizations 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, and the private non-profit institutes mainly serving them.

(88, 89) 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 which R&D is the main activity (commercial R & D institutes and laboratories). In

addition, it includes public enterprises ("industries of government",) 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 be less than the full cost of production.

b) Government Sector

(101) This sector is composed of all departments, offices and other bodies which furnish but normally do not sell to the community those common services which cannot otherwise be conveniently and economically provided and administer the state and the economic and social policy of the community. (Public enterprises are included in the Business Enterprise sector.)

c) Private Non-profit Sector

(109) This sector includes private or semi-public organizations which are not established primarily with the aim of making a profit (except for those controlled by institutions in the other sectors), and private individuals or households.

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

- Those mainly rendering services to enterprises;
- Those which primarily serve government;
- Those entirely or mainly financed and controlled by government;
- Those offering higher education services or controlled by institutes of higher education.

d) Higher Education Sector

(117) The sector is comprised of 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.

e) Abroad (Foreign Sector)

(124) This sector consists of all institutions and individuals located outside the political frontiers of a country except for vehicles, ships, aircraft and space satellites operated by domestic organizations and testing grounds acquired by such organizations, and all international organizations (except business enterprise) including facilities and operations within the frontiers of a country.

VI Measurement of Personnel and Expenditure Devoted to R&D

(170) The measurement of personnel employed on R&D involves two exercises:

- identifying which types of personnel should be initially included;
- measuring their R&D activities in full-time equivalence (person-years).

(171, 172) All persons employed directly on R&D should be counted, as well as those providing direct services such as R&D managers, administrators and clerical staff. Those providing an indirect service, such as canteen and security staff, should be excluded, even though their wages and salaries are included as an overhead cost in the measurement of R&D expenditure.

(177) Full-Time Equivalence (Person-Years): R&D may be the primary function of some persons (e.g. workers in an R&D laboratory) or it may be a secondary function (e.g. members of a design and testing establishment). It may also be a significant part-time activity (e.g. university teachers or post-graduate students). To count only persons employed in R&D establishments would result in an underestimate of the effort devoted to R&D; to do a head-count of everyone spending some time on R&D would lead to an overestimate. The number of persons engaged in R&D should, therefore, be expressed in full-time equivalents.

VII Categories of R&D Personnel

a) Researchers

(184) Researchers are scientists or engineers (RSE) engaged in the conception or creation of new knowledge, products, processes, methods and systems.

(185) Also included are managers and administrators engaged in the planning and management of the scientific and technical aspects of a researcher's work. They are usually of a rank equal to or above that of persons directly employed as researchers and will often be former or part-time researchers.

(187) Post-graduate students engaged in R&D should be considered as researchers.

b) Technicians and Equivalent Staff

(188, 189) Technicians participate in R&D projects by performing scientific and technical tasks normally under the supervision of scientists and engineers. Equivalent staff perform the corresponding tasks under the supervision of researchers in the social sciences and humanities. Their tasks include:

- carrying out bibliographic searches and selecting relevant material from archives and libraries;

- preparing computer programs;
- carrying out experiments, tests and analyses;
- preparing materials and equipment for experiments, tests and analyses;
- recording measurements, making calculations and preparing charts and graphs;
- maintaining and operating specialized R&D equipment and machinery;
- carrying out statistical surveys and interviews.

c) Other Supporting Staff

(190, 191) Other supporting staff include skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D projects or directly associated with such projects. Included under this heading are all managers and administrators dealing mainly with financial and personnel matters and general administration, in so far as their activities are a direct service to R&D.

VIII R&D Expenditures

(205, 206, 207) R&D expenditure data should be compiled on the basis of performers' reports of intramural expenditures. Intramural expenditures are all expenditures for R&D performed within a statistical unit or sector of the economy, whatever the source of funds. Expenditures made outside the statistical unit or sector but in support of intramural R&D (e.g. purchase of supplies for R&D) are included. Both current and capital expenditures are included.

a) Labour Costs

(209, 210) Labour costs includes comprised annual wages and salaries and all associated costs or fringe benefits such as bonus payments, holiday pay, contributions to pension funds and other social security payments, payroll taxes, etc. In the case of post-graduate students performing R&D, the corresponding share of their grants, stipends, etc., should, wherever possible, be included.

b) Other Current Costs

(212) These comprise non-capital purchases of materials, supplies and equipment to support R&D performed by the statistical unit in a given year. Examples of the former are: water and fuel (including gas and electricity), books, journals, reference materials, subscriptions to libraries, scientific societies and so on, imputed or actual costs of small prototypes or models made outside the research organization, materials for laboratories (chemicals, animals etc.).

Expenditures on services (hired or purchased) for R&D are included. Examples of such services are security; storage; use, repair and maintenance of buildings and equipment; computer services and printing of R&D reports. Administrative and other overhead costs (such as interest costs) should also be included, prorated if necessary to allow for non-R&D activities within the same statistical unit.

c) Depreciation

(213) All depreciation provisions for building, plant and equipment, whether real or imputed, should be excluded from the measurement of intramural expenditures.

d) Capital Expenditures

(214) Capital expenditures are the annual gross expenditures on fixed assets used in the R&D program of statistical units. They are composed of expenditures on:

- Land and buildings: This comprises land acquired for R&D (e.g. testing grounds, sites for laboratories and pilot plants) and buildings constructed or purchased, including major improvements, modifications and repairs. Depreciation is excluded.

- Instruments and equipment: This comprises major instruments and equipment acquired for use in the performance of R&D.

IX Sources of Funds

(220) R&D is an activity where there are significant transfers of resources between units, organizations and sectors. These transfers may be measured in two ways:

- Performer-based reporting of the sums which one unit, organization or sector has received from another unit, organization or sector for the performance of intramural R&D.
- Source-based reporting of extramural expenditures which are the sums a unit, an organization or a sector reports having paid to another unit, organization or sector for the performance of R&D.

(221) The first of these approaches is strongly recommended.

(223) Transfers may take the form of contracts, grants or donations and may take the form of money or of other resources (e.g. staff or equipment lent to the performer). When there is a significant non-monetary transfer, the current value has to be estimated since all transfers must be expressed in financial terms.

a) Contracts or grants

(225) Contracts or grants paid for the performance of current or future R&D are clearly identifiable as a transfer of R&D funds.

b) Facilities

(226) In theory, when a government allows a firm or university to use, free of charge, facilities such as a wind-tunnel, observatory or launching site while carrying out R&D, the value of the service (an imputed rental) should be identified as a transfer. In practice, the beneficiary would not normally be able to make such an estimate nor, indeed, might the donor.

c) Loans

(227) In some cases, a firm's R&D project may be financed by loans from a financial institution, an affiliated company or a government. Loans which are to be repaid are not to be considered transfers; loans which may be forgiven are to be considered transfers (by convention).

d) Government Incentives

(228) There are also a variety of other government incentives of R&D in the Business Enterprise sector. Examples are the remission of income taxes for industrial R&D, the payment by a government, on demand and after audit, of a certain portion of some or all of firms' R&D expenditures, bonuses added to R&D contracts to encourage a firm in its own R&D, remission of taxes and tariffs on R&D equipment and the reimbursement of part of a firm's costs if it hires more R&D staff. For the present, even where these transfers can be separately identified, they should not be counted as direct support for R&D. The statistical units should, thus, report gross expenditures as incurred, even when their actual costs may be reduced because of remissions, rebates or post-performance grants.

e) Sub-Contracting and Intermediaries

(232) Further problems arise when the money passes through several organizations. This can occur when R&D is sub-contracted, as is sometimes the case in the Business Enterprise sector. The performer should indicate, so far as possible, the original source that provided the funds for R&D. In some countries intermediary non-performing organizations play an important role in the financing of R&D by distributing among performers grants received from several different sources but not "earmarked" for specific projects. In such cases it is acceptable to regard these organizations as the source, although it is preferable to attempt to retrace the funds to their original sources.

f) Public General University Funds (GUF)

(233) The largest single area of disagreement about sources of funds analysis occurs with "public General University Funds" (GUF). Universities usually draw on three types of funds to finance their R&D activities:

- R&D contracts and earmarked grants received from government and other outside sources. These should be credited to their original source.

- Income from endowments, shareholdings, property plus receipts from the sales of non-R&D services such as fees from individual students, subscriptions to journals, sales of serum or agricultural produce. These retained receipts are clearly the universities' "Own Funds". In the case of private universities these may be a major source of funds for R&D.

- 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.

X Gross Domestic Expenditure on R&D (GERD)

(236) GERD is total intramural expenditure on R&D performed on the national territory during a given period.

(237) It includes R&D performed within a country and funded from abroad but excludes payments made abroad for R&D. GERD is constructed by adding together the intramural expenditures of the four performing sectors. It is often displayed as a matrix of performing and funding sectors (see appendix "D"). The GERD and GERD matrix are fundamental to the international comparison of R&D expenditures. They also provide the accounting system within which the institutional classifications and functional distributions may be applied.

XI Conclusion

(42) To conclude, four general points about the use of both R&D statistics and R&D funding data:

- Such series are only a summary quantitative reflection of very complex patterns of activities and institutions. For this reason, it can be dangerous to use them "neat". They should, as far as possible, be analyzed in the light of any relevant qualitative information. Particularly in the case of international comparisons, the size, aspirations and institutional arrangements of the countries concerned should be taken into consideration.

- Users generally refer to R&D data with a question in mind: "Is our national university research effort declining?" "Does my firm spend a higher proportion of its funds on basic research than the average for my industry?" etc. In order to answer these questions it is necessary to identify the basic data relevant to each one which are then used to construct an R&D indicator to answer the question.

However, some basic data may be accurate enough to answer on question but not another.

For example, government R&D funding data are usually accurate enough to answer general questions about trends in easily defined objectives: "Is there any sign that defence R&D is picking up again in the OECD area?" - but are not suitable for specific questions for less easily defined objectives - "Does my country spend more or less in absolute terms on environmental protection R&D than country X?"

- One way of constructing such indicators which is particularly useful for making international comparisons is to compare R&D inputs with a corresponding economic series, for example, by taking GERD as a percentage of the Gross Domestic Product. Such broad indicators are fairly accurate but, although the classifications and norms used to collect R&D statistics are as far as possible compatible with those for general statistics, it is much more difficult to make detailed comparisons between R&D and non-R&D series both because of the residual differences in methodology and because of defects in the non-R&D data.

- The problems of data quality and comparability which have been noted above are characteristic of the whole range of data on dynamic socio-economic activities - such as employment on international trade - which are important to policy makers, managers, analysts and others. The philosophy underlying the evolution of R&D statistical standards in the Manual has been to identify and gradually resolve these problems through exploring various approaches and learning from Member countries' experience.