1. Introduction

The Statistic on scientific research and technological development (R+D) activities arose with the objective of measuring economic and human resources (inputs) destined to these activities, in order to satisfy a dual purpose:

1. To provide an instrument for the management, planning, decision and control of national scientific policy.

2. To provide statistical institutions with the information that they request, obtained in accordance with international regulations that facilitate comparability between various countries.

Background

In 1960, the majority of OECD member states, stimulated by the rapid growth of national resources used for research and experimental development (R+D), commenced collection of statistical data in this field. During this first stage theoretical difficulties were found, and the differences in scope, methods and concepts made international comparison difficult. It was therefore necessary to carry out a standardisation of concepts and definitions that were acceptable to all OECD member states.

Thus, a group of experts was created which met in Frascati (Italy) and elaborated and approved the document *"Proposed standardised methodology for surveys on research and experimental development*" (OECD, 1963), better known as the Frascati Manual.

This manual is the methodological base for R+D Statistics

The first survey on scientific and technical research in Spain, extended to both the public as well as the private sector, was elaborated with reference to the year 1964 by a group of Spanish experts in collaboration with the OECD. The results were published by the Ministry of Education and Science in 1966, in the so-called "Yellow Book".

Subsequently, the Planning group of the Technical Office of the "Juan de la Cierva" Trust Foundation elaborated a *Survey on scientific and technical research activities in Spain in 1967*. This was the first systematic and complete study on scientific and technical research activities of the public and private sectors. The elaboration of a company's directory for this survey served as the basis for the subsequent surveys carried out by the National Statistics Institute (INE).

Subsequently, conforming with the Government Order dated the 1st of April 1971, which entrusted the INE with the elaboration of the R+D statistic, this organism began to elaborate surveys on scientific research and technological development activities, the first of which was referenced to the year 1969.

The R+D Statistic in Spain has been elaborated following the recommendations issued by the OECD in the Frascati Manual, the sixth version of which was published in 2002. This Manual is one of the pillars of the actions carried out by the OECD in an effort to obtain a better understanding of the role of science and technology. Moreover, by providing internationally accepted R+D definitions and classifications, the results obtained from this Statistic comply with the criteria that allows for their international comparison.

2.1 Objectives

The objective of this study is the measurement of the national effort in R+D activities, so that it is possible to provide the necessary information for the taking of adequate scientific-technological policy decisions. To this end, the aim is to ascertain information on the economic and human resources destined to research by all the economic sectors of the country.

With the purpose of ascertaining the financial resources employed, the aggregated *Domestic R+D expenditure* is calculated, consisting of the totality of R+D expenditure for each one of the sectors in which the economy is divided into, irrespective of the source of the funds and the nationality of the party providing the finance. To ascertain human potential, the number of *Personnel* (researchers and other personnel) *dedicated to R+D activities,* in equivalence to a full working day, is calculated.

2.2 Scope

POPULATION SCOPE

With this Statistic a study is carried out on companies, public institutions, universities and private non profit institutions that carry out scientific research and technological development activities in any scientific field, including social sciences and humanities, and which are situated within national territory. Excluded are scientific activities tied to R+D activities, called *related activities,* effected by the units that carry out R+D.

This scope will be delimited by the definitions and rules that will be outlined further below.

TERRITORIAL SCOPE

This extends to all of Spain.

TIME FRAME

The main reference period of this statistic is the year immediately prior to the year the data is collected. For *expenditure*, the reference period will be the natural year. With regards to *personnel*, to determine the number of persons who work in R+D, the statistic uses both the annual average as well as the equivalence in full working days of the personnel who carry out the R+D activities (persons/year).

The Statistic is elaborated annually, although certain non-basic data is obtained biennially. In this sense, the OECD and EUROSTAT recommend the collection of R+D data at least during the odd reference years, although in some countries, amongst them Spain, it has been carried out annually.

The implementation of the Survey on technological innovation in companies has made it necessary to coordinate same with the R+D Statistic, with the purpose of optimising the available resources without reducing the basic information supplied up until now, and bearing in mind the information requests from national and international institutions, as well as those derived from the National Statistical Plan.

2.3 Statistical unit

These are the units from which the desired base information is obtained. For the purposes of the collection of the information and the presentation of results, the analysis units are grouped by sectors, the contents of which is based to a large extent on the National Accounts System, with the difference that Higher Education has been considered an independent sector and households have been grouped within private non profit institutions. The sectors considered are defined below, as are the analysis units for each one of them.

COMPANIES SECTOR

The following groups are included in this sector:

a) Companies, bodies and institutions whose main activity is the production of goods and services destined to sale at a price that corresponds to economic reality. A company is defined as all juridical units which constitute an organisational unit producing goods and services, and which enjoy certain decision-making autonomy, mainly when it comes to employing the current resources that it has available. From a practical point of view, and in its more general definition, the concept of company is defined as a legal or juridical unit, that is, all physical or juridical persons (companies, cooperatives, ...) whose activity is recognised by the Law, and which is identified by its corresponding Fiscal Identification Number (NIF).

Essentially, this group is formed by private companies (companies and quasi-companies), some of which have as their main activity R+D, but also included are public companies whose main activity consists in the production of goods and services destined to sale, although, due to social reasons, the price of these products and services may be below their production costs.

b) Private non-profit institutions (including research associations) that are mainly at the service of companies and which, to a large extent, are financed and controlled by same.

Within this sector a sub-sectorisation is carried out, as follows:

– public companies
– private companies
– national companies
– multinational companies (foreign capital participation amounts to at least 50%)
– research associations and other institutions

PUBLIC ADMINISTRATION SECTOR

This sector comprises:

a) Institutions that provide the community, free of charge or at conventional prices, public interest services that would not be economical or easy to provide in another manner, which administer public issues and carry out the economic and social policy of the group.

This group must include all public institutions (except public companies and higher education institutions) irrespective of the manner in which they are included within the national budget and their level of jurisdiction (central, autonomous, ...). The activities of these centres are very diverse and numerous, and are usually related to the Public Administration, defence, public order, health, education, culture, economic promotion and development, well-being, scientific and technical development, ...

b) Private non-profit institutions mainly controlled and financed by the Public Administration.

Within this sector a sub-sectorisation is carried out, as follows:

– state administration
– autonomous administration
– local administration
– other centres

The State administration institutions that conform this sector are the State, the Autonomous Institutions that are dependent on same, as well as state companies, public entities, ..., which due to their main activity and the source of their resources may be considered as belonging to the public administration sector. Also considered a part of this sector are the entities that administer Social Security, as well as hospitals that depend on same, and which perform this function on behalf of the State.

The same occurs with the institutions that are dependent on the autonomous and local administrations.

Within the State Administration, and for result presentation purposes, due to its special importance, another subsectorisation has been carried out between major public

research institutions (OPIS) directly implicated in research tasks pursuant to the *Science Act,* and other State Administration institutions. The following have been included within the section "Major OPIS":

– El Pardo Model Basin (CEHIPAR)

– National Institute for Aerospace Technology (INTA)

– Higher Council for Scientific Research (CSIC)

– Canary Islands Astrophysics Institute (IAC)

– Geological and Mining Institute of Spain (IGME)

– National Agricultural Research and Technology Institute (INIA)

– Spanish Institute of Oceanography (IEO)

– Carlos III Health Institute (ISCIII)

– Research Centre for Energy, Environment and Technology (CIEMAT)

– Centre for Studies and Experimentation on Public Works (CEDEX)

HIGHER EDUCATION SECTOR

This sector includes all the universities (faculties, technical schools and university schools), PNPI working for higher education institutions, technological institutions and other post-secondary institutions, irrespective of the source of their financial resources and their legal situation. It likewise includes all research institutions, test stations, astronomy and clinical observatories that fall under the control of higher education institutions, which are administered by same or are associated to the latter.

The following subsectorisation is made within this sector:

- Public universities
- Private universities
- other centres

PRIVATE NON-PROFIT INSTITUTIONS (PNPI)

The field covered by this sector has been noticeably reduced in the revision of the Frascati Manual in 2002. It includes private non-profit institutions outside the market and at the service of households (that is, the public in general) and individuals. They provide individual or group services to households, either free of charge or at below market prices. They may be constituted by associations of persons that provide goods or services destined mainly to its own members or with philanthropic ends. These institutions are financed with fees, contributions or donations from its members or sponsors, and with subsidies granted by companies and the Public Administration. Included within this sector are institutions such as professional associations or cultural societies, charity organisations, aid or assistance bodies, trade unions, consumer associations, ...

By agreement this sector covers the residual R+D activities of individuals (households). R+D tasks of individuals must solely be carried out in their free time, within their own facilities and with their own resources or with the aid of a *non-refundable* subsidy.

Excluded from this sector are the following private non-profit institutions:

– those in which the main activity is carried out to the benefit of companies.

– those that mainly serve the public administrations.

– those which are completely or mainly financed and controlled by the public administration.

– those that offer higher education services or are controlled by higher education institutions.

ABROAD

This sector comprises all the institutions and individuals located overseas, with the exception of vehicles, boats, airplanes and satellites used by Spanish institutions, and the experimental land acquired by same. Also included are international organisations (except companies), including their installations and activities, within our borders.

Foreigners appear in the R+D survey solely as a source of finance of the R+D carried out by national units and as the destination of the external R+D expenditure of these units.

This sector may be subdivided into:

• foreign companies

– subsidiaries (if more than 50% of the capital is held by a Spanish company)

– joint (if participation is more than 50%)

– associated (with participation less than 50%)

– other companies

• foreign public administrations

– foreign private non-profit institutions

– foreign higher education institutions

– European Union

– Other international organisations

DEFINITION PROBLEMS BETWEEN SECTORS

In the event that any unit is of a mixed participation, between two or more sectors (university / company, university / public research institutions, public administration / company, ...), to assign the unit to a specific sector it will be necessary to bear in mind whether same imparts higher education, as well as the sector to which the institutions that control and mainly finance the unit belong.

2.4 Variables and their definition

ECONOMIC ACTIVITY

This variable is only investigated in the companies sector.

The R+D activities of companies are classified according to the main economic activity that they carry out. The classification used is the National Classification of Economic Activities (NCEA-1993), considering the activities that are presented in chart 1, and which coincide with those recommended by the OECD. This classification serves to determine who is carrying out the research.

Chart 1. List of branches of activity and their correspondence with the National Classification of Economic Activities (NCEA-93)

Branches of activity	NCEA
1. AGRICULTURE	01+02+05
2. EXTRACTIVE	10+11+12+13+14
3. MANUFACTURING INDUSTRY	15 to 37
4. Food, beverages and tobacco	15+16
5. Food, beverages	15
6. Tobacco	16
7. Textiles, clothes, hides and leather	17+18+19
8. Textiles	17
9. Clothing and furs	18
10. Leather and footwear	19
11. Wood, paper, printing, publishing	20+21+22
12. Wood and cork (except furniture)	20
13. Cardboard and paper	21
14. Printing, publishing and reproduction of recorded supports	22
15. Coke, petroleum, chemistry, rubber and plastic	23+24+25
16. Coke, refinement of petroleum and nuclear fuel	23
17. Chemistry	24
18. Chemistry (except pharmacy)	24-24.4
19. Pharmaceutical products	24.4
20. Rubber and plastic	25
21. Non-metallic mineral products	26
22. Basic metallurgy products	27
23. Iron metallurgy products	27.1+27.2+27.3+27.51+27.52
24. Non-iron metallurgy products	27.4+27.53+27.54
25. Metallic manufacturers (except machinery and equipment)	28
26. Machines, computers, instruments and transport equipment	29+30+31+32+33+34+35
27. Mechanical machinery and equipment	29
28. Office machines, calculators and computers	30
29. Electrical machinery	31
30. Electronic equipment	32
31. Electrical components	32.1
32. Radio apparatus, TV and communication	32-32.1
33. Optical and time-keeping instruments	33
34. Motor vehicles	34
35. Other transport material	35
36. Naval construction	35.1
37. Manufacture of aircraft and spacecraft	35.3
38. Other transport equipment	35-35.1-35.3
39. Furniture, other manufacturing activities	36
40. Furniture	36.1
41. Other manufacturing activities	36-36.1
42. Recycling	37
43. PRODUCTION AND DISTRIBUTION OF ELECTRICITY, GAS AND WATER	40+41
44. CONSTRUCTION	45
45. SERVICES SECTOR	50 to 99
46. Trade, repair of vehicles, ...	50+51+52
47. Catering	55
48. Transport, storage	60+61+62+63
49. Communications	64
50. Postal services, post office	64.1
51. Communications	64.2
52. Financial intermediation (including insurance)	65+66+67
53. Estate agents, rentals and services to companies	70+71+72+73+74
54. Computing activities and related activities	72
55. Software	72.2
56. Other computing activities	72.2.2
57. R+D services	73
58. Other real estate activities, rentals and corporate services	70 + 71 + 74
59. Public administration, social services and group services, ...	75 to 99

In the case of research associations and companies whose main activity is the realisation of R+D activities essentially for the benefit of a certain company or group of companies, units with NCEA 7310 or 7320, information is also requested on the main activity of the companies or group of companies that benefit from their R+D activities, and their results will be recorded within the branch of activity that benefits from the research.

DIMENSION OR SIZE OF THE COMPANY

This variable is only investigated in the companies sector.

Occupied personnel is defined as the set of persons, fixed and temporary, who in the reference year of the statistic, are carrying out paid or unpaid work for the company, belonging to and being paid by same. Included are personnel on vacation, leave, sick leave and part time personnel (if they work more than 1/3 of the working day), Not included are home workers, personnel that work for the company but whom are paid by others, redundant personnel, retired personnel, on military service (if they genuinely do not continue to work for the company), nor the members of the Board of Directors (provided that these do not work more than 1/3 of the normal working day).

To determine the average number of persons occupied, all personnel occupied during the period will be taken into account, averaged according to the time that they have rendered their services to the company. Thus, for example, it will take into account if any of these persons did not work during the whole year, if their working day is shorter than the normal working day, ...

TURNOVER

This variable is only investigated in the companies sector.

It is the total amount resulting from the sum of sales (once deducted volume discounts over sales and sales returns) of the goods manufactured by the company itself (or by third parties, in the form of subcontracted production), be they finished, semi-finished, sub products, recyclable residues or material, plus the net sales of goods or merchandise acquired by the company for their subsequent sale without processing, plus the amount for services rendered to other companies (including revenues from subcontracting).

Deductible VAT invoiced by suppliers will not be included in the valuation of turnover.

Both this variable, as well as the previous variable regarding the average number occupied personnel, allow for the research activity to be related to the size of the company that carries same out, as well as the proportion of R+D personnel that the various companies destine to this task.

SCIENTIFIC RESEARCH AND TECHNOLOGICAL DEVELOPMENT (R+D)

This is defined as the set of creative work that is systematically undertaken with the objective of increasing the volume of knowledge, including the knowledge of man, culture and society, as well as the use of this sum of knowledge to conceive new applications.

R+D includes three types of activities:

a) **Basic research.** It consists of original, experimental or theoretical work that is mainly undertaken to obtain new knowledge on the essentials of phenomena and observable facts, without being directed at a specific application or use.

Basic research analyses properties, structures and relationships with the purpose of formulating and contrasting hypothesis, theories or laws. The reference to *without being directed at a specific application or use* in basic research is crucial, given that the researcher might not have any knowledge of genuine applications

when carrying out the research. The results of basic research are not normally put on sale, but are generally published in scientific magazines or are directly divulged between institutions or interested persons. On occasions, the dissemination of the results of basic research may be considered *confidential* for security reasons.

b) **Applied research.** This also consists of original work undertaken with the objective of acquiring new knowledge. However, it is mainly directed towards a specific practical objective.

Applied research is undertaken to determine the possible uses of the results of basic research, or to determine new methods or forms for attaining specific predetermined objectives. This type of research implies taking into consideration all existing knowledge, in depth, with the intention of solving specific problems. The results of applied research refer, firstly, to a sole product or a limited number of products, operations, methods or systems. This research facilitates putting ideas into practice. The knowledge or information obtained in applied research is frequently patented, although it may also be maintained secret.

c) **Technological development**. It consists of systematic work based on existing knowledge, obtained through research and / or practical experience, directed at the manufacture of new materials, products or devices; to establish new processes, systems and services; or the significant improvement of those already existing.

The following examples, extracted from the Frascati Manual allow us to illustrate the differences between basic research, applied research and technological development:

a) The study of a determined class of polymerisation reactions under diverse conditions, of the products obtained from same and of their physical and chemical properties, is basic research. When attempts are made to optimise one of these reactions to obtain a polymer with certain physical or mechanical properties (that confers a particular use), applied research has been undertaken. Technological development consists in undertaking on a larger scale the process optimised in the laboratory and evaluating the possible polymer production methods and, eventually, the articles that may be manufactured from same.

b) Theoretical research on the factors that determine the regional differences in economic growth is basic research; however, the same research, carried out with the objective of being able to develop state policy to this end, would be applied research. The elaboration of operational models based on the knowledge obtained through research, and destined to reducing regional imbalance, is technological development.

c) In the field of information technology, basic research includes the search for alternative calculation methods, like quantum calculus and quantum information theory. Applied research includes researching the application of the information to new fields or according to new processes (for example, software *development* for algebraic transactions and numeric analysis. Oriented basic research encompasses the tasks relating to the simulation of human language and determined tasks (for example, work in the field of man/machine communication directly using input and output words, research on basic algorithms for future information processing applications, studies on the possibility of simulating programming procedures). Applied research includes the work on the application of the information to new fields or according to new procedures (for example, elaboration of a new programming language, new operating systems, program generators, ...), work on the application of the information processing with a view to elaborate, for example, tools such as geographic information and experts systems. Technological development consists in the elaboration of new application programs, noticeable improvements in the operating systems and in the applications, ...

Definition problems between R + D and other scientific-technological activities

For statistical purposes, R + D must be differentiated from a broad range of related activities that have a scientific-technological base. These activities are very closely related to R + D, both through the information flows as well as with regards to the operations, institutions and personnel, but, where possible, they should not be taken into account in the measurement of R + D activities.

The basic criteria that allows R + D to be distinguished from other related activities is the existence, within the core of R + D, of an appreciable element of creativity and the resolution of a scientific and / or technological uncertainty. Or, in other words, when the solution to a problem does not seem evident to anyone who is up to date with the totality of the basic knowledge available and the techniques used in the sector under consideration.

Parting from this criteria, a specific project may be considered R + D if it is undertaken with a determined goal, but it will not be considered as such if it is undertaken with another. The application of this criteria is illustrated with these examples extracted from the Frascati Manual:

– In the field of medicine, a routine autopsy that serves to determine the causes of a death is an example of current practice that is not R + D; in contrast, the autopsy carried out to study a specific case of mortality, for example, to verify the secondary effects of a cancer treatment, is an R + D activity. Routine blood analysis tests or bacteriological examinations are not R + D activities, but a specific blood analysis program for the introduction of a new pharmaceutical product will be considered R + D.

– The daily recording of temperatures or atmospheric pressure is not an R + D activity, but rather an example of operations carried out in a routine manner by the meteorological forecasting service. However, research into new methods for the measurement of temperatures and the study and development of new systems and data interpretation methods will be considered R + D activities.

Related scientific and technological activities that should be excluded are the following:

Education and training

This includes education and training of personnel in all the disciplines imparted in universities, higher education and post-secondary institutions. Nevertheless, research carried out by postgraduate students (doctoral thesis) and the supervision of this work by professors must be included as R + D. These supervision activities must be classified in R + D if they are equivalent to the administration and management of a specific R + D project that contains a sufficient element of creativity and which have as their objective the creation of new knowledge. In this case, both the supervision by members of the university teaching body as well as the work carried out by the student are included in R + D. If this supervision solely consists in teaching R + D methods, or the reading and correction of a thesis, reports or the work of undergraduate students, it must be excluded from R + D.

On the other hand, the attainment of a more profound personal knowledge on the part of the members of the university teaching body includes the time dedicated to continuous professional training (personal readings), assisting conferences and seminars, etc. Solely considered R + D activity is the attainment of a more profound personal knowledge for a research project.

Other related scientific and technological activities

It includes the activities that are listed below, which must be excluded from R + D, except when they are solely and mainly carried out for the benefit of an R + D project.

a) Scientific and technical information service

Activities specialised in the collection, cataloguing, registration, classification, dissemination, translation, analysis and evaluation, carried out by scientific and technical personnel, bibliographic services, patent services, scientific and technical information dissemination services, and consultancy services, and scientific conferences, are excluded from R+D except when they are exclusively or mainly carried out in support of R+D tasks (thus, the preparation of an original report on R+D results will be included amongst R+D activities).

The activities scientific and technical information services, or a library integrated within a research laboratory, which is mainly used by the laboratory's researchers, must be included within R+D. On the other hand, the activities of a company's documentation centre open to all the company's workers must be excluded from R+D, even when this centre is included in the same location as the company's research department. In this same manner, the activities of central libraries of universities must be excluded from R+D.

b) The collection of general data

It is usually carried out by public organisations with the object of elaborating statistics on natural, biological or social phenomena that are of public interest, or with regards to which only the Public Administration has the means to elaborate. For example, it is possible to cite ordinary tasks for the elaboration of topographic maps, elevated geological maps, hydrological, oceanographic and meteorological plans, as well as astronomy observations. However, data collection exclusively or mainly carried out within the framework of an R+D project is included within R+D activities (for example, data on the trajectory and characteristics of particles within a nuclear reactor). This reasoning also applies to the processing and interpretation of data.

Specifically, social sciences depend to a large extent on the precise collection of social facts in the form of censuses, sample surveys, ... If this data is collected or specially processed for scientific research purposes, its cost must be allocated to R+D, and should include planning, systemisation, etc. However, data collected for other purposes or generally, such as active population quarterly surveys, should be excluded from R+D, even when they are exploited for research purposes. Market studies are also excluded.

c) Standardisation tests and work

This heading includes tasks destined to the adaptation to national rules, the adaptation to subsidiary rules, trials and routine analysis of materials, components, products, processes, earth, atmosphere...

Public institutions administer laboratories whose main objective is the realisation of analysis and the elaboration of rules. Nevertheless, personnel from these laboratories may also dedicate time to the creation or notable improvement of the methods used in analysis, and these activities should be included in R+D.

d) Viability studies

It refers to the study of an engineering project using existing techniques with the purpose of providing complementary information for putting same into operation. In the social sciences field, viability studies consist in examining the socioeconomic characteristics and the consequences of determined situations (for example, a study on the possibility of implanting a petrochemical plant in a determined region). Conversely, viability studies of research projects form part of R+D.

e) Specialised medical studies

This heading includes current practice tasks and the habitual application of specialised medical knowledge. However, there may be an R+D element within what is known as *advanced medical care*, which arises, for example, in university hospitals.

As a general rule, this advanced medical care must not be considered R + D, hence any medical care not directly linked to a specific R + D project is excluded from the scope of this statistic.

f) Work on patents and licences

This includes all administrative and legal tasks on patents and licences. However, tasks on patents directly related to R + D projects form part of R + D.

g) Studies of a political and operational nature

The word *policy* not only includes national policy, but also regional and local policy, as well as company policy that pursues a certain economic objective. Studies of a political nature include activities such as the analysis and evaluation of programs in progress, ministerial policies and activities, as well as from other governmental institutions, tasks carried out by departments that handle the analysis and permanent control of external phenomena (like, for example, the analysis of defence and national security activities); and the tasks of parliamentary research commissions on the policies and activities of the government and the ministries.

Generally, the studies intend to open channels for decision-making on the part of the public administrations (on a central, regional or local) level, or with regards to industrial and commercial companies. As a general rule these studies should be excluded, given that normally they only use contrasted methods. However, in the elaboration of operational models, sometimes it is necessary to modify the methods previously used, or develop new methods, which requires important research work. In theory these modifications or development work should be taken into account in the measure of R + D, but it is necessary to bear in mind the difficulties that arise in the determination of the R + D element in a determined study, if they exist. In the practice, to determine if a specific activity may be considered included within R + D, or related to R + D, it is not of importance that this activity, or the resulting report, is denominated study. If it conforms with the definition of R + D, it is considered R + D; to the contrary, R + D will be excluded.

h) Prospecting activities

Confusion is frequently created between research into new or considerably improved resources (food, energy, ...) and research in the sense of prospecting for existing reserves of natural resources, confusion that fades the distinction between R + D on the one part, geological surveying and prospecting on the other. The geological surveying and prospecting activities of commercial companies is excluded from R + D. Thus, the drilling of exploration shafts to evaluate the resources in a deposit should be considered an example of scientific and technological services, but not R + D.

i) Routine software development activities

These activities include the tasks relative to improvements in systems or programs already made available to the public before the commencement of the tasks. Also excluded are technical problems that have been overcome in previous projects pertaining to the same operating systems and computer architecture. Software activities such as the maintenance of existing systems, the conversion and/or translation of computer languages, the increase in user functions in applications, systems filtering, the adaptation of existing software, the preparation of documentation for users, ..., which do not imply scientific and/or technical progress are not considered R + D.

On the other hand, for a software development project to be classified as R + D its completion must require scientific and/or technological progress, and it must have as its objective the systematic resolution of scientific and/or technological uncertainty. Apart from the software that forms part of an R + D project, it is also necessary to consider as R + D the research and development work carried out on the

software, considering the latter as a final product.

Due to the nature of software, the development of same does not facilitate the delimitation of its R+D component, when same exists. It forms an integral part of the numerous projects that do not involve any R+D elements. However, the part of these projects related to the development of software may be classified as R+D, if progress is obtained within the computer field. In this field, progress normally comes from evolution instead of revolution. For this reason, moving on to a more potent version, an accessory or a modification of a program or an existing system may be considered R+D if it incorporates scientific and / or technological advances that lead to an increase in knowledge. However, the use of a software package for a new application or purpose does not constitute in itself progress.

Nature of internal R+D activities

Units are asked about the nature of their R+D activities.

Some departments carry out R+D activities every year, while others carry out R+D activities, that is, they may be involved in a project one year, and have no R+D activity the following. This project-based R+D work is frequently carried out by persons from various sections of the department, without a formal R+D organisation. In the general definition of R+D in the Frascati Manual, a project furnished with specific objectives and budget satisfies the criterion of *creative work undertaken systematically*. Moreover, the Frascati Manual recommends that all units carrying out R+D work, either continuously or sporadically, be included in R+D surveys.

OTHER INDUSTRIAL ACTIVITIES

These activities may be classified into two groups, in some cases overlapping, and which should be excluded from R+D.

Innovative activities

Scientific and technological innovation may be considered as the transformation of an idea into a new or improved product launched into the market, or a new or improved operational process used in industry or in commerce, or a new social service method. For the moment, international rules for data collection, like the OECD Oslo Manual, have only been elaborated for technological innovation.

Technological innovations include new products and processes, as well as important technological modifications of same. An innovation is considered as such when it is launched into the market (product innovation) or used in a production process (process innovation). All types of scientific, technological, organisational, financial and commercial activities intervene.

R+D is only one of these activities and may be carried out in different stages of the innovation process, being used not only as a source of innovative ideas but also to solve problems that may arise in any phase of the process until its completion.

Apart from R+D, often it is possible to distinguish five other innovative activity fields within the innovative process:

–The acquisition of machinery and equipment consists in the acquisition of advanced machinery, computer equipment specifically purchased for the realisation of new or sensibly improved products (goods/services) and/or processes.

– The acquisition of other external knowledge consists in the purchase of the rights to use patents and non patent inventions, licences, know-how (non patented knowledge), trademarks, software (computer programs) and other types of knowledge from other organisations to be used in company innovations.

– Costs incurred in the design and tooling up of production and/or distribution are the costs pertaining to technical procedures and preparations for the genuine realisation of product innovations (goods/services) and processes not included in other sections.

– Training costs include costs incurred in the internal or external training of personnel directly involved in the development and/or introduction of innovations.

– Launching innovations onto the market is defined as the internal or external commercialisation activities (marketing) that are directly related to introducing into the market of new or noticeably improved products (goods / services).

It is advisable to carefully exclude from R + D the activities which, although forming part of the innovation process, barely affect R + D; it is the case of patent lawsuits and the granting of licences, market research studies, the launching of manufacturing, the equipment used and the modification of the design for the manufacturing process. Nevertheless, some activities like the fine-tuning of equipment, the development of processes, the design and the elaboration of prototypes may entail a non depreciable R + D component, hence the difficulty in precisely determining what must and must not be considered R + D. This warning is applied in particular in the defence sector and large scale industries, like the aerospace sector.

With regards to the measure of R + D, the greatest source of error is probably due to the difficulty in precisely establishing the line that separates technological development from the development that takes place before production (pre production), including the latter the elaboration of user demonstration models, as well as the corresponding trials, as well as the production design so that it is applicable to any industrial situation. It will be necessary to elaborate a series of criteria for each activity branch. The main rule elaborated by the National Science Foundation (NSF) of the United States presents a practical base that allows for an appraisal of difficult cases. This rule, the scope of which has been slightly broadened, is expressed in this manner:

If the main objective of the tasks is to provide new technical improvements to the product or the process, then they fall within the definition of R + D. If, on the contrary, the product, process or study is to a large extent *established* and the main objective is to find outlets, elaboration of pre production plans or harmonised controls, then it would not be R + D.

Below are outlined a few cases of problems in the delimitation of the line between R + D and other innovative activities.

i) Prototypes

The construction and trial of a prototype frequently constitutes the most important phase of technological development. A prototype is an original model that presents all the technical qualities and operating characteristics of the new product. Nevertheless, once the last modifications are introduced and the prototype trial phase has successfully finished, subsequent activities will not fall within the field of R + D.

ii) Pilot installations

The construction and use of a pilot installation forms part of R + D as far as its main objective is to acquire experience and collect technical data, or data of a different kind, which will be used subsequently.

Once the experimental phase has finished, if the pilot installation begins to operate as a normal production unit, its activity cannot be considered R + D, even if it continues to be called a *pilot installation.*

iii) Large scale projects and very costly pilot facilities

Large scale projects, of which aerospace and defence activities constitute the most notable examples, generally include a range of activities that go from technological development all the way to pre production development. Under these conditions, the organisation that finances and/or carries out these projects frequently cannot establish a distinction between R + D and the remaining costs. This distinction must be established parting from the application of the criterion elaborated by the National Science Foundation.

On the other hand, it is very important to attentively examine the nature of the more costly pilot installations or prototypes, especially when dealing, for example, with the first sheet of a new podium for nuclear power stations or the head for an icebreaker. These installations and prototypes may almost be carried out with the assistance of existing materials and known technology, and frequently are built so as to simultaneously serve for the realisation of R + D tasks, and for the rendering of the main services to which they are destined (production of electricity or ice breaking). Its production should not be completely considered as R + D.

iv) Launch of the manufacture

The manufacturing launch phase commences when a prototype, to which all the necessary modifications have been introduced, have been tested with a satisfactory result. This process is related to industrial scale production. Given that it does not require new design work and industrial engineering, it must not be considered within R + D, given that the main objective is not the improvement of the product but rather commencing and equipping production. The first trial units in series production should not be considered as prototypes in the sense of R + D, even when, due to an abuse of the language, they are called as such.

v) Detection of breakdowns

Difficulties in the launch phase may sometimes require complementary R + D tasks, but commonly operating defects, once detected, lead to minor modifications in the equipment and in processes. Therefore, these tasks should not be considered R + D.

vi) Supplementary R + D

When a new product or process is delivered to the production department, some technical problems may arise, hence they will require complementary R + D tasks. Such tasks should be borne in mind in the measure of R + D.

vii) Industrial equipment and engineering

In the majority of the cases, the industrial equipment and engineering phases of the product are considered a part of the production process. However, if the equipping phase is translated into new R + D tasks, these activities are classified as R + D.

b) Production activities and related technical activities

This includes industrial production, pre production and the allocation of goods and services, as well as the diverse technical services linked to the corporate sector and the whole economy, and related activities that use disciplines included within social sciences, like market research studies.

Financing and other indirect support activities

The genuine realisation of R + D activities requires the provision of funds and the management of the project and it's financing. Strictly speaking, R + D financing activities of organisations like ministries or committees of inquiry do not form part of R + D. In the case of the internal management of R + D projects and their financing, a distinction is made between the direct R + D support activities carried out by persons such as executives responsible for R + D that are closely linked to each project, which are taken into account both with respects to personnel as well as expenditure, and those persons that solely provide indirect or auxiliary support and which are solely included in expenditure as other current costs.

Indirect support activities include a certain number of activities that do not alone constitute R + D activity, but which provide support to same. By agreement, the data on R + D personnel include genuine R + D activities but exclude indirect auxiliary activities, while the latter are taken into account in the R + D expenditure of those executing the activities as current costs. To

this end, transport activities, storage, cleaning, repair, maintenance and security are some characteristic examples.

Some activities, like those of a library or computing services, form part of genuine R + D if they are exclusively destined to R + D, but they become indirect support activities when they are carried out by central services that attend to both R + D activities as well as to other activities. Management and administration activities, as well as office tasks, are also characterised by this situation.

When these activities directly contribute to R + D projects and are exclusively undertaken with R + D purposes, they form part of genuine R + D, and they are taken into account in the entry relative to R + D personnel. We can cite as characteristic examples the manager responsible for R + D who attends to programming and the supervision of scientific and technical aspects of the project, or the writer who elaborates reports on the intermediate and final results of the project.

Lastly, it would be necessary to determine whether the accounting activities associated to a specific R + D project are direct (genuine R + D) or auxiliary activities. By agreement, these activities are classified as genuine R + D, rather than as indirect support activities, when they are strongly associated to R + D activities.

Other definition problems

a) Activities related to social sciences and humanities

Social sciences and humanities rely, much more than other scientific fields, on external disciplines and techniques to support their research activities. Namely, mathematics and statistics are used in the majority of economic and social research activities. Some disciplines like psychology, geography and anthropology also depend on techniques that are characteristics of related disciplines like clinical psychology, geology and anatomy. Economic and social research and, in particular, with respects to the economy, is multi disciplined, thus the line separating the various disciplines is very imprecise. Due to the methodological differences used in the research, the definition that allows for the inclusion of the R + D elements of social sciences and humanities must necessarily be more general than in the case of exact sciences, natural sciences and engineering.

Thus, knowledge on man, culture and society *have been included in the definition of R + D*. The notion of novelty should continue to serve as the basic criterion for the definition of the line between R + D and related scientific activities (routine). Said activities can solely be considered to be included within R + D if they form an integral part of a specific research project, or if they are solely destined to a specific research project. Consequently, there exists a certain number of fields in which social sciences specialists use established methodologies and facts, which are characteristic of social sciences, to resolve a specific problem, but these may not be classified as R + D.

The following work constitutes an example of what could be included within the aforementioned category but which are not R + D: the interpretation of the probable economic effects of a modification of the fiscal system, carried out with help of the existing economic data; the prevision of the variations susceptible of arising in the structure of the demand of social services in a certain region as a consequence of changes in the demographic structure; operation research (OR) considered as assistance in the decision-making process, for example the optimisation of a plant's distribution system; the use of standardised techniques in applied psychology for the selection and classification of industrial and military personnel, students, ..., and for the examination of dyslexic children or children that present any other incapacity.

b) Space exploration

With regards to space exploration, the difficulty is due to the fact that due to diverse reasons a large part of this activity is currently routine; there exist no doubts that the costs essentially refer to the purchase of goods and services not related to R+D. However, space exploration still has the objective of increasing knowledge, hence it should be completely included within R+D. It may be useful to distinguish the activities related to space exploration, including the fine tuning of vehicles, equipment and techniques, of those associated to the routine practice of the launching into orbit of satellites or the creation of communication and control stations.

EXPENDITURE ON INTERNAL R+D ACTIVITIES

The measurement of R+D expenditure is one of the procedures for obtaining the input of the research activity.

Defined as expenditure on R+D activities are all the amounts destined to R+D activities, carried out within the research department or unit **(internal expenditure)** or outside same **(external expenditure)**, irrespective of the source of the funds. Expenditure incurred outside the department but related to internal support tasks of R+D (acquisition of supplies for R+D, for example) are also included as internal R+D expenditure. The data relative to internal R+D expenditure must be collected from the information on internal R+D expenditure. However, it is also desirable to collect data on external R+D expenditure, like complementary information.

Nature of R+D expenditure

Internal expenditure include both current as well as capital costs. By agreement, deductible VAT invoiced by suppliers is excluded.

Current expenditure

Within current expenditure a distinction is made between personnel costs and other current costs.

Personnel costs include the total remuneration of staff, including social security (wages and extraordinary payments, other salary supplements or diverse payments, such as bonuses, holiday pay, remunerations in kind, contributions to pension funds, corporate insurance paid by the company,...), that is, what is denominated as corporate personnel costs.

Wage costs of persons who provide indirect services and which are not taken into account in the data pertaining to R+D personnel (principally, security and maintenance personnel, canteen service personnel, information technology, central library services and office management personnel) must be excluded and recorded as other current costs.

Only the *wages/study grants* and similar costs corresponding to postgraduate students must be included. Travel allowances of R+D personnel should be included in other current costs.

Distinction will be made between the remuneration of researchers and the rest of the staff.

The remaining current costs include the costs of the acquisition of non inventory material and diverse supplies not considered capital goods; consumption of energy (gas, electricity, ...) and water; books, magazines, reference material and subscriptions to libraries, participation in scientific companies, laboratory material (chemical products, animals, ...); and the real and allocated cost of small prototypes or models manufactured externally. Administration and other general costs (such as office expenses, postal expenses, telecommunications, insurance and bank interest) should also be included, in the proportion that they affect R+D activities;

Costs of indirect services (security, storage; use, repair and maintenance of buildings and equipment; information technology and library services; cafeteria, ...) must be

included, both if they are services provided by the company itself, as well as if they are leased or acquired externally, in the proportion that they affect R + D activities.

By agreement, genuine or allocated provisions for the amortisation of buildings, installations and equipment must be excluded from the measure of internal costs.

Capital expenditure

It is the gross investment in fixed capital used by units in R + D programs.

It must be integrally declared within the period in which it has taken place, and cannot be considered an element of amortisation. It is necessary to record genuine costs, in such a manner that if other activities are carried out in the company, besides R + D, a proportion of total expenditure must be allocated to the latter, calculated according to the use of these capital goods. This expenditure may be in land buildings and in equipment and instruments.

Expenditure on land and buildings arise as a result of the purchase of land for R + D purposes (for example, trial land, land for the construction of laboratories and pilot plants), as well as the construction costs of the buildings or the acquisition of same, including the costs for important renovation, modification, extension or repair work.

Expenditure on instruments and equipment include the cost corresponding to the acquisition of inventoried equipment and material used in R + D tasks.

Approximation to company accounting

i) Immaterial assets

Investment (or disinvestment) is defined as immaterial assets like the increases (or reductions) in the real value of these types of resources (computer applications, R + D costs, goodwill, industrial property, administrative concessions, ...) carried out by the institution during the reference year.

Increases in these types of assets originate with the purchase from third parties of assets included under this heading, or the self-production of same with the following qualification: computer applications can only be improvements and self-production is limited to that carried out in computer applications and R + D costs. Goodwill, administrative concessions and the remaining assets can only be acquired against payment. Reductions or disinvestments are not the object of research in this survey.

For the purposes of this Statistic, self-production of R + D must be considered as internal R + D expenditure, distinguishing between current costs (including wages of R + D personnel) and capital costs.

Improved computer applications or self-production will solely be included in this section to the extent that they are exclusively or mainly used for the purposes of an R + D project. Otherwise, it must be excluded form the measure of R + D expenditure (see the section R + D expenditure activity).

In the case of purchasing these types of assets from third parties, it is necessary to distinguish between the acquisition of R + D services and other types of costs.

The acquisition of R + D services must be reflected as external R + D costs and must be broken down bearing in mind the R + D supplier.

Purchasing other immaterial assets from third parties is excluded from the scope of R + D. Specifically, the acquisition of industrial property (patents, trademarks, *know-how,* ...) are costs related to the innovative activity of a company or organisation, but which cannot be considered R + D expenditure.

Nevertheless, the real or allocated cost of small prototypes, models or elements of industrial property manufactured externally, purchased solely or mainly for an R + D project, will be considered as current R + D costs.

On the other hand, this statistic does not only include costs arisen in successful R + D projects, which is the accounting concept of R + D, but also the costs of unsuccessful R + D.

ii) Material fixed assets

With regards to investments in material assets, the General Accounting Plan covers the following accounts:

1. Natural land and assets
2. Constructions
3. Technical installations
4. Machinery
5. Tools
6. Other installations
7. Furniture
8. Equipment for data processing
9. Transport elements
10. Other material fixed assets

For the purposes of our statistic, accounts 4, 5, 7, 8, 9 and 10 will be included in Equipment and Instruments, and accounts 1, 2 and 6 in Land and Buildings. Technical installations (account 3) include elements from both groups (buildings, machinery, ...) and, although due to their nature they can be separated, because of the manner in which they operate they are definitely connected and subject to the same amortisation rhythm, but for statistical purposes it will be necessary to estimate the part corresponding to land, constructions and installations, and the part corresponding to the other heading. For example, an ocean research vessel, by agreement, must be considered a technical installation and broken down as such. Important work on the vessel involving an improvement, modification, extension or repair of same must be borne in mind in Land and Buildings, and the improvement of the technical equipment, instruments, ... in Equipment and Instruments.

It is necessary to consider the real costs, in such a manner that if other activities are carried out in the vessel or in any other capital asset, apart from R + D, same will be allocated a proportion of the total estimated cost depending on the level of use of this capital asset.

On the other hand, it is necessary to declare the costs incurred in the reference year of the statistic. This response must be taken into account in particular in the case of the inclusion of assets acquired through a financial lease (*leasing*).

Allocations for the amortisation of material or immaterial fixed assets must not be included as an R + D cost.

Source of R + D funds

The intention with this question is to determine who finances the research.

R + D is an activity that implies important transfers of resources between units, organisations and sectors. These transfers are measured with the information provided by those carrying out R + D activities based on the amounts that said unit, organisation or sector has received from another unit, organisation or sector for the realisation of internal R + D activities.

In order for this financial flow to be identified correctly, two conditions must be met:

– a direct transfer of resources must exist

– this transfer should also be budgeted and genuinely used for R + D activities.

The transaction may be in the form of a contract, financial assistance or a donation, and may consist in a monetary contribution or the contribution of other resources (for example personnel or material). In the case of important non monetary transfers, it is necessary to evaluate the market value of the transaction, because all transfers must be expressed in financial terms.

In theory, when a public administration authorises a company or a university to freely use for its R + D activities certain installations, like, for example, a wind tunnel, an observatory or a launch ramp, the value of the service (allocated rent)

must be assimilated to a transfer. In practice, it will be normal for neither the beneficiary of this transaction nor perhaps the "donor" from being able to establish this estimate.

It could occur that an R+D project of a given company is financed through a loan granted by a financial institution, by a subsidiary or by a Public Administration. Refundable loans should not be considered transfers; to the contrary, non-refundable loans must be considered by agreement a transfer. Refundable loans will be considered as own funds.

There also exist a series of public incentives for R+D within the companies sector. It is possible to cite, for example, the exemption of income tax for industrial R+D, the payment by the Public Administration, on request and after verification, of part or the totality of the R+D expenditure of the company, the granting of bonuses linked to a research contract with the purpose of encouraging the company in its R+D tasks, franchising of taxes and customs tariffs pertaining to R+D material, and the reimbursement of part of the company's costs if the latter increases its staff with more R+D personnel. For the moment, although these transfers may be specified separately, they must not be recorded as direct R+D assistance. Therefore, units must record the gross amount of their costs, even when these have been reduced through the granting of exemptions, deductions or assistance that has been subsequently made effective.

The problem is complicated when the transactions pass through various organisations. This may arise when R+D activities are carried out through subcontracting, as sometimes occurs within the companies sector. The party executing R+D must indicate, where possible, the original source of funds received for R+D.

The most problematic aspect of the analysis of the source of the funds resides in the general university funds (GUF). Universities turn to three types of financing for their R+D activities:

i) R+D contracts and well-defined specific funds for R+D stemming from the Public Administration and other external sources of financing. These funds are assigned to their original source.

ii) Income from allocations, share and asset portfolios, as well as income stemming from the sale of services that are not R+D, such as academic fees, magazine subscriptions, sale of serum or agricultural products. This *generated.* income is clearly *own funds* of the universities. In the case of private universities, this income may constitute an important source of R+D financing.

iii) General subsidies received from the Ministry of Education or from the corresponding autonomous or local authorities and destined to the financing of global research and education activities. In this case, there exists a conflict between the principle that consists in finding the original source of funds and that which consists in using the information provided by the executing party, and there also exists disagreement regarding the form in which the criteria pertaining to the intentions of the financial backer must be applied. One view states that because the public administration is the original source, and the intention here is that at least part of these funds be dedicated to R+D, the Public Administration should be considered the source of financing with respects to the R+D content of these public general university funds. On the other hand, it is believed that because it is within universities where the decision is made regarding the amount that must be assigned to R+D, amount that is taken from both their "own funds", according to the definition of paragraph b), as well as from the GUF, the higher education sector should therefore be considered the source of the funds. For the purposes of international comparability, the public GUF are assigned to the public sector as a source of financing.

On the other hand, institutional fees not corresponding to a specific R+D assignment (for example, those received by a research association from the companies

it works for; those received by a research company created by another company specifically for the realisation of an R+D project, where the latter finances said activities; budgetary funds from a public research organisation, ...) will be considered own funds of the unit.

With these specifications, the basic classification by source of funds is the following:

– Own funds
– From companies
– From the Public Administration
– From tertiary education centres
– From private non profit institutions
– From abroad

Depending on each sector, this classification may be broken down even further.

EXTERNAL R+D EXPENDITURE

The only costs that can be classified as external expenditure are the amounts paid as consideration for the R+D work that the unit specifically outsources to other units. Not included are institutional fees to finance other companies, research associations ....., which does not imply a direct R+D acquisition.

The basic classification of the destination of external R+D expenditure is the following:

• National

– Companies
– Public Administrations
– Tertiary education
– Private non-profit institutions

• Abroad

– Companies
– Public Administrations
– European Union institutions
– Other international institutions
– Other institutions

Depending on each sector, this classification may be broken down even further.

PERSONNEL IN R+D ACTIVITIES.

The measure of personnel employed in R+D activities is the other manner in which R+D input may be obtained.

R+D personnel is defined as all personnel directly employed in R+D activities, without distinguishing their level of responsibility, as well as those who supply services directly linked to R+D work, such as managers, administrators and office personnel. Excluded are persons who carry out indirect services like, for example, canteen personnel, security personnel, maintenance workers, ..., although their wages must be recorded as other current R+D costs.

Personnel data may be measured in two ways, in the number of physical persons and in their full time equivalence.

Number of physical persons as at December 31st

Data on the total number of persons that are completely or partially employed in R+D allow us to establish a correspondence with other series of data, like, for example, education or employment, or population censuses. On the other hand, data relative to physical persons is the most appropriate measure to collect complementary information on the characteristics of R+D personnel, like age, gender or country of origin.

Full time equivalent (FTE) during the year

For measuring personnel it is advisable to introduce the concept of full time equivalence, given that the activity of R+D personnel is usually a partial or secondary activity. It includes:

– **Full time R+D personnel** is defined as persons who employ at least 90 per cent of their working day in R+D activities.

– **Part time R+D personnel** is defined as persons who employ approximately between 10 to 90 per cent of their working day on R+D activities, and the rest of the day to other types of activities.

Also considered as such are persons that have carried out R+D activities during a period not exceeding one natural year.

– **Full time equivalence of part time personnel** is the sum of the fractions of time that they have dedicated to R+D activities.

– **Personnel employed in R+D activities in full time equivalence** is the sum of personnel employed full time plus the equivalence of those persons working part time.

Additionally, personnel employed in R+D activities are provided broken down by gender.

Occupation of the R+D personnel

R+D personnel are classified according to the following categories:

• **Researchers**

These are scientists and engineers involved in the concept or creation of new knowledge, products, processes, methods and systems, and in the management of the corresponding projects.

Also included are managers and administrators dedicated to the planning and management of the scientific and technical aspects of the researchers' work and which, normally, have a category equal or superior to that of persons employed directly as researchers, often dealing with former researchers or part time researchers.

Also included are postgraduate students with a *"study salary/grant"* who carry out R+D activities.

As a general rule, they possess advanced university education but, for the purposes of this study, also considered researchers are those persons that, being devoid of the aforesaid qualification, they occupy positions of this nature.

• **Technicians**

Technicians and similar personnel are persons whose main tasks require knowledge and technical experience in one or various fields: engineering, biological and physical sciences, or social sciences and humanities. They participate in R+D projects carrying out scientific and technical tasks applying operational principles and methods, generally under the supervision of researchers. Similar personnel carry out tasks corresponding to social sciences and humanities under the supervision of researchers.

Their tasks are mainly the following:

– search for bibliographic material and discover appropriate information sources in archives and libraries.

– prepare computer programs

– prepare material and the necessary equipment for the realisation of experiments, trials and analysis.

– carry out experiments, trials and analysis

– carry out measurements and calculations and prepare tables and graphs

– carry out surveys and interviews

– guarantee logistical support to researchers.

Normally they possess intermediate-level university education (technical engineers and university diploma), but others do not, although they occupy positions of a comparable level. It can also include top level personnel entrusted with the use of very sophisticated apparatus, but they are distinguished from researchers in that the latter are in charge of directing or orienting research tasks.

• **Assistants**

Auxiliary staff includes workers, qualified or unqualified, and secretarial and office personnel who participate in the realisation of R+D projects, or whom are directly related to said projects.

Included in this category are all managers **and administrators mainly occupied in financial matters, personnel management**

and administration in general, provided their activities are directly related to R + D tasks.

Qualifications of R + D **personnel**

The International Standard Classification of Education (ISCED) provides the basic elements that allow for R + D personnel to be classified, according to the academic qualification possessed, into the following categories:

• University doctorates

– University graduates, architects, engineers and similar.

– University diplomas, technical architects, technical engineers and similar.

– Advanced level professional training (FPII), industrial masters, qualified accountants and similar.

– High School graduates, BUP (secondary education), COU (university orientation course), FPI (first level professional training), intermediate professional training and other secondary studies.

– Other studies (of a level inferior to that outlined above).

Chart 2. Correspondence between the categories of R + D personnel by occupation of the Frascati Manual and the ISCO-88 classes

This chart provides an indication of the ISCO-88 classes in which are included researchers and other categories of R + D personnel. It must be read in one direction only. For example, researchers are included amongst health professionals, but not all health professionals are researchers. The chart also does not include certain categories of R + D personnel, for example, those in the *Armed Forces* and post-graduate students who are not registered in a specific job.

The International Standard Classification of Occupations (ISCO) (ILO, 1990) consists of ten main groups in the first level, subdivided into 28 sub-main groups (apart from 116 minor groups and 390 groups of units)

RESEARCHERS – ISCO-88 CLASSES (sub-main groups and minor groups):

21. Physics, mathematics and engineering professionals

211 Physicists, chemists and related professionals
212 Mathematicians, statisticians and related professionals
213 Information technology professionals
214 Architects, engineers and related professionals

22. Life sciences and health professionals

221 Life sciences professionals
222 Health sciences professionals (except nursing)

23. Teaching professionals

231 Teaching professionals in Universities and Higher level institutions

24. Other professionals

241 Business professionals
242 Legal professionals
243 Archivist, librarians, documentation and information professionals related thereof
244 Social sciences and related professionals

Moreover, Unit Group 1237 Managers of research and development departments

TECHNICAL AND EQUIVALENT PERSONNEL – ISCO-88 CLASSES (sub-main groups and minor groups):

31. Professionals related to physics and engineering

311 Physics and engineering technicians
312 Professionals related to information technology
313 Operators of optical and electronic equipment
314 Naval and air technicians and controllers
315 Security and quality control inspectors

32 Life sciences and health associate professionals

321 Life science technicians and related associate professionals
322 Modern health associate professionals (except nursing)

Moreover, Unit Group 3434 Statistics professionals, mathematics and other related associate professionals

OTHER SUPPORT PERSONNEL – ISCO-88 CLASSES (main groups)

4. Office personnel
6. Workers skilled in agriculture and fishing
8. Plant and machinery operators, and assemblers

Moreover, Minor Group 343
Administrative associate professionals (except unit group 3434)[1]

1. Legislators, civil servants and management executives n.e.c.

1. Statistics professionals, mathematics and other related associate professionals (included here are "Technicians and equivalent personnel")

FUNCTIONAL DISTRIBUTIONS

Type of research

A break-down of current costs according to the type of research carried out is requested from the units:

– Fundamental or basic research

– Applied research

– Technological or experimental development

Scientific field or discipline

The classification by fields of study or scientific disciplines used is that proposed by UNESCO in the *Recommendation relative to the standardisation of statistics on Science and technology,* which considers the following important areas:

– Exact and natural sciences

– Engineering and technology

– Medical sciences

– Agricultural sciences

– Social sciences

– Humanities

This is the classification recommended for the companies sector. In the case of the Public Administration and tertiary education sectors, a more broken down classification is used, which is presented in chart 3.

Socioeconomic objective

To determine the socioeconomic objective of the research, the research units are requested to distribute the resources assigned to R+D amongst the various socioeconomic objectives in proportion to the expenditure dedicated to each one.

The list of socioeconomic objectives that is used is that recommended in the Frascati Manual, indicated in chart 4.

REGIONALISATION OF THE RESOURCES DESTINED TO R+D

To ascertain the special distribution of the resources destined to R+D, a regionalisation by Autonomous Communities of expenditure and R+D personnel is carried out.

The regionalisation criteria varies according to the sector under study. In the case of the corporate sector, public administrations and NPPI, it is requested that the units that carry out R+D activities in various centres located in different Communities distribute the R+D expenditure and personnel amongst those Communities in which their activities have taken place. To this end, expenditure, as well as managers, directors of R+D activities and other personnel directly related to R+D activities, which may be common to different research centres of the unit, will be distributed geographically according to the percentage that the unit estimates corresponds to each centre.

The distribution of university R+D data by Autonomous Community is carried out taking into account the location of the vice-chancellor's office, essentially coinciding with the location of the majority of the faculties, schools and research centres belonging to each one of the universities.

Chart 3. Classification by scientific field or discipline

1. Exact and natural sciences

1.1 Mathematics

1.2 Information technology and other related disciplines (software development exclusively); the development of hardware must be classified in the pertinent fields of engineering and technology.

1.3 Physical sciences
(Astronomy and space sciences, physics, other related fields)

1.4 Chemical sciences
(Chemistry and other related fields)

1.5 Geological sciences and related environmental sciences.
(Geology, geophysics, mineralogy, physical geography and other geological sciences, meteorology and other atmospheric sciences, including climate research, oceanography, volcanology, paleoecology and other related sciences).

1.6 Biological sciences
(Biology, botany, bacteriology, microbiology, zoology, genetics, entomology, biochemistry, biophysics, other related disciplines with the exception of medical and veterinary).

2. Engineering and technology

2.1 Civil engineering
(Architectural techniques, technical and scientific studies in the field of construction and civil engineering/building, study of urban infrastructures, and other related disciplines).

2.2 Electric, electronic engineering
(Electrical engineering, electronics, telecommunications engineering, information technology engineering -hardware exclusively- and other related disciplines)

2.3 Electronic engineering and other CIT

2.4 Other engineering
(Chemical engineering, aeronautical and aerospace techniques mechanics, metallurgy and engineering materials and specialised subdivisions; applied sciences such as geodesy, industrial chemistry, etc.; food science and technology; specialised technologies or inter-discipline fields, for example, systems analysis, metallurgy, mines, textile technology and other related fields)

3. Medical sciences (including pharmacy)

3.1 Basic medicine
(Anatomy, cytology, physiology, genetics, pharmacy, pharmacology, toxicology, immunology and immunohematology, clinical chemistry, clinical microbiology, pathology)

3.2 Clinical medicine
(Anaesthesia, paediatrics, obstetrics and gynaecology, internal medicine, surgery, stomatology, neurology, psychiatry, radiology, therapy, otorhinolaryngology, ophthalmology)

3.3 Health sciences
(Public health, hygiene in the workplace, environmental protection, nursing, epidemiology)

4. Agricultural sciences

4.1 Agriculture, forestry, fishing and related sciences
(Agronomy, zootechnics, fishing, forestry, horticulture, and other related fields)

4.2 Veterinary medicine

5. Social sciences

5.1 Psychology

5.2 Economics

5.3 Educational sciences
(Education, training and other related fields)

5.4 Other social sciences
(Anthropology, -social and cultural- and ethnology, demography, geography -human, economic and social-, urban and rural organisation, management and administration, law, linguistics, political sciences, sociology, organisation and methods, diverse social sciences and inter-discipline, methodological and historic C+T activities that are related to disciplines within this group. Physical anthropology, physical geography and psychophysiology must be classified normally within the heading exact and natural sciences)

6. Humanities

6.1 History
(History, prehistory and history, as well as sciences related to history, such as archeology, numismatics, paleography, genealogy, etc.)

6.2 Language and literature
(Ancient and modern languages and literature)

6.3 Other humanities
(Philosophy -including the history of science and techniques-, art, history of art, art review, painting, sculpture, musicology, dramatic art except artistic "research" of any type, religion, theology, other fields, subjects and C+T activities related to humanities).

Chart 4. Classification by socioeconomic objectives

1. Exploration and exploitation of the Earth
It covers research where the objectives are related with the exploration of the Earth's crust and surface, the seas, oceans and atmosphere, and research on the exploitation of the Earth. It also includes climatic research and meteorology, polar exploration and hydrology. Does not include improvement of the land and use thereof, research on pollution or on fishing.

2. Infrastructures and territorial organisation
It covers research on infrastructures and territorial development, including research on the construction of buildings. In general it encompasses research relative to general planning of the land. This includes research to counter the harmful effects of urban and rural development, but not research on other types of pollution.

3. Control and protection of the environment
It includes research on the control of the pollution destined to the identification and analysis of the sources of pollution and its causes, and all pollutants, including its dispersion into the environment and the effects on mankind, on living species (fauna, flora, micro organisms) and the biosphere. Includes the development of control installations for the measurement of all types of contaminants. The same is valid for the elimination and prevention of all types of contaminants in all types of environments.

4. Protection and improvement of human health
This includes research destined to protecting, promoting and restoring human health, interpreted in its broadest sense in order to include health aspects of nutrition and food hygiene. It covers preventive medicine, including all the aspects of medical and surgical treatment, both for individuals and groups as well as for hospital care and home service care, all the way to social medicine, paediatrics and geriatrics.

5. Production, distribution and rational use of energy
It covers research on the production, storage, transport, distribution and rational use of all forms of energy. It also includes research on processes designed to increase the efficiency of the production and distribution of energy, and the study and conservation of energy. Does not include research related to drilling, or research for vehicle and engine propulsion.

6. Agricultural production and technology
It covers all research on the promotion of agriculture, forests, fishing and the production of food. Includes: research on chemical fertilisers, biocides, biological control of plagues and the mechanisation of agriculture; research on the impact of agricultural and forestry activities on the environment; research on the development of productivity and food technology. Does not include: research for reducing pollution; research on the development of rural areas, planning and construction of buildings, improvement of rural installations for recreation and rest, and the supply of water in agriculture; research into forms of energy; research into the food industry.

7. Industrial production and technology
It covers research on the improvement of industrial production and technology. Includes research on industrial products and manufacturing processes, except in cases in which it forms an integral part of the search for other objectives (for example, defence activities, space, energy, agriculture).

8. Social structures and relations
Includes research on social objectives, like those analysing in particular social sciences and humanities, which have no obvious connections with other socioeconomic objectives. This analysis encompasses the quantitative, qualitative, organisational and prospective aspects of social problems.

9. Space exploration and exploitation
It covers all civil research in the field of space technology. Analogous research carried out within the military field is classified within the defence socioeconomic objective. Although civil space research is not generally centred on a specific objective, frequently it does have a specific purpose, like increasing general knowledge (for example, astronomy), or it refers to special applications (for example, communications satellites).

10. Non oriented research
It covers all budgetary credits that are allocated to R+D but which cannot be attributed to an objective. A supplementary distribution by scientific discipline may be useful.

11. Other civil research
It covers research that cannot (as yet) be classified within a specific socioeconomic objective.

12. Defence activities
It covers research (and development) for military purposes. It also includes basic research and nuclear and space research financed by the Ministry of Defence. Civil research financed by the Ministry of Defence, for example, in relation with meteorology, telecommunications and health, must be classified within the pertinent socioeconomic objectives.

OTHER CLASSIFICATION CHARACTERISTICS

Apart from the institutional sub-sectorisation of the companies sector (public, private national, private multinational and research associations), companies are asked whether they are independent or if they form part of a group of companies.

The companies that form part of a group of companies are classified, in turn, according to their relationship with the group:

– holding company (if it has effective control of the group)

– subsidiary (if more than 50% of the capital is held by a holding company)

– joint venture companies (if participation is 50%)

– associated company (if participation is below 50%)

These companies are also asked, for classification purposes, if the group's headquarters are located in:

- Spain
- Remaining countries of the European Union
- Other European countries
- United States
- Japan
- Remaining countries

Lastly, to avoid duplicities, the full name of the group is requested or, for lack of, the name of the holding company.

In the public administration sector, apart from the institutional sub-sectorisation (State Administration, Autonomous Administration and Local Administration), the public research organisations are asked to outline the form which they take, i.e., the type of entity constituted, in accordance with the following classification:

– Administrative service

– Administrative autonomous institution

– Commercial, industrial, financial or analogous autonomous organisation

– Social Security administration agency

– Other public law entity (public entity, state entity, public company, ...)

To avoid duplicities, information is also requested on the administrative unit immediately above, to which the public organisation responds. In the case of health establishments (hospital, clinic, sanatorium, hospital complex, ...), information is requested on which physical or legal person manages the centre, according to the following categories:

– National Health Institute (INSALUD)

– Regional health service, jurisdiction having been transferred by INSALUD

– Council or City Hall (including Regional Parliament, City Council and similar)

– Other units from the state administration and social security

– Other departments of the Autonomous Administration

– Other entities (public organisations from different administrations sharing jurisdiction, private charities, private non charity, ...)

In the higher education sector information is requested regarding the size of the university, the number of students enrolled in any academic year (including doctorate, master, specialised courses, ...) on the faculty, school, university centre or similar.

Information is also requested on the budget of the university, variable that is used to distribute universities by size.

Lastly, information is requested on which unit is entrusted with channelling the R+D contracts (foundation, company, association, organisation, ...) and which are the university departments dependent on the university.

Within the private non-profit institutions, information is requested on the dependence of the institution, as well as its objectives and activities, and the Trust or governing council of the institution.

2.5 Sample design

Due to the coordination of the R+D Statistic and the Technological Innovation in Companies Survey (TIS), the population framework is the Central Companies Directory (CCD). This is an organised information register with identification, localisation and territorial distribution data, and classification by size and economic activity of companies, obtained from administrative sources and complemented by other information that stems from current INE statistical operations.

Likewise, the survey includes within the population object of the study a directory of units (companies, public research organisations, ...) that are considered possible research units, either because they were considered as such in prior years, or because they have received public financing for the realisation of R+D during the reference year of the survey, or because they have declared the realisation of systematic R+D activities in the innovation survey during the year preceding the reference year.

Information is requested each year on the destination of R+D funds from diverse State and Autonomous organisations. This information is cross-referenced with the previous year's directories, incorporating new registrations and modifications, and delistings.

The population of companies object of this statistic has been stratified by crossing the following variables:

a) Belonging to the directory of companies that potentially might carry out research, which is analysed exhaustively.

b) Size of the company: The following intervals are considered:

– Less than 10 employees

– From 10 to 49

– From 50 to 199

– 200 and more

The strata made up of companies with 200 or more employees have been analysed exhaustively.

c) Branch of main activity according to NCEA-93 Rev.1: 54 divisions or groups of activity are considered.

SIZE OF THE SAMPLE. ALLOCATION

The sample size of the R+D Statistic exceeds 25,000 units, of which more than 24,000 are companies, approximately 600 are public research organisations (including public hospitals), 69 are universities and 33 are centres that are dependent on the former, and 200 are private non-profit institutions. Companies, public organisations, universities and private non-profit institutions that conform the directory of possible research units have been exhaustively analysed. The remaining units of the companies sector has been studied through sampling.

ESTIMATORS

The estimator of the total of a characteristic X in domain m is given by:

$$\hat{X}_m = \sum_{j \in m} X_j \cdot F_j \ ,$$

where X_j is the value of the characteristic X from questionnaire j belonging to domain m.

F_j is the elevation factor from questionnaire j that is calculated as follows:

a) If the company j was selected in stratum h and according to the questionnaire it is included within the different stratum k, then:

$$F_j = \frac{N_h}{n_h} \quad (1)$$

b) If the company j continues to belong to the same stratum h, where it was selected, then:

$$F_j = \frac{\hat{N}_h^*}{n_h^*} \quad (2)$$

c) In specific cases that are appropriately specified $F_j = 1$.

Variables used

N_h, number of companies in stratum h.

$_nh$, number of companies selected in stratum h.

n^*_h, number of companies that have replied, selected in stratum h and that have not changed stratum.

$$\hat{N}^*_h = N_h \left(1 - \frac{nh^*_n}{n_h}\right) - \sum_{k \neq h} \sum_{j=1}^{n^k_{hn}} F_j$$

being n''_h the number of companies selected in stratum h and which have the following incidents: they correspond to closures, are not industrial, they are duplicated or correspond to self-employed persons.

n^k_h, number of companies selected in stratum h, and which according to the questionnaire are in the different stratum k.

Sample errors are also calculated by expressing the variation of the estimator of the total stratified sample.

2.6 Collection of the information

The collection of the questionnaires on this statistic is coordinated with the collection of other structural surveys carried out by INE. For this purpose a coordinated collection unit has been created, named URCO, and a reduced questionnaire has been used that excludes the questions that are common to other surveys. The remaining units were collected by the Centralised Collection Unit (URCE). However, due to the lack of resources, part of the collection has been carried out via an external company.

The follow-up of the calendar of the fieldwork and the quality control of the information has been carried out from the Central Services of the INE. The percentage of non responses has been approximately 4 per cent of the total.

The personnel involved in the survey work are compelled by law to preserve statistical secrecy.

The survey inspectors are responsible for the theoretical and practical training of the personnel involved in same, and for the control of the work relating to the collection of the information. To this end, the corresponding manuals and training and enquiry documents are prepared.

The questionnaire is forwarded by mail to the informant units together with a presentation letter, the rules for completion and an informative brochure with the last results of the R+D Statistic. Companies count with a period of 15 days to return same duly completed.

The collection unit establishes an initial telephone contact with the company to verify receipt of the questionnaire. If once the established period has elapsed the completed questionnaire has not been received, the necessary telephone and written reminders are carried out.

The R+D Statistic is obligatory pursuant to the National Statistical Plan.

The collection unit puts into practice an integrated information collection procedure, which consists in the filtering and recording of the data as soon as the information is received. If necessary, the companies are requested to provide the necessary clarification in relation with the data furnished.

The R+D information from the Public Administration, higher education and private non-profit institutions is collected directly by the INE department elaborating this Statistic.

2.7 Processing of the information

The following are the processing phases with regards to information received from companies:

– Manual control and filtering of the company questionnaires within the collection unit, in order to recover possible missing data or to correct questionnaires errors

– Recording, filtering and interactive correction of the inconsistencies of the information validated in the collection unit

– Control of the information received from the collection unit by the INE department promoting the survey

– Control of the scope and processing of errors by the INE department promoting the survey

– Imputation of partial non responses

– Elaboration of a first phase of tables analysing the results

– Use of macro edition techniques at the INE department promoting the survey to eliminate errors and inconsistencies in the aggregates, which have not been detected in the previous micro filtering phase

– Analysis of the data

– Creation of definitive data files

– Attainment of tables of final results elaborated by the aforesaid INE department from the final data files corresponding to companies

For the remaining sectors, the aforesaid INE department handles all the information processing phases (control of the scope, filtering, recording, analysis and attainment of results tables).

2.8 Presentation of the results

The tabulation of results is presented in chapter 3 of this publication. The data has been structured in the following manner:

– Science and technology indicators

– National summary

– Results from the corporate sector

– Results from the public administration sector

– Results from the higher education sector

– Results from non-profit private institutions

– Results by Autonomous Community

The results pertaining to companies are presented in tables bearing in mind two classification variables:

– Grouping of the main economic activity, according to the NCEA-93 Rev.1 code

– Division of the company according to number of employed persons

For the rest of the sectors the results are presented by scientific field or discipline.

Moreover, results tables may be obtained that meet the information requirements of national and international institutions, as well as individual users interested in the subject. In all cases statistical secrecy is maintained, with the limits delimited by the sample errors.

This publication is available on paper, CD and at the INE web site.