Measuring Intangible Investment

Intangible Investment in the Statistical Frameworks for the Collection and Comparison of Science and Technology Statistics

by

OECD Secretariat

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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CHAPTER 1. RESEARCH AND EXPERIMENTAL DEVELOPMENT

1.1 International Standards: The *Frascati Manual*

1.1.1 General content

The *Frascati Manual* (OECD, 1994) deals with R&D expenditures and personnel. R&D is defined and guidelines are given for distinguishing it from closely associated science and technology activities and also from industrial production. A system of institutional sectors and classifications is presented plus a number of more detailed functional classifications. Further specifications are given on the measurement of R&D expenditures and personnel, notably flows of funds between sectors and the construction of national totals. Guidelines on survey methods are also included. An additional chapter deals with timely estimates of government support for R&D derived from budgetary sources broken down by socio-economic objectives such as defence, environmental protection, health, etc. There are a number of annexes including one on R&D deflators and currency converters and another on satellite accounts for R&D.

Over the years the *Frascati Manual* has been revised four times to take into consideration changes in policy preoccupations, increased understanding of how science and technology work as a system and mesh with the economy, more sophisticated appreciation of differences in economic structures and S&T institutions between countries and improvements in the international standards and classifications on which it draws. The fifth edition was issued in 1994.

1.1.2 Basic Definition

> "Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications.

R&D is a term covering three activities: basic research, applied research and experimental development. *Basic research* is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. *Applied research* is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective. *Experimental development* is systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed." (OECD, 1994, paras. 57-58).

1.1.3 General rules for distinguishing R&D from other activities

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

These activities are discussed in the *Manual* under four headings:

i) education and training;

ii) other related scientific and technological activities;

iii) other industrial activities;

iv) administration and other supporting activities.

The definitions in the *Manual* are practical and designed solely to exclude these activities from R&D.

[OECD, 1994, paras. 60-62]

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

At the borderline between R&D and other industrial activities, "the basic rule laid down by the National Science Foundation (NSF) provides a practical basis for the exercise of judgement in difficult cases. Slightly expanded, it states:

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

Despite this elaboration, definitions can be difficult to apply in individual industries. It may not be clear when there is an appreciable element of novelty in R&D, or when a product/process is substantially set."(OECD, 1994, paras. 112-113).

1.1.4 The business enterprise sector and classifications

Paper 4 (Vosselman) recommends that intangible investment should be measured in the Business enterprise sector and then make suggestions about the statistical units and classifications. This section reproduces the corresponding paragraphs in the *Frascati Manual* 1993 (OECD, 1994) for fuller information.

1.1.4.1 Definition of the sector

This sector includes:

> All firms, organisations and institutions whose primary activity is the market production of goods or services (other than Higher Education) for sale to the general public at an economically significant price;

The core of the sector is made up of *private enterprises* (corporations or quasi-corporations) whether or not they distribute profit. Amongst these enterprises may be found some firms for which R&D is the main activity (commercial R&D institutes and laboratories). Any private enterprises producing Higher Education services should be included in the Higher Education sector.

In addition, it includes *public enterprises* (public corporations and quasi-corporations owned by government units) mainly engaged in market production and sale of the kind of goods and services which are often produced by private enterprises, though as a matter of policy the price set for these may be less than the full cost of production. In order to qualify as market production in this context, the charges should be related to the amount (quality and quantity) of the goods and services furnished, the decision to purchase them should be voluntary and the price charged should have a significant effect on the quantities supplied and demanded. Any public enterprises producing Higher Education services should be included in the Higher Education sector.

This sector also includes NPIs who are market producers of goods and services other than Higher Education. These are of two kinds:

i) The first are NPIs whose main activity is the production of goods and services for sale at prices designated to recover most or all their costs. Such research institutes, clinics, hospitals, medical practitioners in private, fee-paying practices, etc. may be able to raise additional funds in the form of donations or own assets generating property income which allow them to charge below average cost.

ii) The second are NPIs serving business. These are typically created and managed by associations of businesses whose services they are designated to promote such as chambers of commerce, agricultural, manufacturing or trade associations. Their activities are usually financed by contributions or subscriptions from the businesses concerned which provide "institutional" support for their R&D. However, any NPIs carrying out similar functions but which are controlled or mainly financed by government, for example if they depend for their existence on a block grant from government, should be included in g sector.

TABLE 1.1 **Industrial classification for resources devoted to R&D in the business enterprise sector in the OECD R&D survey and correspondence with ISIC Rev.3, NACE Rev.1 and approximate correspondence with ISIC Rev.2**

	Title	ISIC Rev.3 Division/Group/Class	Corresponding NACE Rev. 1 Div./Group/Class	**Approximate** correspond. with ISIC Rev. 2 Div./Group/Class
1.	**AGRICULTURE, HUNTING & FORESTRY**	**01+02+05**	**01+02+05**	**1**
2.	**MINING**	**10 thro' 14**	**10 thro' 14**	**2**
3.	**MANUFACTURING**	**15 thro' 37**	**15 thro' 37**	**3**
4.	**Food, Beverages & Tobacco**	**15+16**	**15+16**	**31**
5.	Food Products & Beverage	15	15	311 thro'313
6.	Tobacco Products	16	16	314
7.	**Textiles, Wearing Apparel, Fur & Leather**	**17 thro' 19**	**17 thro' 19**	**32**
8.	Textiles	17	17	321
9.	Wearing Apparel & Fur	18	18	(
10.	Leather Products & Footwear	19	19	(322 thro'324
11.	**Wood, Paper, Printing, Publishing**	**20 thro' 22**	**20 thro' 22**	**331+34+3832 (part)**
12.	Wood & Cork (not Furniture)	20	20	331
13.	Pulp, Paper & Paper Products	21	21	341
14.	Publishing, Printing & Reproduction of Recorded Media	22	**22**	342+3832 (part)
15.	**Coke, Petroleum, Nuclear Fuel, Chemicals & Products, Rubber & Plastics**	**23 thro' 25**	**23 thro'25**	**35**
16.	Coke, Refined Petroleum Products & Nuclear Fuel	23	23	353+354
17.	Chemicals & Chemical Products	24	24	351+352
18.	*Chemical Products less Pharmaceuticals*	*24 less 2423*	*24 less 24.4*	*351+352 less 3522*
19.	*Pharmaceuticals*	*2423*	*24.4*	*3522*
20.	Rubber & Plastic Products	25	25	355+356
21.	**Non-Metallic Mineral Products ("Stone, Clay & Glass")**	**26**	**26**	**36**
22.	**Basic Metals**	**27**	**27**	**37**
23.	Basic Metals, Ferrous	271+2731	27.1 thro' 27.3 + 27.51/52	371
24.	Basic Metals, Non-Ferrous	272+2732	27.4 + 27.53/54	372
25.	**Fabricated Metal products (except Machinery & Equipment)**	**28**	**28**	**381**
26.	**Machinery Equipment, Instruments & Transport Equipment**	**29 thro' 35**	**29 thro' 35**	**38 less 381 & 3832 (part)**
27.	Machinery, nec	29	29	382 less 3825+3829 (part)
28.	Office, Accounting & Computing Machinery	30	30	3825
29.	Electrical Machinery	31	31	383 less 3832
30.	Electronic Equipment (Radio, TV & Communications)	32	32	3832 (part)
31.	*Electronic Components (includes Semiconductors)*	*321*	*32.1*	
32.	*Television, Radio & Communications Equipment*	*32 less 321*	*32 less 32.1*	
33.	Medical, Precision & Optical Instruments, Watches clocks (instruments)	33	33	385
34.	Motor Vehicles	34	34	3843
35.	Other Transport Equipment	35	35	384 (part)+3829(part)
36.	*Ships*	*351*	*35.1*	*3841*
37.	*Aerospace*	*353*	*35.3*	*3845+3829(part)*
38	*Other Transport nec*	*352+359*	*35.2+35.4+35.5*	*3842+3844+3849*
39.	**Furniture, Other Manufacturing nec**	**36**	**36**	**332+39**
40.	Furniture	361	36.1	332
41.	Other Manufacturing nec	369	36.2 thro' 36.6	39
42.	**Recycling**	**37**	**37**	**NA**
43.	**ELECTRICITY, GAS & WATER SUPPLY (UTILITIES)**	**40+41**	**40+41**	**4**
44.	**CONSTRUCTION**	**45**	**45**	**5**
45.	**SERVICE SECTOR**	**50 thro' 99**	**50 thro' 99**	**6 thro' 9**
46.	**Wholesale, Retail Trade & Motor Vehicle etc. Repair**	**50 thro' 52**	**50 thro' 52**	**61+62+6(part)**
47.	**Hotels & Restaurants**	**55**	**55**	**63**
48.	**Transport & Storage**	**60 thro' 63**	**60 thro' 63**	**71**
49.	**Communications**	**64**	**64**	**72**
50.	Post	641	64.1	
51.	Telecommunications	642	64.2	
52.	**Financial Intermediation (including Insurance)**	**65 thro' 67**	**65 thro' 67**	**81+82**
53.	**Real Estate, Renting & Business Activities**	**70 thro' 74**	**70 thro' 74**	**83+932**
54.	Computer & Related Activities	72	72	8323
55.	*Software Consultancy*	*722*	*72.2*	
56.	*Other Computer Services nec*	*72 less 722*	*72 less 72.2*	
57.	Research & Development	73	73	932
58.	Other Business Activities nec	70+71+74	70+71+74	83(part)
59	**Community, Social & Personal Service Activ., etc.**	**75 thro' 99**	**75 thro' 99**	**9 less 932**
60	**GRAND TOTAL**	**01 thro' 99**	**01 thro' 99**	**1 thro' 9**

a. Activities carried out in these industries by the Business enterprise sector only. Figures are expected to be neglible: the heading is included as an aide-memoire.

Table 1.2. **Concordance between industrial classification for past R&D surveys and the international standard classification of all economic activities** [1]

	ISIC Classification[1]
1 AGRICULTURE	Major division 1
2 MINING	Major division 2 [2]
3 Electrical Machinery 4 Electronic Equip. & Comp.	383 except 3832 3832 (industries separated as from ISY 1979, previously included in electrical machinery)
5 SUB-TOTAL	383
6 Chemicals 7 Drugs 8 Petroleum Refining	351 + 352 (except 3522) 3522 353 + 354
9 SUB-TOTAL	351 + 352 + 353 + 354
10 AEROSPACE	3845 and part of 3829
11 Motor Vehicles	3843
12 Ships	3841
13 Other Transport Equipment	3842, 3844 + 3849
14 SUB-TOTAL	384 less 3845
15 Ferrous Metals 16 Non-Ferrous Metals 17 Fabricated Metal Products	371 372 381
18 SUB-TOTAL	371 + 372 + 381
19 Instruments 20 Office & Computing Mach. 21 Machinery nec	385 3825 (industries separated as from ISY 1979, previously included in machinery, except for certain countries which classified them with electronics) 382 (except 3825 and part of 3829)
22 SUB-TOTAL	385 + 382 (except part of 3829)
23 Food, Drink and Tobacco 24 Textiles, Footwear & Leather 25 Rubber & plastic Products	31 32 355 + 356
26 SUB-TOTAL	31 + 32 + 355 + 356
27 Stone, Clay and Glass 28 Paper and printing 29 Wood, Cork and Furniture 30 Other Manufacturing	36 34 33 39
SUB-TOTAL	31 + 32 + 355 + 356
27 Stone, Clay and Glass 28 Paper and Printing 29 Wood, Cork and Furniture 30 Other Manufacturing	36 34 33 39
31 SUB-TOTAL	31 + 34 + 36 + 39
32 TOTAL MANUFACTURING	Major division 3
33 Utilities 34 Construction 35 Transport, Storage 36 Communications 37 Commercial and Engineering Services 38 Other Activities	Major division 4 Major division 5 71 72 8324 (if not distributed by ind.) 9320 (if relevant) 6,81,82,83 (except 8324) and any items of 9 included in sector
39 TOTAL SERVICES	4 + 5 + 6 + 7 + 8 + 9 (if relevant)
40 TOTAL BUSINESS ENTERPRISE	See *Frascati Manual*.

1. *International Standard Classification of All Economic Activities: Series M*, N° 4, Revision 2 (United Nationals Statistical paper)
2. Including extraction of crude oil and natural gas

Source: DSTI/IP.90.9, Table 3.

Finally, this sector includes units associated with the Higher Education and Government sectors whose main purpose is the development of, and contribution to the Business enterprise sector. The criterion for the classification of the unit is the sector it mainly serves and not any co-operation concerning projects, use of equipment, or of personnel belonging to or used by Higher Education or Government sector institutions." (OECD, 1994, paras. 154-151).

1.1.4.2 The classification by industry

Classification list

For international comparisons of R&D statistics, units in the Business enterprise sector are classified into a number of significant industry groups and sub-groups by the International Standard Industrial Classification (ISIC). Table 1.1 shows the current version based on ISIC Rev 3 (United Nations, 1990) and Table 1.2 earlier version based on ISIC Rev 2 (UN, 1968).

The statistical unit

R&D by business enterprises may be organised in a number of ways. Core R&D may be carried out in units attached to establishments or in central units serving several establishments of an enterprise. In some cases, separate legal entities may be established to provide R&D services for one or more related legal entities. Ad hoc R&D, on the other hand, is usually carried out in an operational department of a business such as the design, quality or production department.

The choice of the statistical unit(s) must be determined by the nature of the information normally collected. While this is described in detail in Chapter VI, we can state here that one of the most fundamental questions concerns the sources of funds for R&D. This will generally concern the legal entity which controls the performance of the R&D rather than the smaller units which actually carry out the work. The R&D unit may have to prepare a budget and record its costs but only the central administration of the company may know where the money actually came from to cover the expenditures. Contracts and taxation must involve a legal entity.

This enterprise-type unit is, therefore, recommended as the **reporting unit** and, with exceptions, as the **statistical unit** in the Business enterprise sector. In most cases the legal entity defined in paras. 78 and 79 of the ISIC Rev. 3, is the appropriate unit.

When an enterprise is heterogeneous with regard to its economic activities and carries out significant amounts of R&D for several kinds of activity units, the R&D activity should be sub-divided (if the necessary information can be obtained). In some countries this is done by division into statistical units corresponding to economic units within the enterprise. In other countries, the R&D activity might be broken down according to data on the products and processes involved.

Within a group of enterprises, it is desirable to obtain separate returns in respect of each of the legal units for which records are kept. Where such records are not kept by the enterprise, the data could be compiled for analytical units created by the statisticians.

Criteria for classification

Firms

The principal activity classification of these statistical units should be determined by "the class of the ISIC in which the principal activity, or range of activities, of the unit is included" (ISIC Rev. 3, para. 114).

According to ISIC, this principal activity should be determined by reference to the value added of the goods sold or the services rendered by the activities. If this is not possible, the principal activity can be determined either on the basis of the gross output of the goods sold or services rendered by each activity, or by the number of persons assigned to them (ISIC Rev. 3, para. 115; UN, 1990).

To conform as far as possible with the ISIC principles outlined in paragraph 159, the R&D statistical units in the Business enterprise sector should be linked with the division on the family of industries which benefit directly from their R&D. In most cases, this will be determined by the principal activity classification of the R&D statistical units.

R&D units serving enterprises

When the R&D is carried out in a legal entity specialising in research and development, that unit will be classified in research and services for enterprises (ISIC Rev. 3, Section 73). It is therefore desirable for the purpose of R&D analysis to identify for it an additional classification reflecting the division in the family of industries which benefit from its R&D activities. This may be based on activity or product data obtained in R&D surveys." (OECD, 1994, paras. 152-161).

1.1.4.3 Other institutional sub-classifications

Size of institution

The extent and nature of the R&D programmes of entities in the Business enterprise sector are normally affected by the size of the entity. Two size classifications are possible: one based on revenue or other financial items, one on employment. Employment is preferable since it is a less ambiguous measure (e.g. total revenue including investment income, operating revenue, sales, turnover, extra-enterprise sales only, might all be used for the financial classification). Since this classification is based on the assumption of the likelihood of some sort of relationship between size of enterprise and resources available for R&D, non-commercial institutions should be separated from the commercial enterprises as their high ratios of R&D inputs to size are not comparable to those of enterprises for whom R&D is auxiliary. For the same reason, enterprises and institutes whose primary activity is R&D should be separated from the other commercial enterprises. It seems best, therefore, to confine this classification to statistical units in the manufacturing industries (and possibly even to commercial enterprises only).

The following size groups (according to number of employees) are recommended:

Under 100
100 - 499
500 - 999
1 000 - 4 999
5 000 - 9 999
10 000 and above." (OECD, 1994, paras. 166-167).

Type of institution

The *Frascati Manual* suggests a further classification by type of institution.

The nature of the R&D performed by an entity in the Business enterprise sector often reflects the type of entity and it would be useful if R&D data could reflect these differences. In particular, the evolving nature of the Business sector both within countries and on a global scale require sub-division within both private and public enterprises.

If private enterprises are broken down between nationally and multinationally owned enterprises some trends in the internationalisation of industry can be examined. Public enterprises on the other hand, would benefit from an identification of how much of their R&D effort is carried out in conjunction with institutions classified in the Business enterprise sector, but which are at the border of the Higher Education and Government sectors.

It is recommended therefore, that if possible the following classification by type of institution be used:

i) Private enterprises:

- national
- multinational (at least 50 per cent foreign ownership of capital);

ii) Public enterprises:

- units associated with the Higher Education sector
- units associated with the Government sector
- all other public enterprises;

iii) Other research and co-operative institutes." (OECD, 1994, paras. 162-164)

1.1.5 Borderline between R&D and other intangibles

Attempts to deal systematically with possible areas of overlap between the different categories of intangible investment. The following sections reproduce the relevant passages of text from the *Frascati Manual*.

1.1.5.1 Education and training

All education and training of personnel in the natural sciences, engineering, medicine, agriculture, the social sciences and the humanities in universities and special institutions of higher and post-secondary education should be excluded. However research by post-graduate students carried out at universities should be counted, wherever possible, as a part of R&D." (OECD, 1994, para. 62).

1.1.5.2 Software

Software activities can also be R&D under two circumstances:

i) They are sufficiently novel to be R&D in their right.

ii) Because, even if routine, they are an integral part of an R&D project. For example, the purchase of a standard package for use in a project is a legitimate expenditure on R&D (as would be the purchase of a calculator or a block of paper).

Measures of the overlap, for example the Canadian data which are often quoted, cover the first kind but not the second.

Principles for classification software development as R&D

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

In addition to software which is part of an overall R&D project, research and development associated with software as an end-product should also be classified as R&D.

Software development, of its nature, makes it difficult to identify its R&D component, if any. It is an integral part of many projects which of themselves have no elements of R&D. The software development component of such projects, however, may be classified as R&D if an advancement occurs in the area of computer software. Advancement in software is normally incremental rather than revolutionary. Therefore, an upgrade, addition or change to an existing programme or system may be classified as R&D if it embodies scientific and/or technological advancements the resolution of which result in an increase in the stock of knowledge. Use of software for a new application or purpose, however, does not by itself constitute an advancement.

A scientific and/or technological advancement in software may be achieved even if a project is not completed. This situation arises because a failure can increase knowledge of the technology of computer software by showing that a particular approach will not succeed, within the limits of the business environment. Alternatively, the project’s objectives may not be achieved having exhausted all of the planned approaches.

Concurrent advancement in other fields resulting from a software project has no effect on whether an advancement in computer software has occurred. (OECD, 1994, paras. 105-109).

"This is an indicative list of the possible R&D elements in the broad areas of software development.

1. **Theoretical**: Generally, the technological or scientific advancements computer in this area produce new theorems and algorithms. As science in any scientific or technological endeavour where uncertainty exists, negative results are expected to be associated with some R&D activities.

2. **Operating**: Technological advances consist in: *i)* a technological systems improvement in resource and interface management; *ii)* a truly new operating system; or *iii)* the conversion of an operating system to a significantly different hardware environment. In disputed cases, an assessment of what is "significantly different" needs to be made by computer scientists with experience in the particular area in question.

3. **Programming**: Technology advances are *i)* new languages; *ii)* languages significant extension to an existing language; and *iii)* new or significantly different language translators.

4. **Applications**: In addition to the situations previously discussed, technological advances may occur when a development represents a significant technological step forward (e.g. new combinations of established computer program components or known programming principles), provided that this integration requires the resolution of technological uncertainties.

5. **Data**: Technological advances include the development of: *i)* management algorithms to achieve significantly better basic operations (e.g. retrievals from a database); *ii)* new or enhanced query languages for databases which significantly increases the power or search or manipulation capabilities; and *iii)* new object representations or data structures.

6. **Software**: Advances in the methodology required to construct engineering computer programmes with greater flexibility, efficiency, reliability and ease of maintenance.

7. **Artificial**: Scientific and technological advances are made in such intelligence domains as machine vision, robotics, inference, knowledge representations, expert systems, theorem proving, natural language understanding, automatic language translation, logic programming, and future generation systems. In most areas of AI, there is not yet an established practice; however, demonstration of the attempt to resolve a technological uncertainty is required in order to provide a basis for the establishment of the eligibility of expenditures. Frequently in this area, the existence of any kind of solution will reflect this indeterminacy."

Source: OECD, 1994*a*, Annex 4.

Exclusion of routine software development

"Software-related activities of a routine nature are not considered to be R&D. Such activities include work on system or programme-specific advancements which were publicly available prior to the commencement of the work. Technical problems which have been overcome in previous projects on the same operating systems and computer architecture are likewise excluded. Software-related activities such as:

i) supporting existing systems

ii) converting and/or translating computer languages

iii) adding user functionality to application programs

iv) de-bugging of systems

v) adaptation of existing software

vi) preparation of user-documentation

which do not involve scientific and/or technological advancement are not classified as R&D.

Routine computer maintenance is not included. Quality assurance, routine data collection and market research are also excluded." (OECD, 1994, paras. 72-73).

Mixed cases

"In the systems software area, individual projects may not be considered as R&D but their aggregation into a larger project may qualify for inclusion. For example, changes in file structure and user interfaces in a fourth generation language processor may be made necessary by the introduction of relational technology. The individual changes may not be considered R&D if viewed in their own right but the whole modification project may result in the resolution of scientific and/or technological uncertainty and thus be classified as R&D." [OECD, 1994, para. 81(e)].

1.1.5.3 Mining and prospecting

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

The development of new surveying methods and techniques.

Surveying undertaken as an integral part of a research project on geological phenomena.

Research on geological phenomena *per se* undertaken as a subsidiary part of surveying and prospecting programmes.

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

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

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

It follows that the surveying and prospecting activities of commercial companies will be almost entirely excluded from R&D. For example, the sinking of exploratory wells to evaluate the resources of a deposit should be considered as scientific and technological services." (OECD, 1994, paras. 101-103).

1.1.5.4 Marketing

It is specified in para. 66 of the *Frascati Manual* (OECD, 1994) that market surveys should be excluded from R&D as they are general purpose data collection.

1.1.5.5 Other activities at the borderline of R&D and industry

At the borderline between R&D and other industrial activities "care must be taken to exclude activities which, though undoubtedly a part of the innovation process, rarely involve any R&D, e.g. patent filing and licensing, market research, manufacturing start-up, tooling-up and re-design for the manufacturing process. Some activities such as tooling-up, process development, design and prototype construction may contain an appreciable element of R&D, thus making it difficult to identify precisely what should or should not be defined as R&D" (OECD, 1994, para. 111) (see Table 1.3).

Table 1.3 **Some borderline cases between R&D and other industrial activities**

ITEM	TREATMENT	REMARKS
Prototypes	Include in R&D	As long as the primary objective is to make further improvements
Pilot plant	Include in R&D	So long as the primary purpose is R&D
Industrial design and drawing	Divide	Include design required during R&D. Exclude design for production process
Industrial engineering and tooling-up	Divide	Include "feedback" R&D and tooling-up/industrial engineering associated with development of new products and new processes. Exclude for production processes
Trial production	Divide	Include if production implies full-scale testing and subsequent further design and engineering; start-up. Exclude all other associated activities
After-sales service and trouble-shooting	Exclude	Except "feedback" R&D
Patent and licence work	Exclude	All administrative and legal work connected with patents and licences. (Except patent work directly connected with R&D projects).
Routine tests	Exclude	Even if undertaken by R&D staff
Data collection	Exclude	Except when an integral part of R&D
Public inspection control, enforcement of standards, regulations	Exclude	

Source: OECD (1994), Table II.2.

Patenting

"All administrative and legal work connected with patents and licenses is excluded. However patent work connected directly with R&D is R&D." (OECD, 1994, para. 70).

Engineering and design

"The vast bulk of design work in an industrial area is that geared towards production processes, and as such is not classified as R&D. There are, however, some elements of design work which should be included as R&D. These include plans and drawings aimed at defining procedures, technical specifications and operational features necessary to the conception development and manufacturing of new products and processes.

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

R&D activities in the mechanical engineering industry often have a close connection with design and drawing work. Usually there are no special R&D departments in small and medium size companies in this industry and R&D problems are mostly dealt with under the general heading design and drawing. If calculations, designs, work drawing and operating instructions are made for the setting-up and operating of pilot plants and prototypes, they should be included in R&D. If they are carried out for the preparation, execution and maintenance of production standardisation (e.g. jigs, machine tools) or to promote the sale of products (e.g. offers, leaflets, spare parts catalogues) they should be excluded from R&D." (OECD, 1994, paras. 125-126 and 81).

1.2 International data

OECD is the main source of internationally comparable R&D statistics in general including those for the Business enterprise sector.

1.2.1 Data collection

For statistical purposes, two inputs are measured: R&D expenditure and R&D personnel. These inputs are usually measured on an annual basis. Total expenditure and the number corresponding to full-time equivalent person-years are calculated for the twelve month period.

These statistics, which are based on the standards laid down in the *Frascati Manual*, are for the main part collected by means of the international survey of the resources devoted to R&D by OECD Member countries, using questionnaires sent to Member countries. The first of these surveys covered the year 1963-64. Reliable data is generally only available from the early 1970s. All OECD Member countries except Luxembourg have supplied data.

1.2.2 There are three possible sets of data in Business enterprise R&D databases at OECD

1.2.2.1 Total expenditure on R&D in the BE sector

This set of data covers total R&D in the sector with no breakdown by industry. These **expenditure data** are also broken down according to source of funds (Enterprises, Direct Government, Higher Education, PNP and Abroad), according to the type of cost, according to the type of R&D activity (Basic Research, Applied Research, Experimental Development), according to socio-economic objectives, according to the main scientific fields [Natural Sciences and Engineering (NSE), Social Sciences and Humanities (SSH) and all scientific fields (NSE+SSH)].

The first two source of funds and type of cost are standard breaks and are almost always available. The others are often less likely to be collected from the Business enterprise sector. For national interpolated data or forward estimates, only total R&D expenditure in the sector is usually available with perhaps a break by source of funds.

1.2.2.2 Business enterprise sector broken by industry (BERD)

The basic classification is the International Standard Industrial Classification (ISIC). For the purposes of international comparisons, the R&D statistics are classified under a certain number of groups and sub-groups of industries, the most detailed being the 4-digit level. Table 1.1 applies from 1987 and Table 1.2 for earlier years.

In general the data in this set are the direct results of national surveys and do not, like the total BERD series, include national interpolations or other estimates. They are sometimes referred to as OFFBERD.

The two relevant cross-classifications for intangible investment are those by source of funds and by type of cost. The source of funds is more detailed than that for the total BERD in that it distinguishes between the firms own resources and R&D funds received from other enterprises.

1.2.2.3 ANBERD

The ANBERD database was constructed with the objective of creating a consistent data set, that overcomes the problems of international comparability and time discontinuity associated with the official BERD data provided to the OECD Member countries. Based on estimates, the ANBERD database is published on the responsibility of the Secretary General of the OECD and does not represent Member countries' official submissions of business enterprise R&D data. The ANBERD estimates presented cover the period 1975 to 1996 and 26 industries for 15 countries: Australia, Canada, Denmark, Finland, France, Federal Republic of Germany before unification as well as Germany, Ireland, Italy, Japan, the Netherlands, Norway, Spain, Sweden, the United Kingdom and the United States.

These data cover total intramural R&D expenditure in the Business enterprise data regardless of source of funds or type of cost. There are no cross-classifications.

For the period 1973-1985, the classification in Table 1.2 applies except that estimates were only made systematically for missing manufacturing industries. As from 1986, Table 1.1 applies and the services are fully included.

1.2.3 Availability of the survey results

The first two sets of data are available from a publication entitled *Basic Science and Technology Statistics* (OECD, biennial) which is also available annually on diskette. The diskette reports data from 1981 whereas the publication shows the latest years only. "Basic Statistics" is probably the most useful source for those wishing to compile intangible investment data. The availability of data in the OECD base is shown in Tables 1.4 and 1.5 for established OECD countries. For the new Member countries (Czech Republic, Hungary, Korea, Mexico, Poland), time series began in the early 1990s.

The ANBERD data are published annually as *Research and Development in Industry* (OECD, annual). The latest version of the publication and the electronic release have been somewhat modified. The current publication presents only ANBERD and, new this year, the ANRSE databases. The diskette, however, presents:

- ANBERD in ISIC Revision 2 in national currencies as well as in PPPs, for 1973-96;
- ANBERD hybrid tables: ISIC Revision 2 for the manufacturing sectors and ISIC Revision 3 for the services in national currencies and in PPPs, for 1987-96;
- ANRSE in ISIC Revision 2 in full-time equivalent, for 1973-94;
- OFFBERD data in ISIC Revision 2 for the 1973-87 time period and in ISIC Revision 3 for the 1987-97 time period, in national currencies as well as the numerical notes which identify the numerous anomalies found in the industry-level R&D data for all OECD Member countries;
- OFFRSE data in ISIC Revision 2 for the 1973-87 time period and in ISIC Revision 3 for the 1987-95 time period, in full-time equivalent.

1.2.4 Technical information

Users also need information about the characteristics of the data available, how it has been obtained and any serious problems of international comparability. All the data in the *Basic Science and Technology Statistics* (OECD, biannual) publications are annotated with a set of standard notes flagging different types of anomalies and further details are given in the ANBERD volume.

For R&D in the Business enterprise sector, the two major problems of international comparability are that the date for the United States include depreciation instead of any capital expenditure and that the Japanese expenditure data maybe overestimated as they cover the costs of all persons working "regularly" on R&D rather than being reduced to their "full-time equivalent".

Table 1.4. **Availability of data on business R&D expenditure (GERD segment)** by classification, years: established OECD countries

Country	Frequency	First year in OECD database					
		Total (BERD)	Source of funds	Type of costs	Type of activity	Socio-economic objective	Field of science
Australia	B	76	78	78	78	77	78
Austria	A (I before 78)	64	64	70	75P	81	67
Belgium	B	63	71P	69	63	--	67
Canada	A	63	63	75	--	--	71
Denmark	T (except 73-79)	67	67	70	70	82	73
Finland	B	69	69P	69	69P	--	69
France	A	63	63P	75P	67P	--	--
Germany	A	64	64P	64	67P	--	64
Greece	B	79	79P	83P	88P	--	79
Iceland	B	71	71	71	71	83	71
Ireland	B since 1967	63	63	63	63	81	67
Italy	A (B before 67)	63	63	67P	63P	79P	63
Luxembourg	--	--	--	--	--	--	--
Japan	A	63	71	75P	69P	75P	63
Netherlands	A since 1969	64	64P	69	70P	79	64
New Zealand	A (except 77-79)	72	72	77P	--	80P	72
Norway	A (B or A before 77)	63	63	69	67	77	70
Portugal	B (I before 76)	64	64P	64	72	72	71
Spain	A (except 76-79 and before 1969)	64	64	69	76P	79P	67
Sweden	B since 1967	64	64	64	67	77	64P
Switzerland	A, I after 79	63	63P	63	63	77	63
Turkey	I	83	--	83	--	--	--
United Kingdom	T (A or B before 1969)	81	64P	66P	64P	--	64P
USA	A (B before 72)	70	63P	63P	63	--	70P

A: Annual T: Triennial B: Biennial I: Irregular
lP: Breakdown incomplete or available for certain sectors only
First year published is 1981.

Table 1.5. **Availability of data on business enterprise R&D expenditures by industry (BERD)**

by classification, years: established OECD countries

		First year in OECD database		
Country	Frequency	Total (BERD)	Source of funds	Type of costs
Australia	B	73P	76	81
Austria	A (I before 78)	66	66	78
Belgium	B	67	71	81
Canada	A (before 1979)	67	67	72
Denmark	B	67	70	79
Finland	B	67	69	79
France	A	70	71	81
Germany	B	64	64	79
Greece	P	81	81	--
Iceland	B	71	71	71
Ireland	B since 1967	63P	63P	79
Italy	A (B before 67)	63	71	79
Luxembourg	--	--	--	--
Japan	A	63	67	79
Netherlands	A	69P	--	79P
New Zealand	B	72P	--	--
Norway	A (I before 67)	63	63	79
Portugal	B (I before 76)	64P	64P	78
Spain	A (except 76-79 and before 1969)	64	64P	79
Sweden	B since 1967	64	64	64
Switzerland	I (B before 1981)	77	--	--
Turkey	I	83P	--	83P
United Kingdom	T (A or B before 1969)	67	67	78
USA	A	81P	67	79

A: Annual T: Triennial B: Biennial

lP: Breakdown incomplete or available for certain sectors only

First year published is 1981.

1.3 Problems of adjusting R&D series for use as measures of intangible investment

1.3.1 Capital expenditure and depreciation

Expenditure on R&D as defined in the *Frascati Manual* and as collected in OECD surveys is the sum of current expenditures and gross capital expenditures. Current expenditures are divided between labour costs and other current costs and capital expenditures between land and buildings and instruments and equipment. Current expenditures do not make any allowance for depreciation.

This causes two problems. First there is a certain degree of overlap with tangible investment. This can be significantly seen as a percentage of total R&D expenditure in the Business enterprise sector as in Table 1.6. Second in certain statistical frameworks expenditure on an activity should include the cost of depreciation of fixed assets.

Of the countries included in the OECD database only the United States collects industrial R&D data including depreciation and excluding capital expenditure. Japan is the only one of the four to collect

both capital expenditure and depreciation and where it is possible to compare to see whether the two are significantly different. Depreciation is the consistently lower of the two.

Table 1.6 **BERD by type of cost**

	Current expenditure			*Capital*			
	Total	*Labour*	*Other*	*Total*	*Land and buildings*	*Instruments and equipment*	*Not distributed*
Australia (1995)	88.1	37.1	51.0	11.9	1.4	10.5	..
Austria (1993)	88.9	59.7	29.1	8.4	0.2	8.2	2.7
Belgium	..	..	..	..	..	..	..
Canada (1994)	90.3	50.0	40.2	8.3	..	..	1.4
Czech republic (1996)	89.2	28.7	60.5	10.8	1.3	9.5	..
Denmark (1993)	87.3	57.7	29.6	12.7	4.2	8.5	..
Finland (1995)	87.9	51.5	36.4	12.1	0.5	11.5	..
France (1993)	93.0	50.7	42.3	7.0	1.4	5.6	..
Germany (1993)	92.0	59.3	32.6	7.0	..	..	1.0
Greece (1991)	72.0	54.1	17.9	28.0	..	..	..
Hungary (1995)	86.7	26.7	59.9	13.3	3.8	9.5	..
Iceland (1992)	90.2	60.0	30.2	9.8	5.9	3.9	..
Ireland (1993)	77.9	38.1	39.8	22.1	6.2	15.9	..
Italy (1993)	90.3	48.8	41.5	9.7	..	..	..
Japan (1996)	89.5	43.5	46.0	10.5	1.7	8.8	..
Korea (1996)	74.0	33.8	40.2	26.0	6.0	20.0	..
Mexico (1995)	85.9	46.4	39.5	14.1	4.2	9.9	..
Netherlands (1991)	90.5	52.4	38.2	9.5	2.6	6.9	..
New Zealand	..	..	..	..	..	..	..
NorwaY (1995)	89.3	52.1	37.1	10.7	0.6	10.2	..
Poland (1996)	75.6	39.1	36.5	24.4	12.1	12.3	..
PortugaL	80.3	48.2	32.0	19.7	3.5	16.2	..
Spain (1995)	83.1	54.4	28.8	16.9	2.2	14.7	..
Sweden (1995)	90.9	41.5	49.5	9.1	1.6	7.4	..
Switzerland (1992)	91.1	58.4	32.7	8.9	..	..	..
Turkey (1995)	66.3	34.2	32.1	33.7	10.1	23.6	..
United KingdoM (1995)	89.1	39.2	49.8	10.9	2.6	8.3	..
United StateS	..	..	..	..	..	..	..

Source: OECD, GERD database, August 1998.

1.3.2 R&D from the demand side

When measuring intangible investment one needs figures which show how much a firm, industry in Business enterprise sector invests in:

i) R&D on own account,

ii) R&D purchased from third parties.

This should preferably be measured on the demand side. R&D statistics, however, are collected on the *supply side* i.e. from the units which "perform" the R&D projects concerned. This is because it is felt that they are in the best position to measure the actual amounts of resources involved.

1.3.2.1 Excluding R&D undertaken for third parties

The first step when assembling intangible investment series is to break down the amount spent on R&D performance between that which is done on own account and that which is undertaken for third parties. The R&D series provide a breakdown as shown in Table 1.7. At first sight R&D financed by own funds should be treated as R&D on own account and the remainder as R&D for others. However the situation is a little more complicated in that not all the payments from third parties are payments for R&D services.

Table 1.7 **Breakdown of BERD by source of funds**

<table>
<tr><th>Total BERD in GERD</th><th>BERD by industry</th></tr>
<tr><td>From Business enterprise</td><td>Own funds
Funds from other enterprises</td></tr>
<tr><td colspan="2">From Government</td></tr>
<tr><td>From Higher Education</td><td rowspan="2">From other national sources</td></tr>
<tr><td>From PNP</td></tr>
<tr><td colspan="2">From Abroad</td></tr>
<tr><td colspan="2">TOTAL</td></tr>
</table>

In order to be treated as an external source of funds in R&D surveys according to the *Frascati Manual* there must be a direct transfer of resources which is both intended and used for the performances of R&D.

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

Resources may be transferred in a number of ways not all of which may be considered direct.

Contracts or grants paid for the performance of current or future R&D are clearly identifiable as a transfer of funds. Transfer of funds from the government to other sectors is particularly important to the users of R&D data.

Two categories of such government funds may be identified:

i) those which are specifically for the procurement of R&D, i.e. the results of the R&D belong to the recipient of the output or product of the R&D. This may not necessarily be the funder of the R&D;

ii) those which are provided to the performers of R&D in the form of grants and subsidies where the results of the R&D remain the property of the R&D performers." (OECD, 1994, paras. 369-371). These are also referred to as financial incentives.

The *Frascati Manual* 1993 recommends that, "if possible, both categories of transfer of government R&D funds be identified in the R&D data of the Business enterprise sector. This is a new recommendation which is only now being added in OECD questionnaires. Only *i)* above should be treated as the purchase of an R&D service when measuring intangible investment.

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

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

There are also a variety of *other government incentives* for R&D in the Business enterprise sector. Examples are the remission of income taxes for industrial R&D, the payment by a government, on demand and after audit, of a certain portion of some or all the firms' R&D expenditures, bonuses added to R&D contracts to encourage a firm in its own R&D, remission of taxes and tariffs on R&D equipment and the reimbursement of part of a firm's costs if it hires more R&D staff. For the present, even where these transfers can be separately identified, they should not be counted as direct support for R&D. The statistical units should, thus, report gross expenditures as incurred, even when their actual costs may be reduced because of remissions, rebates or post-performance grants."(OECD, 1994, paras. 373-376).

The situation is also not clear for funds received from abroad. These may be for the purchase of R&D services but again they may be simple transfers within international groups or financial incentives for R&D from international organisations.

1.3.2.2 R&D purchased from third parties

The second step is to add back R&D undertaken from firms in the Business enterprise sector by third parties. At the level of the total Business enterprise sector this information can be derived for the reports of the performers in the Government, PNP and Higher Education sectors, though in some cases the flows may be grants rather than payments for services. However such series do not cover payments made for R&D carried out abroad. Information at the level of the firm and the industry has to be derived from question on the "extramural" expenditures of firms which are included in most countries industrial R&D surveys. Note that such series are not currently included in OECD R&D surveys.

1.3.3 Prices and currency converters

1.3.3.1 Current practice

The main disadvantage of R&D input series expressed in monetary terms is that they are affected by differences in price levels between countries and over time. It can be shown that current

exchange rates often do not reflect the balance of R&D prices between countries and that in times of high inflation general price indices do not accurately reflect trends in the cost of performing R&D. The *Frascati Manual* recommends the use of purchasing power parities and the implicit GDP price index for use with R&D statistics though it is recognised that these reflect the opportunity cost of the resources devoted to R&D rather than the "real" amounts involved. Methods of developing special R&D deflators and R&D exchange rates are discussed in Annex X of the *Frascati Manual* 1993 (OECD, 1994).

1.3.3.2 The need for R&D deflators and currency converters

Such deflators are justified if it is believed that the cost of R&D has moved significantly differently for general costs and/or if trends in the cost of R&D have varied considerably between sectors or industries. In general, over the long term, it is reasonable to suppose that the implicit GDP (output) deflator would tend to increase less rapidly than a "true" R&D (input) deflator because of productivity increase.

The optimum solution is to calculate special R&D deflators based on weights and prices which were specific to R&D. The cost and complexity of carrying out the price surveys needed for this exercise rules it out except for specialised analysis. The most common approach is to use weights derived from R&D surveys combined with proxy prices (a possible method is described).

Converting R&D expenditures to a common numerary currency such as the US dollar or the ECU (i.e. deflating inter-spatially) using GDP-PPPs effectively involves adjusting to allow for differences in the general price level between countries, *not* for differences in the price level for R&D. If R&D is relatively expensive in one country compared with another, then use of the GDP-PPP will distort the comparison between real expenditures on R&D.

Here, as for inter-temporal deflators, the ideal solution is to calculate specific currency converters based on international relative prices for R&D inputs. Once again, carrying out the price surveys needed for this exercise (using an international standard "basket" of R&D inputs) would be both costly and complex. The more practical solution would be to use weights from R&D surveys and detailed parities from general PPP exercises conducted by the OECD and Eurostat in the context of the International Comparison Project (ICP) carried out under the aegis of the United Nations Statistical Office. A major difficulty arises because the general PPPs are calculated using an international basket of goods and services entering into GDP, more precisely, final demand (i.e. output), whereas R&D expenditures represent mainly inputs.

1.3.4 Satellite accounts

Satellite accounts for R&D were first developed in the early 1970s to apply the principles in the 1968 version of the SNA. They never became very widespread and there was no pressure to include them in the *Frascati Manual*. Only France continued to publish satellite accounts for R&D on a regular basis (Minder *et al.*, 1989; Braibant *et al.*, 1994). With the discussion for the revised SNA the topic was taken up again and at least two other countries, the United States (Carson *et al.*, 1994) and the Netherlands (Bos *et al.*, 1992) have made significant efforts to establish satellite accounts.

The *Frascati Manual* 1993 has an annex dealing with R&D satellite accounts based largely on French experience.

1.3.5 Calculating R&D capital stock

The members of the Group of National Experts on Science and Technology Indicators who oversee the *Frascati Manual* and supply the R&D data to OECD have always implicitly regarded R&D as an investment activity. For example, comparisons were made in OECD S&T Indicators Reports between spending on R&D and on Gross Fixed Capital Formation. The group has never, however, discussed the question of how to measure stocks of R&D capital, rather preferring to move on to trace the output and impact of R&D through other types of data notably the innovation surveys described in the next chapter.

CHAPTER 2. INNOVATION

2.1 International standards: The *Oslo Manual*

2.1.1 General content

The *Oslo Manual* provides guidelines for the measurement of technological innovation. The first edition was issued in 1992 (OECD, 1992) and the second, prepared jointly with the European Commission, (OECD/Eurostat, 1997) in 1997. The following text is drawn from the second edition.

The manual is restricted in coverage as follows:

- it covers innovation in the business enterprise sector only; The first edition dealt only with manufacturing. The second edition also covers market services.
- it deals with innovation at the level of the firm;
- it concentrates on technological product and process (TPP) innovation, with optional guidelines for other forms such as organisational change;
- it covers diffusion up to "new to the firm";

"The body of the manual starts with a general discussion of points that are likely to have some effect on the choice of indicators (Chapter 2): (an adequate conceptual understanding of the structure and characteristics of the innovation process and its implications for policy making; the key unresolved problems which further data could clarify; consequences for the scope of the manual.

It continues with definitions, criteria and classifications which are relevant for studies of industrial innovation: basic definitions of technological product & process – TPP – innovation and innovation activities (Chapter 3); institutional classifications (Chapter 4).

After that, suggestions and recommendations are advanced for national and international TPP innovation surveys: measuring aspects of the TPP innovation process (Chapter 5); measuring the expenditure on TPP innovation (Chapter 6); innovation survey procedures (Chapter 7).

The manual closes with a set of annexes dealing with topics which either offer alternative procedures to those generally recommended or which are of relevance but not sufficiently developed for inclusion in the body of the manual: the "object" approach to data compilation/collection (Annex 1) the collection of non-technological innovation data (Annex 2).

2.1.2 Basic definitions

Technological product and process (TPP) innovations comprise implemented technologically new products and processes and significant technological improvements in products and processes. A TPP innovation has been **implemented** if it has been introduced on the market (product innovation) or used within a production process (process innovation). TPP innovations involve a series of scientific, technological, organisational, financial and commercial **activities**. **The TPP innovating firm** is one that has implemented technologically new or significantly technologically improved products or processes during the period under review.

The minimum entry is that the product or process should be new (or significantly improved) to the firm (it does not have to be new to the world).

TPP innovations relating to primary and secondary activities are included, and so are process innovations in ancillary activities.

The term "product" is used to cover both goods and services. This is in line with the System of National Accounts (CEC *et al.*, 1994; OECD/Eurostat, 1997, paras. 130-132 and 134).

2.1.3 TPP innovation activities

The *Oslo Manual* gives two descriptions, one in terms of stages in the process with a good deal of overlapping and a second designed for expenditure data collection (Table 2.1) where conventions are established to exclude double counting and where the sub-classes correspond more to the categories of intangible investment. The following is drawn from the definitions chapter.

"TPP innovation activities are all those scientific, technological, organisational, financial and commercial steps, including investment in new knowledge, which actually, or are intended to, lead to the implementation of technologically new or improved products or processes. Some may be innovative in their own right, others are not novel but are necessary for implementation.

Innovation activities may be carried out within the firm or may involve the acquisition of goods, services or knowledge from outside sources, including consulting services. Thus a firm may acquire external technology in disembodied or embodied form.

The list of activities below is not exhaustive. Its aim is to explain when certain activities should be included in TPP innovation. innovation expenditure. Activities leading to purely organisational innovation are dealt with in Annex 2."

Table 2.1 **Recommended breakdown of innovation expenditures**

- R&D expenditure; (distinguishing between intramural and extramural) - Expenditure for the acquisition of disembodied technology and know-how; - Expenditure for the acquisition of embodied technology; - Expenditure for tooling up, industrial engineering, industrial design and production start-up including other expenditure for pilot plants and prototypes not already included in R&D; - Expenditure for training linked to TPP innovation activities; - Marketing for technologically new or improved products.

2.1.4 Acquisition and generation of relevant knowledge new to the firm

(a) Research and experimental development

"Research and experimental development (R&D) comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications (as defined in the *Frascati Manual*).

Construction and testing of a prototype is often the most important phase of experimental development. A prototype is an original model (or test situation) which includes all the technical characteristics and performances of the new product or process. The acceptance of a prototype often means that the experimental development phase ends and the other phases of the innovation process begin (further guidance on this will be found in the *Frascati Manual*).

Software development is classified as R&D as long as it involves making a scientific or technological advance and/or resolving scientific/technological uncertainty on a systematic basis.

(b) Acquisition of disembodied technology and know-how

Acquisition of external technology in the form of patents, non-patented inventions, licences, disclosures of know-how, trademarks, designs, patterns and computer and other scientific and technical services related to the implementation of TPP innovations, plus the acquisition of packaged software that is not classified elsewhere.

(c) Acquisition of embodied technology

Acquisition of machinery and equipment with improved technological performance (including integrated software) connected to technological product or process innovations implemented by the firm.

2.1.5 Other preparations for production

(a) Tooling- up and industrial engineering

Changes in production and quality control procedures, methods and standards and associated software required to produce the technologically new or improved product or to use the technologically new or improved process.

(b) Industrial design n.e.c.

Plans and drawings aimed at defining procedures, technical specifications and operational features necessary to the production of technologically new products and the implementation of new processes.

(c) Other capital acquisition

Acquisition of buildings, or of machinery, tools and equipment – with no improvement in technological performance – which are required for the implementation of technologically new or improved products or processes, *for example, an additional moulding or packaging machine to produce and deliver a technologically improved CD-ROM player.*

(d) Production start-up

This may include product or process modifications, retraining personnel in the new techniques or in the use of the new machinery, and any trial production not already included in R&D.

2.1.6 Marketing for new or improved products

Activities in connection with the launching of a technologically new or improved product. These may include preliminary market research, market tests and launch advertising, but will exclude the building of distribution networks to market innovations"(OECD/Eurostat, 1997, paras. 177 and 180-191).

2.1.7 Distinguishing between TPP innovation and other activities

The manual gives guidelines for distinguishing TPP innovation from organisational innovation at the level of the firm (reorganisation of production methods may be TPP innovation) and from other changes in products and processes. The latter are changes which are insignificant, minor, or do not involve a sufficient degree of novelty or make "other creative improvements" where the novelty does not concern the use or objective performance characteristics of the products or in the way they are produced or delivered but rather their aesthetic or other subjective qualities.

Guidelines are given for borderline activities such as design, training, marketing and software.

2.1.8 Institutional breakdowns

2.1.8.1 General coverage.

"Innovation can of course occur in any sector of the economy, including government services such as health or education. The guidelines in this manual are essentially designed to deal with innovations in the business enterprise sector and more particularly in manufacturing, construction, utilities and marketed services.

Innovation in services, which was not covered in the first version of this manual, is complex and has special characteristics. At the time of drafting there had only been individual, mainly pilot, surveys of innovation in services, and the recommendations in the second edition of the manual are based on less firm ground than for manufacturing." (OECD/Eurostat, 1997, paras. 15-16).

2.1.8.2 The statistical unit

"Taking into account how innovation activities are usually organised, the enterprise-type unit is the most appropriate statistical unit in innovation surveys in many cases. The enterprise or the legal entity defined in paragraphs 78 and 79 of ISIC Rev. 3 is the appropriate unit. However, when considering large enterprises which are engaged in several industries, a smaller unit like the kind-of-activity unit (KAU), "an enterprise or part of an enterprise which engages in one kind of economic activity without being restricted to the geographic area in which that activity is carried out", may be more appropriate" (OECD/Eurostat, 1997, para. 207).

2.1.8.3 Industrial classification

"Statistical units of innovation surveys can be broken down by quite different variables. Perhaps the most important variable is the **principal economic activity of the statistical unit** ("industry"). The International Standard Industrial Classification of all Economic Activities (ISIC Rev. 3) and the statistical classification of economic activities in the European Community (NACE Rev. 1) respectively are appropriate international classifications for this purpose.

The **criteria for classification** by principal activity of these statistical units should be determined by "the class of ISIC (NACE) in which the principal activity, or range of activities, of the unit is included". According to ISIC, this principal activity should be determined by reference to the value added of the goods sold or the services rendered by the activities. If this is not possible, the principal activity can be determined on the basis of the gross output of the goods sold or services rendered by each of the activities, or the number of persons assigned to them.

The proposed **classification list** is presented in Table 2.2 which contains a special arrangement of the divisions, groups and classes of ISIC Rev. 3/NACE Rev. 1 for the purpose of innovation statistics. This table should be seen as the basic arrangement which may be further split, or aggregated, for specific purposes.

2.1.8.4 Classification by size

The other essential classification of statistical units for innovation surveys is by size. Although different variables can be used to define the size of a statistical unit in innovation surveys, **it is recommended that size should be measured on the basis of the number of employees**. This recommendation is in line with similar proposals in other manuals in the Frascati family. Given the strata requirements in sample surveys (see Chapter 7), and given that innovation activities are carried out in units of all sizes but, unlike R&D, are quite widely conducted in small and medium-sized units, the following size classes are recommended:

Classification of statistical units for innovation surveys by size

Number of employees:

- <20
- 20 - 49
- 50 - 99
- 100 - 249
- 250 - 499
- 500 - 999
- 1 000 - 4 999
- 5 000 and above"

(OECD/Eurostat, 1997, paras. 210-213).

Table 2.2 **Industrial classification proposed for innovation survey in the business enterprise sector based on ISIC Rev. 3 and NACE Rev. 1**

Title	ISIC Rev. 3 Division/Group/Class	NACE Rev. 1 Division/Group/Class
MANUFACTURING	15 to 37	15 to 37
Food Products & Beverages	15	15
Tobacco Products	16	16
Textiles	17	17
Wearing Apparel & Fur	18	18
Leather Products & Footwear	19	19
Wood & Cork (not Furniture)	20	20
Pulp, Paper & Paper Products	21	21
Publishing, Printing & Reproduction of Recorded Media	22	22
Coke, Refined Petroleum Products & Nuclear Fuel	23	23
Chemicals & Chemical Products	24	24
Chemical Products less Pharmaceuticals	*24 less 2423*	*24 less 24.4*
Pharmaceuticals	*2423*	*24.4*
Rubber & Plastic Products	25	25
Non-metallic Mineral Products	26	26
Basic Metals	27	27
Basic Metals, Ferrous	*271+2731*	*27.1 to 27.3 + 27.51/52*
Basic Metals, Non-ferrous	*272+2732*	*27.4 + 27.53/54*
Fabricated Metal Products (except Machinery & Equipment)	28	28
Machinery n.e.c.	29	29
Office, Accounting & Computing Machinery	30	30
Electrical Machinery	31	31
Electronic Equipment (Radio, TV & Communications)	32	32
Electronic Components (includes Semiconductors)	*321*	*32.1*
Television, Radio & Communications Equipment	*32 less 321*	*32 less 32.1*
Medical, Precision & Optical Instruments, Watches, Clocks	33	33
(Instruments)	34	34
Motor Vehicles	35	35
Other Transport Equipment	*351*	*35.1*
Ships	*353*	*35.3*
Aerospace	*352+359*	*35.2+35.4+35.5*
Other Transport n.e.c.		
Furniture, Other Manufacturing n.e.c.	36	36
Furniture	*361*	*36.1*
Other Manufacturing n.e.c.	*369*	*36.2 to 36.6*
Recycling	37	37
ELECTRICITY, GAS & WATER SUPPLY	40+41	40+41
CONSTRUCTION	45	45
MARKETED SERVICES	50 to 74	50 to 74
Sale, Retail, Maintenance & Repair of Motor Vehicles & Motorcycles	50	50
Other Wholesale Trade	51	51
Other Retail Trade	52	52
Hotels & Restaurants	55	55
Land Transport & via Pipelines	60	60
Water Transport	61	61
Air Transport	62	62
Supporting & Auxiliary Transport Activities, Travel Agencies	63	63
Post & Telecommunications	64	64
Post	*641*	*64.1*
Telecommunications	*642*	*64.2*
Financial Intermediation	65 to 67	65 to 67
Real Estate, Renting	70+71	70+71
Computer & Related Activities	72	72
Software Consultancy & Supply	*722*	*72.2*
Other Computer Services n.e.c.	*72 less 722*	*72 less 72.2*
Research & Development	73	73
Other Business Activities n.e.c.	74	
Architectural, Engineering & other Technical Activities	*742*	

2.1.9 Borderline between TPP innovation and other intangibles

Of all the above types of work, only R&D and the acquisition of machinery incorporating new technology are by definition TPP innovation activities. The others may or may not be, depending on the reasons for which they are carried out.

2.1.9.1 Design

"*Industrial design* is an essential part of the TPP innovation process. Though it is listed above in the same subsection as tooling up, industrial engineering and production start-up, it may also be a part of the initial conception of the product or process, *i.e.* included in research and experimental development, or be required for marketing technologically new or improved products.

Artistic design activities are TPP innovation activities if undertaken on a technologically new or improved product or process. They are not if undertaken for other creative product improvement, for example purely to improve the appearance of the product without any objective change in its performance.

2.1.9.2 Training

Training is a TPP innovation activity when it is required for the implementation of a technologically new or improved product or process, *for example in order for production workers to be able to identify the desired consistency of a new type of yoghurt in a food factory, for a marketing manager to understand the characteristics of the improved braking system on a new model of car in order to prepare the market launch, or for staff to be able to use different Windows programs after the introduction of a Windows-based PC network in the firm.*

Training in a firm is not a TPP innovation activity when it is undertaken solely in connection with "organisational innovation" or "other creative product improvement", or when it is not oriented towards a specific improvement in productivity at the level of the firm. *For example, the following are not TPP innovation activities: training in existing production methods for new employees, general upgrading training for individuals (supervisors, managers, etc.), ongoing computer training, language classes.*

2.1.9.3 Marketing

Marketing is a TPP innovation activity when it is required for the implementation of a technologically new or improved product (or, more infrequently, a new process). It is not a TPP innovation activity when it is undertaken for purely organisational innovation, *for example a campaign to promote a firm's new structure and corporate image*, or as part of other creative product improvement, *for example publicity for the spring range of clothing*, or to maintain market share for products which are essentially unchanged, *for example soap powder*.

2.1.9.4 Software

The development, acquisition, adaptation and use of software pervade TPP innovation activities. On the one hand, developing new or substantially improved software, either as a commercial product or

for use as an in-house process (TPP innovation in its own right), involves research and experimental development and a range of post-R&D innovation activities. On the other, many of the innovation activities for other TPP innovations involve the use of software as a process and hence its acquisition and adaptation." (OECD/Eurostat, 1997, paras. 192-198).

2.2 Availability of data

"The first edition of the manual was tested in surveys in a wide range of OECD countries. The bulk were undertaken as part of the Community Innovation Survey (CIS), which was jointly initiated by Eurostat and DGXIII [SPRINT Programme, European Innovation Monitoring System (EIMS)]. This used a common questionnaire developed from the one appended to the first version of this manual. Thirteen countries represented by national contractors took part in the exercise (Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain and the United Kingdom), which covered technological innovation in manufacturing industry. This exercise provided a wide range of experience, as the organisations involved in the CIS had different expertise which led to a variety of methods and approaches (see *Evaluation of the CIS Survey – Phase I*, EIMS Publication No.11).

The majority of other OECD countries also tested the concepts and classifications in the first edition of the *Oslo Manual* in full or partial surveys and with varying degrees of success for the different types of questions".

Following the publication of the second edition of the *Oslo Manual* a second CIS was organised and is under way at the time of writing. New surveys are also being organised in other Member countries.

Because of the variety of methods and approaches mentioned above there is no official set of internationally comparable data. Perhaps the best source is the *Second European S&T Indicators Report* published by the European Commission (CEC, 1997).

2.2.1 Relationship between TPP innovation and intangible investment

2.2.1.1 By category of activities

The relationship between the two is summarised in the following table:

Table 2.3 **Treatment of selected activities in expenditure on innovation activities and intangible investment**

	Innovation for New Products and processes = FNPP	**Intangible investment**
R&D	All included	All included
Training	FNPP only	All
Software	FNPP only	All
Marketing	FNPP only	All
Rights	Technology only	Also artistic etc.
Mineral exploration	Some in R&D. Only covers manufacturing so not relevant	All
Development of the organisation	Currently excluded	Major reorganisation included
Design & engineering	FNPP only	Exclusion proposed
Other production activities	FNPP only	Excluded
Acquisition of plant and equipment	FNPP only	Excluded

2.21.2 By type of cost

"*Current expenditure on TPP innovation* is clearly a part of intangible investment. Intangible investment comprises elements which are not part of TPP current innovation expenditure. For example, only training in connection with the introduction of technologically new or improved products and processes is classified as TPP innovation expenditure, whereas intangible investment includes all of the firm's training expenditure. Marketing in connection with the introduction of technologically new or improved products and processes is classified as TPP innovation expenditure. Intangible investment, on the other hand, includes marketing expenditure in general (e.g. improving the image of the firm, or capturing new markets with no direct connection to technologically new or improved products and processes).

At the same time, TPP innovation expenditure includes tangible investment such as *capital expenditure* on R&D, acquisition of new machinery and equipment related to TPP innovations." (OECD/Eurostat, 1997, paras. 302-303).

A further complication is that there are two possible ways of collecting innovation expenditure data,, Survey questions on innovation expenditure may be put in two ways:

⇒ The total expenditure on innovation activities for the firm in a given year (= **the subject approach** or **innovation budget approach).**

⇒ Total expenditure for innovations implemented in a given year or during a given period regardless of the year in which the expenditure occurs (= **the object approach).**

Although the Oslo guidelines are mainly oriented to the subject approach and it is used in the CIS surveys some countries would prefer the object approach. Indeed the expenditure questions proved the most controversial when the first OECD/CIS questionnaire was being drafted and also those with the lowest response rates in the resulting surveys. The experience was repeated during the revision of the *Oslo Manual* and the preparation of the second questionnaire. the tables concerned are shown as Tables 2.4 to 2.6.

Table 2.4 **Expenditure question from the first CIS**

We are interested to know more about expenditures associated with innovation related activities in your enterprise.	
13 a) Please estimate the total costs associated with the following innovation-related activities in 1991, and the percentage share:	
- R&D	**%**
- acquisitions of patents and licences	**%**
- product design	**%**
- trial production, training and tooling-up	**%**
- market analysis (excluding launch costs)	**%**
	100%
b) Estimated total amount spent on investment in machinery or equipment in 1991 linked to innovations (in national currency units)	**.....**
c) Estimated total innovation expenditure in 1991 (in national currency units)	**.....**
d) Estimated percentage of total innovation costs spent on external specialist services (e.g. for R&D, marketing, patenting, training, design.)	**.....%**

Table 2.5 **Question on technological innovation in manufacturing from the second CIS**

Resources devoted to innovation activities in 1996

In this question some information is asked about engagement in and resources devoted to the following innovation activities of the enterprise.

Research and experimental development (R&D) [1] comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, and the use of this stock of knowledge to devise new applications, such as technologically new or improved products and processes. Construction, design and testing of a prototype is often the most important phase of R&D. Software development is included as long as it involves making a scientific or technological advance. R&D can be carried out within the enterprise or R&D services can be acquired.

Acquisition of machinery and equipment(including integrated software) **linked to product and process innovations** implemented by the enterprise

Acquisition of other external technology linked to product and process innovations in the form of patents, non-patented inventions, licenses, know-how, trademarks, drawing plans and consultancy services (excluding R&D), related to the implementation of technological innovations, plus the acquisition of packaged software that is not classified elsewhere.

Industrial design and other production preparations for technologically new or improved products include plans and drawings aimed at defining procedures, technical specifications and operational features necessary for the production of technologically new or improved products and the implementation of technologically new processes. This item also include changes in production and quality control procedures, methods and standards and associated software required to produce the technologically new or improved product or to use the technologically new or improved process. Product or process modifications needed to start production, including trial production (not included in R&D) are also included.

Training directly linked to technological innovations is training for the implementation of a technologically new or improved product or process. Expenditure for training might include acquisition of external services and expenditure for in-house training.

Market introduction of technological innovations includes activities in connection with the launching of a technologically new or improved product. These may include preliminary market research, market tests and launch advertising, but will exclude the building of distribution networks to market innovations.

Did your enterprise engage in the following innovation activities in 1996?

	Yes	No	**If yes, please estimate expenditure involved**
- Research and experimental development within the enterprise (intramural R&D)	[ ]	[ ]	_____
- Acquisition of R&D services (extramural R&D)	[ ]	[ ]	_____
- Acquisition of machinery and equipment linked to product and process innovations	[ ]	[ ]	_____
- Acquisition of other external technology linked to product and process innovations	[ ]	[ ]	_____
- Industrial design, other production preparations for technologically new or improved products	[ ]	[ ]	_____
- Training directly linked to technological innovations	[ ]	[ ]	_____
- Market introduction of technological innovations	[ ]	[ ]	_____
Total expenditure			_____

The expenditure items should cover current (labour costs, acquisition of services, materials, etc.) and capital expenditure (instruments and equipment, computer software, land and buildings). If it is not possible to estimate all expenditure items involved, please at least indicate, if your enterprise has been engaged in a particular innovation activity or not.

R&D personnel within the enterprise in 1996 (in full time equivalents) _____

Did your enterprise engage in R&D between 1994 and 1996?

Continuously [ ] Occasionally [ ] Not at all [ ]

Table 2.6 **Question on technological innovation in services from the second CIS**

Resources devoted to innovation activities in 1996

In this question some information is asked about engagement in and resources devoted to innovation activities of the enterprise

Research and experimental development (R&D) [1] comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, and the use of this stock of knowledge to devise new applications, such as new or significantly improved services or methods to produce or deliver services. Construction, design and testing of a prototype is often the most important phase of R&D. Software development is included as long as it involves making a scientific or technological advance. R&D can be carried out within the enterprise or R&D services can be acquired.

Acquisition of machinery and equipment (including integrated software) **linked to technological innovations**, implemented by the enterprise

Acquisition of software and other external technology linked to technological innovations includes the acquisition of packaged software, acquisition of patents, non-patented inventions, licenses, know-how, trademarks, drawing plans and consultancy services (excluding R&D), related to the implementation of technological innovations.

Preparations to introduce new or significantly improved services or methods to produce or deliver them comprise activities aimed at defining procedures, specifications and operational features (including final tests) necessary for the introduction of innovations.

Training directly linked to technological innovations is training for the implementation of new or substantially improved services or methods to produce or deliver them. Expenditure for training might include acquisition of external services and expenditure for in-house training.

Market introduction of technological innovations includes activities in connection with the launching of new services. These may include preliminary market research, market tests and launch advertising, but will exclude the building of distribution networks to market innovations.

Did your enterprise engage in the following innovation activities in 1996?

	Yes	No	**If yes, please estimate expenditure involved**
- Research and experimental development within the enterprise (intramural R&D)	[ ]	[ ]	_____
- Acquisition of R&D services (extramural R&D)	[ ]	[ ]	_____
- Acquisition of machinery and equipment linked to technological innovations	[ ]	[ ]	_____
- Acquisition of software and other external technology linked to technological innovations	[ ]	[ ]	_____
- Preparations to introduce new or significantly improved services or methods to produce or deliver them	[ ]	[ ]	_____
- Training directly linked to technological innovations	[ ]	[ ]	_____
- Market introduction of technological innovations	[ ]	[ ]	_____
Total expenditure			_____

The expenditure items should cover current (labour costs, acquisition of services, materials, etc.) and capital expenditure (instruments and equipment, computer software, land and buildings). If it is not possible to estimate all expenditure items involved, please at least indicate, if your enterprise has been engaged in a particular innovation activity or not.

R&D personnel within the enterprise in 1996 (in full time equivalents) _____

Did your enterprise engage in R&D between 1994 and 1996?

Continuously [ ] Occasionally [ ] Not at all [ ]

CHAPTER 3. TECHNOLOGY BALANCE OF PAYMENTS

3.1 International Standards: The "TBP Manual"

3.1.1 General content

"Technology and the international diffusion of technology are central to the changes running through the world economy in our era. They are a factor in international competition and an incentive to co-operation between firms in different countries. Some of the reasons for this twofold role are long-standing, others more recent.

It can readily be seen, without going into these reasons in more detail here, that refining the measurement and analysis of international transfers of technology, and more generally the international circulation of technology, is imperative. That is the background to the "Manual on the Technology Balance of Payments (TBP)".

The purpose of the "Technology Balance of Payments (TBP)" is to report all intangible transactions relating to trade in technical knowledge and services with a technology content between partners in different countries." (OECD, 1990, paras. 1, 6 and 92).

3.1.2 Definitions and coverage

The following operations should be *included* in the TBP: patents (purchase, sales); licenses for patents; know-how (not patented); models and designs; trade-marks (including franchising); technical services; finance of industrial R&D outside national territory.

The following should be *excluded*: commercial, financial, managerial and legal assistance; advertising, insurance, transport; films, recordings, material covered by copyright; design; software.

3.1.3 General rules for defining the coverage of the TBP

1. What is the nature of the transaction?

   1.1 Is it an international commercial transaction related to trade in techniques or technology?

2. Is it trade in merchandise?

3. Is it an unrequited transfer?

4. Does it concern financial assets, e.g. direct investment, on input of technology assets or capitalisation of royalties?

5. Does the transaction relate to services?

   5.1 Does it relate to technology factor (i.e. income from a technological asset protected under industrial property law)?

   5.2 Alternatively, does it relate to non-technology factor income (i.e. income from a non-technological asset protected under industrial property law)? Is it thought to be a vehicle for technology transfer?

   5.3 Does it relate to a non-factor service (i.e. not protected under industrial property law) with a technology content?

   5.4 Can a predominantly technological aspect be identified?

   5.5 Does it relate to a non-factor service with no technology content (i.e. intellectual services)?

If the answer to questions 2, 3 or 4 is “Yes”, the transaction does not belong in the TBP. Items covered by question 4 can, all the same, help supplement TBP data in some cases. If the answer to question 5.1 is “Yes”, the transaction belongs in the TBP. With questions 5.2, 5.3, 5.4 and 5.5, more care is needed. The technological aspect of the transaction must be clear and predominant." (OECD, 1990, Table 2.3).

3.1.4 The business enterprise sector

3.1.4.1 General coverage

"Receipts/expenditure recorded in the TBP are very largely financial flows between enterprises in the private sector or comparable agencies in the public sector. However, some types of transaction, particularly under international R&D programmes, may involve official research bodies or universities.

The simplest way of defining sectors would seem to be to follow the recommendations of the *Frascati Manual*. Reference to the same set of definitions will facilitate comparative analysis of R&D and TBP data.

The *Frascati Manual* identifies four major sectors: the case for amalgamating PNP with Government and Higher Education could be argued here on grounds of practicality. We should then have just two major sectors:

i) Business enterprise (largely the market sector);

ii) Other transactors (Government, Higher Education and PNP -- largely non-market)."[OECD, 1990, paras. 180, 181 and 193]

3.1.4.2 Classification by industry

"For cross-country comparisons and analysis, units in the Business enterprise sector are classified in the industry groups and sub-groups defined in the International Standard Industrial Classification of All Economic Activities (ISIC). The classification list in Table 3.1 was compiled just as Revision 3 was being completed. It predates the revised Frascati classification.

When TBP data are compiled, firms may be classified according to national nomenclatures that, by and large, differ from country to country and also from ISIC. For cross-country purposes these nomenclatures can be matched to ISIC by means of conversion keys.

We should note here that classification by industry, using national nomenclatures or ISIC, is based on the enterprise's main economic activity, measured by share of total turnover (and possibly by share of workforce).

Classification by main activity raises problems of three different orders:

1. The first, which is not restricted to TBP, concerns enterprises (or groups) whose activities span several industries. There is no way round this drawback inherent in systems that classify business by main activity, other than to split the legal and economic entity up and assign given segments of the firm to the industries in which it operates.

2. The second difficulty concerns possible discrepancy between the activity (or activities) of the *reporting firm* (and its partner) and the actual industrial area or product covered by the *contract*. One example is where an engineering consultancy (classified in services) is party to a transfer of industrial technology. The classification based on contract characteristics will need to cover this.

3. The third difficulty lies in determining the main activity of the foreign partner. In each economy, data for the TBP are collated from returns by resident enterprises. The latter may not be fully aware of the activities of their foreign partners. That may lead to discrepancies between the foreign partner's main activity, as reported, and its classification in the partner economy. For this reason it does not seem possible to recommend classification by industry for non-resident partners."

   [OECD, 1990, paras. 197-200]

Table 3.1 **Concordance Table between ISIC Rev. 3, ISIC Rev. 2 and CPC rearranged for the technology balance of payments**

Description	ISIC Rev. 3	ISIC Rev. 2	CPC
AGRICULTURE, FORESTRY & FISHING	Categories A&B (div. 01 to 05)	Major division 1 (div. 11 to 13)	Section 0 (div. 01 to 04)
MINING	Category C (div. 10 to 14 exc.11)	Major division 2 (div. 21 to 29 exc. 22)	Section 1 (exc. div. 12, 17 & 18)
Crude petroleum & natural gas extraction	Div. 11	22	12
TOTAL MANUFACTURING	Category D (div. 15 to 37)	Major division 3 (div. 31 to 39)	Sections 2 to 4 (exc. div. 12,17 & 18)
Electrical machinery and apparatus	31	383 exc. 3832	46
Radio, TV and communication equipment	32	3832	47
Electronic components	321	part of 3832	471
Communication equipment	322	part of 3832	472 & part of 474
Television & radio receiving equipment	323	part of 3832	473 & part of 474
Instruments	33	385	48
Office and computing machinery	30	3825	45
Other machinery n.e.c.	29	382 exc. 3825	43 and 44
Transportation equipment	34 and 35	384	49
Motor vehicles	34	3843	491 and 492
Shipbuilding and repairing	351	3841	493 and 494
Railroad equipment	352	3842	495
Aircraft and space	353	3845	496
Other transportation equipment	359	3844 and 3849	499
Basic metals	27	37	41
Ferrous metals	271 and 2731	371	411 and 412
Basic precious and non-ferrous metals	272 and 2732	372	413 to 416
Fabricated metal products	28	381	42
Chemicals	24	351 and 352	34 and 35
Drugs and medicines	2423	3522	352
Basic chemicals	241	3511 essentially	34
Other chemicals	242 (exc. 2423) and 243	352 and part of 3513	35 (exc. 352)
Refined petroleum prods. & nuclear fuel	23	353 and 354	33
Rubber and plastic products	25	355 and 356	36
Food, Drink and Tobacco			
Textiles, wearing, footwear & leather	17 to 19	32	26 to 29
Other manufacturing	36 and 37 (?)	39	38 and 39 (?)
TOTAL SERVICES	Categories E to Q (div. 40 to 99)	Major divisions 4 to 9	Sections 5 to 9 and division 17 and 18
Description	ISIC Rev. 3	ISIC Rev. 2	CPC
Electricity, gas and water supply	Category E (div. 40 & 41)	Major division 4	17 and 18
Construction	Category F (div. 45)	Major division 5	Section 5 (inc. 537)
Transport and storage	60 to 63	71	71 to 74
Post and telecommunication	64	72	75
Computer and related activities	72	8323	84
Research and development	73	932 and part of 8324	85
Architect, engineer. & other tech. act.	742	part of 8324	867
Other services	Cat. G, H, J, K (exc.72, 73, 742), L to Q	Maj. div. 6,8 (exc.8323, 8324), 9 (exc.932)	Div. 6,8 (exc. 84,85 and 867) and 9
GRAND TOTAL	Categories A to Q	Major divisions 1 to 9	Sections 0 to 9

Note: The rearrangement has been made in such a way as to stay as close as possible to the industrial classification of R&D based on the CITI Rev.2) as it appears in the *Frascati Manual* 1980 (Table III.1) and international OECD surveys on resources of R&D.

Source: OECD/DSTI.

Reference documents: ISIC Rev.2: International Standard Industrial Classification of All Economic Activities. Series M N° 4, Rev.2, United Nations, New York, 1968.
ISIC Rev.3: Final draft of the Revised International Standard Industrial Classification of All Economic Activities (ISIC), Rev.3. Provisional ST/ESA/STAT/SER.M/4/Rev.3/A.i.i. 1 14 October 1988, United Nations.
OECD, CPC: Final draft of the Central product Classification (CPC). Provisional ST/ESA/STAT/SER.M/77/Add.1 -- 14 October 1988, United Nations.

Source: "TBP Manual, 1990", Table 3.3.

3.1.4.3 Other sub-classifications

Size of institution

Given the likelihood of comparisons between technology trade and R&D data -- in which firms are as a rule classified by workforce only -- the number of employees could be recommended for the TBP as well. The following classification may be used.

Size groups of firms according to number of employees

Under 100
100 to 499
500 to 999
1 000 to 4 999
5 000 to 9 999
10 000 and above

Looking at the TBP on its own, it is probably preferable, in order to assess the significance of size, to collect data using very simple financial criteria that will allow cross-country comparisons. The following size groups, by turnover, may be used.

Size groups of firms according to turnover
(in US dollars)

Under	50 000
50 000	499 999
500 000	4 999 999
5 000 000	49 999 999
50 000 000	and above

Related/non-related status

Given the scale on which technology is transferred by firms with foreign operations, we felt that a distinction should be made between non-related and related partner companies in order to identify the flows of receipts/expenditure between the parent company and subsidiaries of a multinational group. In this instance we need to look both at the status of the partners and at the type of transaction (intra-firm or not).

Looking for the future, there are strong grounds for recommending that Member countries adopt a common approach, such as the Detailed Benchmark Definition of Foreign Investment proposed by the OECD in 1983.

According to this proposal:

1. A distinction should be made between subsidiaries (majority holding of at least 50 per cent), associate companies (equity holding of between 10 and 50 per cent) and branches (establishments with no legal personality);

2. The minimum for associate company status would be 10 per cent of the equity or voting rights;

3. Calculation of financial links would include both direct and indirect holdings (the latter through subsidiaries, i.e., multi-tier holdings), determined by full consolidation methods. Basically:

   - Subsidiary X of subsidiary Y of company N is considered to be a subsidiary of N;

   - If N and its subsidiaries control between 10 and 50 per cent of the shareholders' voting power in company K, or if N and its subsidiaries control less than 10 per cent, but have an effective voice in the management of K, then K is an associate company of N.

The OECD benchmark definition can be applied only if companies in Member countries draw up consolidated accounts on a world wide basis; otherwise, the OECD recommends that United States practice should be followed."

[OECD, 1990, paras. 215-216, 201 and 208-201]

Geographical classification

"Non-resident transactors are classified by country of residence, regardless of the institutional category to which they are assigned.

Classifying them by geographical region or economic area (EEC, EFTA, OECD, etc.), or by development status (industrialised nations, NICs, etc.), would also clearly be feasible."[OECD, 1990, paras. 194-195]

3.2 International data

3.2.1 Data collection

National TBP data may be collected by means of special surveys but more often are assembled form existing records kept by Central Banks, exchange control authorities, etc.

OECD has collected the data in early years by consulting national documents and experts. A set of experimental tables was included in the R&D survey of 1987. A special summary table was launched in respect of 1991 and the results are now incorporated in the OECD S&T statistics database.

3.2.2 TBP data in the OECD database

Two sets of data are maintained:

i) global series

ii) detailed series.

3.2.2.1 Global series

Total receipts and total payments and balances for 17 OECD Member countries are stored in the database. The earliest year is theoretically 1963, but not many countries could provide data for the early sixties.

3.2.2.2 Detailed series

OECD has recently created a new international database for detailed TBP series (broken down by industry, type of operation and geographical area) starting with Japan, Germany, Italy and Sweden. In parallel, detailed databased on national practices and classifications have been assembled and updated for about ten countries.

3.2.2.3 Availability of data

Data for recent years have been published in OECD, *Main Science and Technology Indicators, twice yearly* and OECD, *Basic Science and Technology Statistics* and the associated diskettes.

3.2.3 Technical material

Definitions and coverage vary from country to country. Descriptions of the methodologies used in some countries can be obtained from the OECD on request.

3.3 The TBP and intangible investment

Most types of expenditure included in the TBP and relevant to intangible investment, the exception being technical assistance.

However they are only very small part of the intangible investment total both because:

i) only international flows are included,
ii) only technology-related flows are included.

As can be seen from Tables 3.2 and 3.3, the TBP deals only with R&D, some types of rights and some types of engineering and design. It excludes software, data banks, advertising, training and non-technical intellectual property.

This confirms the statement in the draft guidelines that "unless TBP data are published at a very detailed level the links between TBP and intangible investment is hard to establish ".

It is clear that the TBP data currently available are not a useful source for intangible investment data. The manual does, nonetheless, offer some useful observation in the intellectual property area and given the grown importance of globalisation may have a role if an international aspect of intangible investment is to be developed.

Table 3.2 **General classification of services (two-by-matrix)**

	Technology-related	Non-technology related	
Factor income	Transactions involving: -- Patents: sale and licensing	Industrial property	Trademarks Patterns Designs
	-- Unpatented inventions -- Know-how (unpatented) (1)	Intellectual property (2)	Copyright Films Recordings Software
Non-factor services	(3) Technical assistance Technical studies Engineering, consultancy Research and development	(4) Commercial assistance Managerial assistance Financial assistance Legal assistance	
	Contract work	Telecommunications, incl. use of databanks Advertising Insurance, transport, etc.	

Notes:

a) Items in Section 1 will go into the TBP.
b) The broken line Sections 2 and 3 separates items that should go into the TBP and those that should not (shaded).
c) Items in Section 4 will not be included in the TBP (shaded).
d) The classification is discussed in paragraphs 24-25.

Source: OECD, 1990, Figure 2.1.

Table 3.3

Transactions	Treatment	Comments
Merchandise, direct investment, etc.		
Trade in merchandise	Exclude	Imports and exports of goods, even high-tech goods.
Unilateral unrequited	Exclude	Such as private or official technical co-operation and assistance, and contributions to scientific organisations. Transactions with no commercial aims, whose content is generally in the public domain, not secret.
Direct investment	Exclude	Intangible in-house flows of know-how, very hard to dissociate from the firm's other assets. This item may be taken as supplementary TBP data when the technology aspect is thought to be substantial.
Input of technology assets	Exclude	Investment consisting wholly or party of a transfer of ownership of patents, licences or know-how. Where the input is entirely technological the transaction could, in theory, be shown as a TBP item. Given the difficulty of obtaining confirmation, the recommendation is to exclude these transactions.
Capitalisation of royalties	Exclude	Non-remitted royalties are converted into shares in the company which received the input. Given the complex reporting procedure, the recommendation is to exclude these transactions.
Services		
Patents (sale/purchase) (licensing)	Include	Industrial property rights on technology.
Know-how (unpatented)	Include	Technology assets not protected under industrial property law.
Invention	Include	As above.
Trademarks (incl. Franchising)	Include	Non-technological industrial property. Hard to separate from licensing and royalties in the balance of payments.
Patterns, designs	Include	Non-technological industrial property. Should only include items of an industrial character wherever possible, excluding those whose value is due to commercial fashion or of purely artistic nature.
Films, recordings, copyright materials	Exclude	Only a small proportion of this item is technology-related.
Software	Exclude	the products are highly diverse, and the technology-related portion is hard to estimate; the recommendation is to exclude software, except where it is part of a patented process.
Other services		
Technical assistance	Include	General technical assistance to be included when the technical aspect is clear cut.
R&D	Include	Can be included when the R&D payment flow reflects a continuing flow of activity. It is a measure of both input and output.
Commercial, financial managerial and legal assistance, advertising, insurance, transport	Exclude	the technology aspect is hard to identify.

Note: The list is not an exhaustive one.
Source: OECD, 1990, Table 2.4.

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