Department of Science and Technology

Human Sciences Research Council

SOUTH AFRICAN SURVEY OF RESEARCH AND DEVELOPMENT INPUTS

2001/2002

USER GUIDE

Research Institutes
Museums

The benefits of knowing one's R&D investment are profound.
Access to indicators provides the ability to benchmark (by sector, nationally and globally).
This in turn can assist strategic direction, policy development and organizational planning,
thus adding value and promoting competitive advantage.

This User Guide has been developed to assist you in completing the survey questionnaire
by providing further background and definitions on R&D
and more information on how to answer questions in the survey form.

This will in turn contribute to the collection of quality data.

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Introduction

This survey is guided by the Organisation for Economic Cooperation and Development (OECD) **Frascati Manual**: *The Measurement of Scientific and Technological Activities – Proposed Standard Practice for Surveys of Research and Development.*

The first Frascati Manual was produced nearly 40 years ago. The latest edition was published in 1993 and a current revision is underway. Frascati compliant Research and Experimental Development (R&D) Surveys are carried out on a regular basis by member countries of the OECD and by many other non-OECD countries. The Frascati Manual provides methods and definitions that enable internationally comparability while recognizing local conditions.

This survey deals exclusively with the **measurement of human resources and financial expenditure devoted to R&D**, often referred to as **R&D "input" data**. In no way does this survey aim to measure "R&D Outputs" or the results from R&D expenditure and efforts. These output data are properly the domain of a different study and for this reason an innovation survey according to the OECD "Oslo Manual" is planned.

With the recent launch of the government's National R&D Strategy, there is an urgent need for official baseline statistical indicators to inform this strategy. Thus, this survey is devoting considerable effort and resources to ensure it is comprehensive, Frascati guided, and carefully documented. Future surveys (to be carried out either annually or in alternate years) will therefore have a sound and tested base. This survey is also being run in close collaboration with Statistics South Africa to enable compliance with the Statistics Act so that the resultant R&D data might at a later stage be recognised as a component of Official Statistics.

The survey results will be an invaluable source of information and should allow different sectors and organisations in the country to benchmark themselves against each other and the international environment.

In South Africa R&D surveys have been undertaken since 1964 but in the last decade these surveys have been fairly irregular and have not been able to measure all sectors of the economy comprehensively enough to provide robust indicators.

This survey aims to address these issues.

You may find it useful to read the notes embedded in the questionnaire as you complete the survey. This User Guide provides additional detail.

Please remember that we encourage you to consult with other available information sources and to seek out Frascati information specific to your industry to ensure your submission is as Frascati compliant as possible.

Thank you for the time & effort you are devoting to this survey.

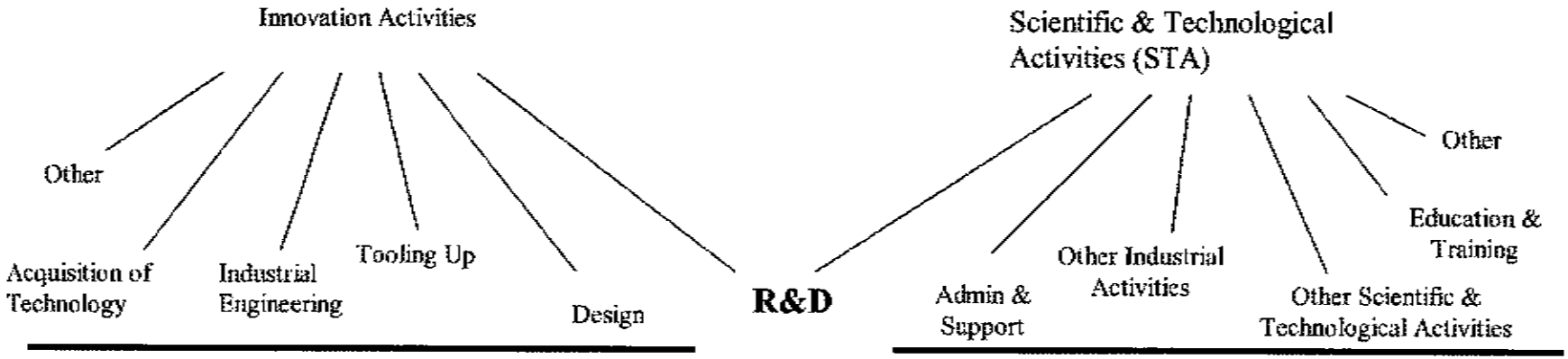
Acknowledgements

This guide has been compiled with reference to various publications including the OECD Frascati Manual and materials generated by the following:

Australian Bureau of Statistcs
Department of Trade and Industry (RSA)
Statistics Canada
Statistics South Africa

Organisation for Economic Cooperation and Development (OECD)

Conceptual Map of R&D Input Measurement



Innovation activities include all scientific, technological, organisational, financial and commercial steps intended to lead to technologically new or improved products or processes.

R&D is only one of these activities and may be carried out at different phases of the innovation process. It may act as an original source of inventive ideas and also as a means of problem solving at any point up to implementation

In no way does this survey attempt to measure the outputs or results of innovation or STA's.

That part of innovation that has an appreciable element of novelty and resolves scientific or technological uncertainty, and is therefore R&D, needs to have it's investment recorded in this survey.

Basic Research, Applied Research & Experimental Development

For survey purposes, R&D must be distinguished from a wide range of activities with a scientific and technological basis.

These activities are closely linked to R&D, but as far as possible, they should be excluded when measuring R&D.

That part of the above which is properly R&D must have it's investment measured.

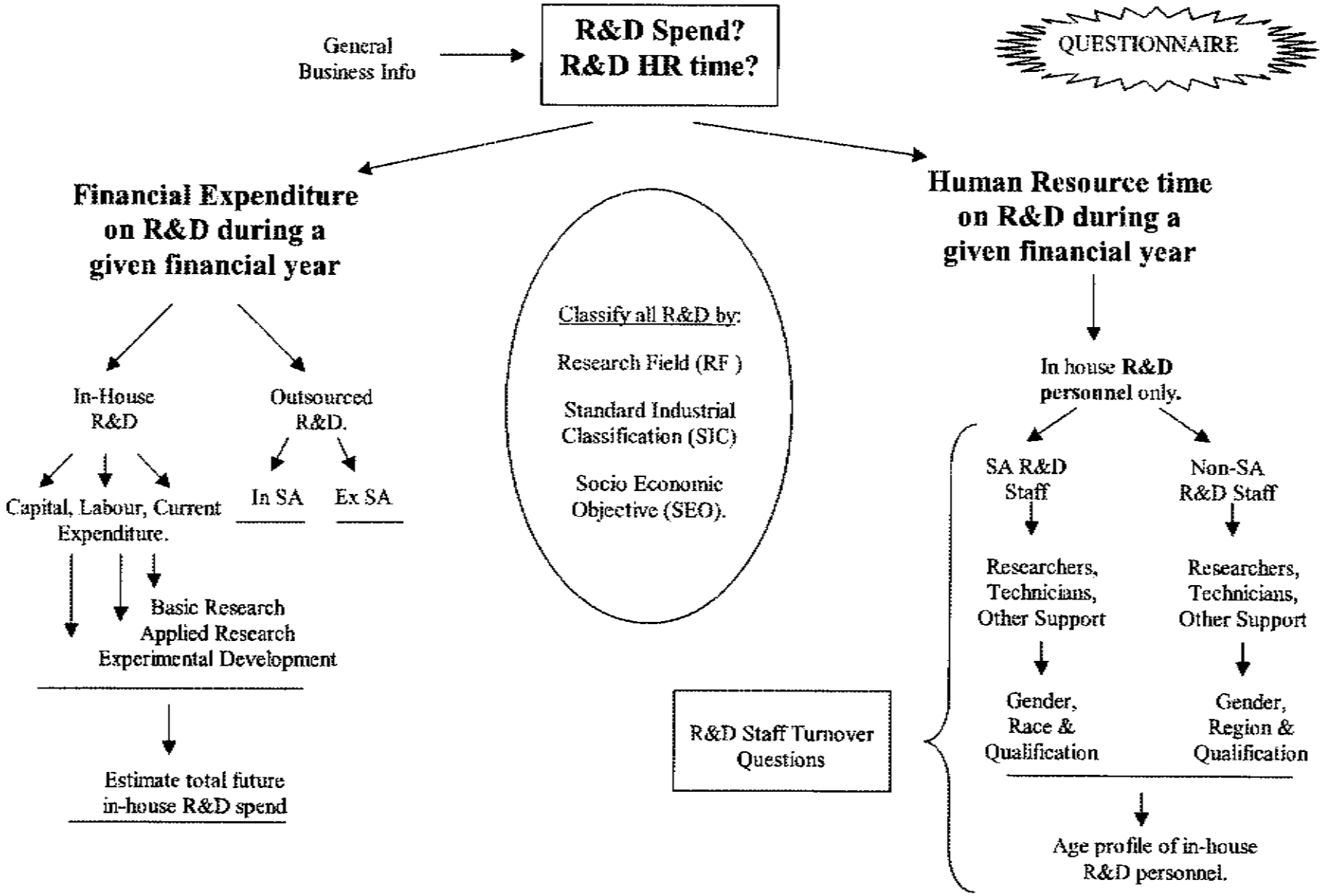
Direct & Indirect Support of R&D

The boundaries of R&D, see:
- Supplementary criteria for distinguishing R&D.
- Problems at the borderline……
- Specific Cases
- Examples etc.

R&D Spend?
R&D HR time?

Fold Here

Map of the Questionnaire



What is R&D?

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 humanity, culture and society, and the use of this stock of knowledge to devise new applications.

The basic criterion for distinguishing R&D from related activities is the presence in R&D of an appreciable element of novelty and the resolution of scientific and/or technological uncertainty,
i.e. when the solution to a problem is not readily apparent to someone familiar with the basic stock of commonly used knowledge and techniques in the area concerned.

R&D work itself can be divided into four types of activities:

- Pure Basic Research
- Strategic Basic Research
- Applied Research
- Experimental Development

These are well described in the embedded notes in the questionnaire itself.

Quite often it is difficult to distinguish between research and experimental development (R&D) and other activities. However, if the activity aims at the increase of scientific and technological knowledge and/or the devising of new applications thereof, if it contains a large element of creative novelty or innovation and if it uses scientific methods, then it should be considered as R&D.

R&D can be carried out on both products and processes and can involve radically new technologies, or can be based on combining existing technologies in new uses.

For the purpose of this survey "R&D" denotes Research and Experimental Development as defined by the Frascati Manual.

Innovation Activities to be excluded from R&D

Apart from R&D, six fields of innovative activities can often be observed in the innovation process and should be excluded from R&D:

Tooling-up and industrial engineering cover acquisition of and changes in production machinery and tools and in production and quality control procedures, methods, and standards required to manufacture the new product or to use the new process. (see table and further notes for clarity on that part of tooling up that is R&D).

Manufacturing start-up and preproduction development may include product or process modifications, retraining personnel in the new techniques or in the use of the new machinery, and trial production if it implies further design and engineering.

Marketing for new products covers activities in connection with the launching of a new product. These may include market tests, adaptation of the product for different markets and launch advertising, but will exclude the building of distribution networks for market innovations.

Acquisition of disembodied technology includes acquisition of external technology in the form of patents, non-patented inventions, licences, disclosure of know-how, trademarks, designs, patterns, and services with a technological content.

Acquisition of embodied technology covers acquisition of machinery and equipment with a technological content connected to either product or process innovations introduced by the firm.

Design is an essential part of the innovation process. It covers plans and drawings aimed at defining procedures; technical specifications; and operational features necessary to the conception, development, manufacturing and marketing of new products and processes. It may be a part of the initial conception of the product or process, i.e. research and experimental development, but it may also be connected to tooling-up, industrial engineering, manufacturing start-up, and marketing of new products.

Scientific and Technological Activities to be excluded from R&D

For survey purposes, R&D must be distinguished from a wide range of related activities with a scientific and technological basis. These other activities are very closely linked to R&D both through flows of information and in terms of operations, institutions and personnel, but as far as possible they should be excluded when measuring R&D. The following four (4) sets of activities should be excluded from R&D measurements except where they are specifically carried out for an R&D project:

Education and Training

Other Scientific and Technological Activities

Other industrial activities

Administration and other (indirect) supporting activities

1. Education and Training

All education and training of personnel in all fields in the higher education sector should be excluded. However, research by students at the PhD and masters levels should be counted, wherever possible, as part of R&D. Supervision activities regarding postgraduate students should be included in R&D only if they are equivalent to the direction and management of a specific R&D project, containing a sufficient element of novelty and having as its object to produce new knowledge.

2. Other Scientific and Technological Activities

The following activities should be excluded from R&D except when carried out solely or primarily for the purpose of an R&D project:

2.1 Scientific and technical information services (such as collecting, coding, recording, classifying, disseminating, translating, analysing and evaluating) except when conducted solely for the purpose of R&D support (e.g. the preparation of the original report of R&D findings for a project should be included in R&D).

2.2 General-purpose data collection (e.g. routine topographical mapping, routine geological, hydrological, oceanographic and meteorological surveying, astronomical observations and market surveys). Only the effort devoted to collecting data for the purpose of scientific research should be recorded.

2.3 Testing and standardisation (e.g. maintenance and calibration of standards).

2.4 Feasibility studies, except feasibility studies on research projects.

2.5 Specialised health care.

2.6 Patent and licence work except where connected directly with R&D projects. Licence fees should be excluded from R&D.

2.7 Policy-related studies, including national policy, policy at regional and local levels as well as that of business enterprises in the pursuit of their economic activities.

2.8 Routine software development.

3. Other industrial activities

- Other innovation activities (all the scientific and financial steps, other than R&D, necessary for the implementation of new or improved products or services and the commercial use of new or improved processes).
- Production and related technical services.

Sometimes it is difficult to define precisely the cut-off point between experimental development and pre-production development, such as producing user demonstration models and testing, and production that is applicable to all industrial applications. The basic rule originally laid down by the National Science Foundation (NSF) of the USA 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, the work is no longer R&D."

4. Administration and other supporting activities

- Purely R&D-financing activities are not R&D. (e.g. the raising, management and distribution of R&D funds to R&D performers by ministries, research agencies, foundations or charities is not R&D).
- Indirect supporting activities cover a number of activities which are not themselves R&D but which provide support for R&D.
- By convention, in surveys, R&D personnel data cover R&D proper but exclude indirect supporting activities.
- Allowance for indirect supporting activities is included under overheads in R&D expenditure of R&D performing companies. Typical examples are transportation, storage, cleaning, repair, maintenance and security activities. Administration and clerical activities undertaken not exclusively for R&D, such as the activities of central finance and personnel departments, also considered indirect supporting activities.
- Note: Direct supporting activities are R&D.

  Indirect supporting activities are not R&D, but allowance is made under overheads in R&D expenditure

The Boundaries of R&D

Supplementary criteria for distinguishing R&D from related activities

A. What are the objectives of this project?

B. What is new or innovative about this project?
   - Is it seeking previously undiscovered phenomena, structures or relationships?
   - Does it apply knowledge or techniques in a new way?
   - Is there a significant chance that it will result in new (extended or deeper) understanding of phenomena, relationships or manipulative principles or interest to more than one organisation?
   - Are the results expected to be patentable?

C. What staff are working on the project?

D. What methods are being used?

E. Under what programme is the project funded?

F. How general are the findings or results of the project likely to be?

G. Does the project fall more naturally into another scientific, technological or industrial activity?

One aspect of these criteria is that a particular project may be R&D if undertaken for one reason, but not if carried out for another as shown in the following examples:

- In medicine, routine tests such as blood and bacteriological tests carried out for doctors are not R&D, whereas a special programme of blood tests in connection with the introduction of a new drug is R&D.
- The keeping of daily records of temperature or of atmospheric pressure is not R&D whereas the investigation of a new method of measuring temperature is R&D.
- In mechanical engineering, if calculations, designs, working drawings and operating instructions are made for the setting up and operating of pilot plants and prototypes, they should be included in R&D. If they are carried out for the preparation, execution and maintenance of production standardisation they should be excluded from R&D.

Problems at the borderline between R&D and related Scientific and Technological Activities

Specific cases

In certain cases, the theoretical criteria for distinguishing between R&D and related scientific and technological activities are particularly difficult to apply. Space exploration, mining and prospecting and the development of social systems are three areas involving large amounts of resources, and any variations in their treatment will have important effects on the international comparability of the resulting R&D data. Large-scale projects also pose problems for the definition of their R&D; these are dealt with further on in this User Guide. The following conventions apply in the areas mentioned.

Space exploration
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 the activities associated with space exploration, including the development of vehicles, equipment and techniques, from those involved in the routine placing of orbiting satellites or the establishment of tracking and communication stations.

Mining and prospecting
Mining and prospecting sometimes cause problems owing to a linguistic confusion between research for new or substantially improved resources (food, energy, etc.) and the search for existing reserves of natural resources, a confusion which blurs the distinction between R&D and surveying and prospecting. In theory, in order to establish accurate R&D data, the following activities should be identified, measured, and summed:

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

In practice, the last of these presents a number of problems. It is difficult to frame a precise definition that would be meaningful to respondents to national surveys. For this reason, only the following activities should be included in R&D:

- 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.
- Surveying undertaken as an integral part of an R&D project on geological phenomena *per se*, including data acquisition, processing and interpretation undertaken for primarily scientific purposes.

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.

The development of social systems
In general, but more particularly in the field of the social sciences, the purpose of a study is to prepare the way for decisions by policy makers at the level of government (central, regional, local) or in industrial and trading enterprises.

Usually, such studies employ established methodologies, but it is sometimes necessary to modify existing methodologies or to develop new ones. This requires an appreciable amount of research. In theory, such modification or development should be included in R&D, but one must be aware of the difficulties involved in evaluating the appropriate share of R&D in a given study. In practice, despite the technical and conceptual problems, it may be feasible either to assign studies which include an appreciable element of novelty entirely to research or to attempt to estimate the proportion of research in those studies and attribute this to R&D.

For determining whether a particular activity should be regarded as R&D or be attributed to R&D, the fact that the activity is called "research" or that the report resulting from the activity performed is called "research" is irrelevant. If a particular activity falls within the definition of R&D, then it is regarded as or attributed to R&D; if not, it is excluded.

Problems at the borderline between R&D and other industrial activities

General approach
Care must be taken to exclude activities which, although undoubtedly a part of the innovation process, rarely involve any R&D, e.g. patent filing and licensing, market research, manufacturing start-up, tooling up and redesign for the manufacturing process. Some activities, such as tooling up, process development, design and prototype construction, may contain an appreciable element of R&D, thus making it difficult to identify precisely what should or should not be defined as R&D. This is particularly true for defence and large-scale civil industries such as aerospace. 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 food and drugs. (See Table 1).

Table 1. Some cases at the borderline between R&D and other industrial activities

Item	Treatment	Remarks
Prototype	Include in R&D	As long as the primary objective is to make further improvements.
Pilot Plant	Include in R&D	As long as the primary purpose is R&D.
Industrial Design & Drawing	Divide	Include design required during R&D. Exclude design for production process.
Industrial Engineering & Tooling Up	Divide	Include "feedback" R&D and tooling up industrial engineering associated with development of new products and new processes. Exclude for production purposes.
Trial Production	Divide	Include if production implies full-scale testing and subsequent further design and engineering. Exclude all other associated activities.
After sales service & Trouble shooting	Exclude	Except "feedback" R&D.
Patent & Licence Work	Exclude	All administrative work connected with patents and licences(except patent work directly connected with R&D projects).
Routine Tests	Exclude	Even if undertaken by R&D staff.
Data Collection	Exclude	Except when an integral part of R&D.
Public Inspection Control, Enforcement of Standards, Regulations	Exclude	

"If the primary objective is to make further technical improvements on the product or process, then the work falls within the definition of R&D. If, however, 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 considered R&D."

Despite this elaboration, it can be difficult to apply in individual industries. It may not be clear when there is an appreciable element of novelty, or when a product/process is substantially set.

Specific cases
Some common problem areas are described below.

Prototypes
A prototype is an original model constructed to include all the technical characteristics and performances of the new product. For example, if a pump for corrosive liquids is being developed, several prototypes are needed for accelerated life tests with different chemicals. A feedback loop exists so that if the prototype tests are not successful, the results can be used for further development of the pump.

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 they are made consecutively or simultaneously. However, when any necessary modifications to the prototype(s) have been made and testing has been satisfactorily completed, the end-point of R&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&D staff, is not part of R&D.

Pilot plants
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 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.

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&D even though it may still be described as a 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 is sold. Such receipts should not be deducted from the cost of R&D activity.

Large-scale projects and costly "pilot plants"
Large-scale projects, of which defence and aerospace are the most significant types, usually cover a spectrum of activity from experimental to preproduction development. Under these circumstances, the funding and/or performing organisation often cannot distinguish between the R&D and other elements of expenditure. The distinction between R&D and non-R&D expenditures is particularly important in countries where a large proportion of government R&D expenditure is directed to defence. Annex 10 provides supplementary guidelines on this question.

It is very important to look closely at the nature of very costly pilot plants or prototypes, such as the first of a new line of nuclear power stations or of icebreakers. They may be constructed almost entirely from existing materials and using existing technology, and they are often built for simultaneous use for R&D and for providing the primary service concerned (power generation, ice breaking). The construction of such plants and prototypes should not be wholly credited to R&D. Only the additional costs due to the prototype nature of these products should be attributed to R&D.

Trial production
After a prototype has been satisfactorily tested and any necessary modifications made, the manufacturing start-up phase may begin. It is related to full-scale production; it may consist of product or process modification or retraining personnel in the new techniques or in the use of new machinery. Unless the manufacturing start-up phase implies further design and engineering, it should not be counted as R&D, since the primary objective is no longer to make further improvements to the products but to start the production process. The first units of a trial production run for a mass production series should not be considered as R&D prototypes even if they are loosely described as such.

For example, if a new product is to be assembled by automatic welding, the process of optimising the settings on the welding equipment in order to achieve maximum production speed and efficiency would not count as R&D (even if joint-strength requirements have to be met).

Trouble-shooting
Trouble-shooting occasionally shows 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.

"Feedback" R&D
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 should be included.

Industrial design
The vast bulk of design work in an industrial area is geared towards production processes and as such is not classified as R&D. There are, however, some elements of design work which should be considered as R&D.

These include plans and drawings aimed at defining procedures, technical specifications and operational features necessary to the conception, development and manufacturing of new products and processes.

For example, if an engineering product which incorporates machined, heat-treated and/or electroplated components has been developed, the drawing up and documenting of the requirements for surface smoothness, heat treatment procedures or electroplating process requirements, whether incorporated in the drawings or as separate specification sheets, are considered to be R&D.

Tooling up and industrial engineering
In most cases, the tooling-up and industrial engineering phases of any project are considered to be part of the production process.

Three phases of tooling up can be identified:

- The first-time use of components (including the use of components resulting from R&D efforts).
- The initial tooling of equipment for mass production.
- Installing equipment linked with the start of mass production.

However, if the tooling-up process results in further R&D work, such as developments in the production machinery and tools, changes to the production and quality control procedures or the development of new methods and standards, these activities are classified as R&D.

"Feedback" R&D resulting from the tooling-up phase should be defined as R&D.

Clinical trials
Before new drugs, vaccines or treatments can be introduced on the market, they must be tested systematically on human volunteers to ensure that they are both safe and effective. These clinical trials are divided into four standard phases, three of which take place before permission to manufacture is accorded. For the purposes of international comparison, by convention, clinical trial phases 1, 2 and 3 can be treated as R&D. Phase 4 clinical trials, which continue testing the drug or treatment after approval and manufacture, should only be treated as R&D if they bring about a further scientific or technological advance. Moreover, not all activities undertaken prior to permission to manufacture are considered to be R&D, especially when there is a significant wait after the completion of phase 3 trials, during which marketing and process development activities may be started.

Problems at the borderline between R&D administration and indirect supporting activities

The R&D activities described above are supported by a number of other activities. In R&D statistics, the practice is that personnel data should cover only R&D proper, whereas expenditure data should cover the full cost of R&D, including the indirect supporting activities which are treated as overheads

Some activities, such as the provision of library or computer services, are R&D proper if they are intended exclusively for R&D, but indirect supporting activities if they are provided by central departments for both R&D and non-R&D uses. The same argument applies for management, administration and clerical activities. When these contribute directly to R&D projects and are undertaken exclusively for R&D, then they are part of R&D proper and included in R&D personnel. Typical examples are the R&D manager who plans and supervises the scientific and technical aspects of the project or the person who produces the interim and final reports containing the results of the project. It remains a moot point whether the bookkeeping associated with a specific R&D project is direct (R&D proper) or indirect (ancillary) activity.

By convention, it is R&D proper rather than an indirect supporting activity if it is carried out in close proximity to the R&D

Identifying R&D in software development, in the social sciences and humanities and in service activities and industries

The model on which the Manual was originally based was that of institutionally structured R&D in the natural sciences and engineering leading to tangible technological innovations in primary and secondary industries. Software development has since become a major intangible innovation activity with a high R&D content. In addition, an increasing share of relevant activities draws on the social sciences and humanities, and, together with advances in computing, leads to intangible innovations in service activities and products, with a growing contributions by service industries in the business enterprise sector.

The tools developed for identifying R&D in traditional fields and industries are not always easy to apply to these new areas. This section deals with the problems of identifying R&D in software development, in the social sciences and humanities and in service activities.

Identifying R&D in software development

For a software development project to be classified as R&D, its completion must be dependent on the development of a scientific and/or technological advance, and the aim of the project must be the systematic resolution of a scientific and/or technological uncertainty.

In addition to the software that is part of an overall R&D project, the R&D associated with software as an end product should also be classified as R&D.

The nature of software development is such as to make identifying its R&D component, if any, difficult. Software development is an integral part of many projects which in themselves have no element of R&D. The software development component of such projects, however, may be classified as R&D if it leads to an advance in the area of computer software. Such advances are generally incremental rather than revolutionary. Therefore, an upgrade, addition or change to an existing programme or system may be classified as R&D if it embodies scientific and/or technological advances that result in an increase in the stock of knowledge. Use of software for a new application or purpose, however, does not by itself constitute an advance.

A scientific and/or technological advance in software may be achieved even if a project is not completed, because a failure can increase knowledge of the technology of computer software by showing, for example, that a particular approach will not succeed given the limits of the business environment.

Advances in other fields resulting from a software project do not determine whether an advance in computer software has occurred.

The following examples illustrate the concept of R&D in software and should be included in R&D:

- R&D producing new theorems and algorithms in the field of theoretical computer science.
- Development of information technology at the level of operating systems, programming languages, data management, communications software and software development tools.
- Development of Internet technology.
- Research into methods of designing, developing, deploying or maintaining software.
- Software development that produces advances in generic approaches for capturing, transmitting, storing, retrieving, manipulating or displaying information.
- Experimental development aimed at filling technology knowledge gaps as necessary to develop a software programme or system.

- R&D on software tools or technologies in specialised areas of computing (image processing, geographic data presentation, character recognition, artificial intelligence and other areas).

Software-related activities of a routine nature which do not involve scientific and/or technological advances or resolution of technological uncertainties are not to be included in R&D. Examples are:

- Business application software and information system development using known methods and existing software tools.
- Support for existing systems.
- Converting and/or translating computer languages.
- Adding user functionality to application programmes.
- Debugging of systems.
- Adaptation of existing software.
- Preparation of user documentation.

In the systems software area, individual projects may not be considered as R&D but their aggregation into a larger project may qualify for inclusion. For example, changes in file structure and user interfaces in a fourth-generation language processor may be made necessary by the introduction of relational technology. The individual changes may not be considered R&D if viewed in their own right, but the entire modification project may result in the resolution of scientific and/or technological uncertainty and thus be classified as R&D.

Identifying R&D in the social sciences and humanities

The social sciences and humanities are covered in the Frascati Manual by including in the definition of R&D "knowledge of humanity, culture and society". For the social sciences and humanities, an appreciable element of novelty or a resolution of scientific/technological uncertainty is again a useful criterion for defining the boundary between R&D and related (routine) scientific activities. This element could be related to the conceptual, methodological or empirical part of the project concerned. Related activities of a routine nature can only be included in R&D if they are undertaken as an integral part of a specific research project or undertaken for the benefit of a specific research project. Therefore, projects of a routine nature, in which social scientists bring established methodologies and facts of the social sciences to bear on a particular problem, cannot be classified as research.

The following are examples of work which might fall into this routine category are generally not R&D: commentary on the probable economic effects of a change in the tax structure, using existing economic data; 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.

Special problems for identifying R&D in service activities

Defining the boundaries of R&D in service activities is difficult, for two main reasons: first, it is difficult to identify projects involving R&D; and, second, the line between R&D and other innovative activities which are not R&D is a tenuous one.

Among the many innovative projects in services, those that constitute R&D result in new knowledge or use of knowledge to devise new applications, in keeping with the definition in the first paragraph under "What is R&D" earlier in this guide.

Identifying R&D is more difficult in service activities than in manufacturing because it is not necessarily "specialised". It covers several areas: technology-related R&D, R&D in the social sciences and humanities (SSH), including R&D relating to the knowledge of behaviour and organisations. This last notion is already

included under the knowledge of "man, culture and society" criterion, but it is particularly important in the case of service activities. Because these types of R&D may be combined in a given project, it is important to circumscribe clearly the various forms of R&D involved. If the analysis is confined to technology-related R&D, for example, R&D may be understated. In many cases, R&D findings in service industries are embodied in software which is not necessarily innovative from the technical point of view but innovates by virtue of the *functions* that it performs.

Also, in service companies, R&D is not always organised as formally as in manufacturing companies (*i.e.* with a dedicated R&D department, researchers or research engineers identified as such in the establishment's personnel list, etc.). The concept of R&D in services is still relatively little known and sometimes goes unrecognised by the enterprises involved. As more experience becomes available on surveying R&D in services, the criteria for identifying R&D and examples of service-related R&D may require further development.

Criteria for identifying R&D in services
The following are among the criteria that can help to identify the presence of R&D in service activities:

- Links with public research laboratories.
- The involvement of staff with PhDs, or PhD students.
- The publication of research findings in scientific journals, organisation of scientific conferences or involvement in scientific reviews.
- The construction of prototypes or pilot plants.

Examples of R&D in selected service activities
The R&D activities listed below may serve as examples of R&D in service activities. The general and supplementary criteria for distinguishing R&D presented earlier have also to be taken into account.

The general boundaries of R&D as defined earlier in this document regarding problems at the borderline of R&D, activities to be excluded from R&D etc. also largely apply to service activities. The element of novelty is a basic criterion for distinguishing R&D from related activities.

Examples of R&D in banking and insurance
- Mathematical research relating to financial risk analysis.
- Development of risk models for credit policy.
- Experimental development of new software for home banking.
- Development of techniques for investigating consumer behaviour for the purpose of creating new types of accounts and banking services.
- Research to identify new risks or new characteristics of risk that need to be taken into consideration in insurance contracts.
- Research on social phenomena with an impact on new types of insurance (health, retirement, etc.), such as on insurance cover for non-smokers.
- R&D related to electronic banking and insurance, Web-related services and e-commerce applications.
- R&D related to new or significantly improved financial services (new concepts for accounts, loans, insurance and saving instruments).

Examples of R&D in some other service activities

- Analysis of the effects of economic and social change on consumption and leisure activities.
- Development of new methods for measuring consumer expectations and preferences.
- Development of new survey methods and instruments.
- Development of tracking and tracing procedures (logistics).
- Research into new travel and holiday concepts.
- Launch of prototype and pilot stores.

Research Field (or Field of Science & Technology)

Resources should be allocated to the various fields of science and technology on the basis of the focus of R&D activities, measured in terms of expenditure or field in which R&D personnel actually work, usually at project level. Where appropriate, e.g. in the case of projects with a multidisciplinary character, a breakdown of resources by several fields of science and technology should be made. (For Codes see Codes Book)

Standard Industrial Classification (SIC) (or Product Field) (For Business Sector Only)

In distributing R&D by Standard Industrial Classification (SIC) (also called Product Field), the distribution should take the nature of the product into consideration (for SIC codes see Codes Book)

Nature of product

When applying the "nature of product" criterion, the R&D input is distributed according to the type of product being developed.

The guidelines formerly used by the National Science Foundation (USA) to survey applied research and experimental development in industry are good examples of operational criteria:

> "Costs should be entered in the field or product group in which the research and development project was carried out, regardless of the classification of the field of manufacturing in which the results are to be used. For example, research on an electric component for a farm machine should be reported as research on electrical machinery. Also, research on refractory bricks to be used by the steel industry should be reported as research on stone, clay, glass and concrete products rather than primary ferrous metals, whether performed in the steel industry or the stone, clay, glass and concrete industry."
>
> **(National Science Foundation, 1983)**

These guidelines should pose few problems for most R&D projects on product development. R&D on processes may be more difficult to deal with. If the results of the R&D will clearly be embodied in materials or equipment, then the guidelines should be applied to those products. If not, then the process should be allocated to the product it is destined to produce. Furthermore, for enterprises engaged in broad R&D programmes, quite detailed records or consultations with R&D personnel are needed in order to provide complete estimates.

Socio Economic Objective (SEO)

Distribution by socio-economic objective

Two approaches to distribution are possible:

a) according to the purpose of the R&D programme or project;

b) according to the general content of the R&D programme or project.

However, **R&D should be classified according to its primary objective.**

Where there are problems in identifying the primary purpose of the funder of the R&D or where there seem to be differences between the "purpose" and the "content" of a programme, two principles may be of use:

- Direct derivation: A project which owes its existence solely to the technical needs of another programme is directly derived from the said programme and should be classified with it.
- Indirect spin-off: Where the results of R&D undertaken for one purpose are subsequently reworked to give an application relevant to another objective, this is indirect spin-off and should be credited to the objective to which the subsequent R&D is oriented.

R&D Personnel

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.

Persons 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 when measuring expenditure.

When measuring human resources devoted to R&D, notice has to be taken of the increased use of on-site consultants as well as the outsourcing of R&D to other units or firms. With the greater use of consultants, human resources devoted to R&D may be underestimated when it is difficult to determine whether consultants are on-site or part of an outsourcing arrangement. To remedy this underestimate, it is proposed to request on-site consultants' full-time equivalence (FTE) on R&D in R&D surveys and to highlight the corresponding costs in "other current costs" in R&D survey results. In the case of outsourcing, consultant costs clearly fall under extramural expenditures.

Categories of R&D Personnel

Researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods, and systems, and in the management of the projects concerned.

Technicians and equivalent staff are persons whose main tasks require technical knowledge and experience in one or more fields of engineering, physical and life science, or social sciences and humanities. They participate in R&D by performing scientific and technical tasks involving the application of concepts and operational methods, normally under the supervision of researches. Equivalent staff perform the corresponding R&D tasks under the supervision of researchers in the social sciences and humanities.

Other supporting staff include skilled and unskilled artisans, secretarial and clerical staff participating in R&D projects or directly associated with such projects.

Percentage time on R&D as a proxy for FTE (Full Time Equivalent)

It is important to note that the Frascati Manual requests data on FTE while this survey asks for the percentage time that personnel groups (researchers, technicians & other support) devote to R&D. The percentage figure submitted by you will be used to derive FTE to ensure compliance with Frascati.

For example. If you state that 4 (four) technicians spend 50% (fifty percent) of their time on R&D for your company, this would imply that the equivalent of 2 (two) full-time R&D technicians work for your company. Thus, even though four people work for your company, their efforts account for two FTEs.

In this way, the percentage time spent on R&D will be used by us to calculate FTE. This fact is mentioned because you may be concerned that the Frascati Manual asks for FTE's , while this survey does not ask for FTE's directly.

R&D Expenditures

Measurement of in-house R&D expenditure

Please note that your best intelligent and careful estimate may be necessary in providing data where company information is not available.

Capital expenditures

Capital expenditures are the annual gross expenditures on fixed assets used in the R&D programmes.They should be reported in full for the period when they took place and should not be registered as an element of depreciation. They are composed of expenditures on:

Land, 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.

Instruments and equipment. This comprises equipment acquired for use in the performance of R&D including software.

Labour costs.

These comprise 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. The labour costs of persons providing indirect services and which are not included in the personnel data (such as security and maintenance personnel or the staff of central libraries, computer departments, or head offices) should be excluded and included in other current costs.

Labour costs are often the largest component of current costs

Other current expenditure.

These comprise non-capital purchases of materials, supplies and equipment to support R&D performed by the statistical unit in a given year. Examples are: water and fuel (including gas and electricity); books, journals, reference materials, subscriptions to libraries, scientific societies and so on; imputed or actual cost of small prototypes or models made outside the research organisation; materials for laboratories (chemicals, animals, etc.). Administrative and other overhead costs (such as interest charges and office, post and telecommunications, and insurance costs) should also be included, prorated if necessary to allow for non-R&D activities within the same statistical unit. All expenditures on indirect services should be included here, whether carried out within the organisation concerned or hired or purchased from outside suppliers. Examples of such services are security; storage; use, repair and maintenance of buildings and equipment; computer services; and printing of R&D reports.

Data on R&D expenditure on both a provider and funder basis should be at factor cost. This means **excluding VAT** and similar sales taxes from the measured cost of the R&D and specifically of R&D financed by government.

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