

# **Methodology related to S&T Indicators**



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We need to define clearly WHAT we are measuring.

Science and Technology?

Research and Experimental Development (R&D)?

Innovation?



**Input indicators:** R&D expenditure and human resources.

**Output indicators:** publications and patents.

**Impact indicators:** innovation, social impact (?).

**Technology transfer indicators:** technology balance of payment.



## **Inputs**

FTE personnel

R&D expenditure

R&D facilities

National R&D efforts



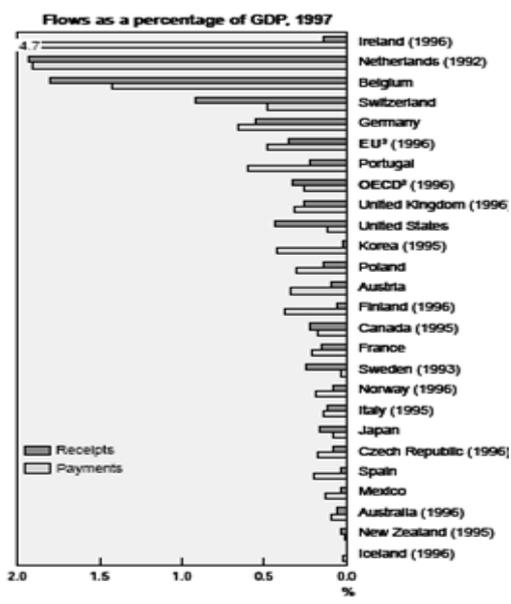
## Outputs

Number of publications

Patents

Innovation surveys

Technological balance of payments



1. Average of technological payments and receipts.  
 2. Including intra-area flows. Data partially estimated.  
 Source: OECD, TBP database, May 1999.



**Table 1. The Frascati Family OECD Manuals.**

Type of data	Title
R&D	Frascati Manual: Proposed Standard Practice for Surveys of Research and Experimental Development (6th Edition, 2002)  R&D Statistics and Output Measurement in the Higher Education Sector. "Frascati Manual Supplement" (1989)
Technology balance of payments	"Manual for the Measurement and Interpretation of Technology Balance of Payments Data – TBP Manual" (1990)
Innovation	OECD Proposed Guidelines for Collecting and Interpreting Technological Innovation Data – Oslo Manual (3rd Edition, 2005)
Patents	"OECD Patent Statistics Manual" (2009)
S&T personnel	The Measurement of Human Resources Devoted to Science and Technology – Canberra Manual (1995)  Revised Fields of S&T (FOS) Classification in the Frascati Manual, OECD (2006)



**Table 2. Other Relevant OECD Framework Documents.**

Type of data	Title
High-technology	"Revision of High-technology Sector and Product Classification" (OECD, STI Working Paper 1997/2)
Bibliometrics	"Bibliometric Indicators and Analysis of Research Systems, Methods and Examples", by Yoshiko Okubo (OECD, STI Working Paper 1997/1)
Globalisation	Handbook of Economic Globalisation Indicators (2005)
Information Society	Guide for Information Society Measurements and Analysis (2005)
Biotechnology	Framework for Biotechnology Statistics (2005)
Productivity	Measuring Productivity. Measurement of aggregate and industry-level productivity growth (2001)



Recommendation concerning the International  
Standardization of Statistics on Science and  
Technology, 1978

UNESCO Manual for Statistics on Scientific and  
Technological Activities ST-84/WS/12, Paris, 1984

International Standard Classification of Education -  
ISCED 1997



### **Scientific and Technological Activities (STA)**

all systematic activities which are closely concerned  
with the generation, advancement, dissemination, and  
application of scientific and technical knowledge in  
all fields of science and technology:

**natural sciences, engineering and technology, the  
medical and the agricultural sciences (NS)(S&T),  
as well as the social sciences and humanities  
(SSH).**

	FOS in FM 2002	Revised FOS
<b>1. Natural Sciences</b>	1.1 Mathematics and computer sciences 1.2 Physical sciences 1.3 Chemical sciences 1.4 Earth and related environmental sciences 1.5 Biological sciences	1.1 Mathematics 1.2 Computer and information sciences 1.3 Physical sciences 1.4 Chemical sciences 1.5 Earth and related environmental sciences 1.6 Biological sciences 1.7 Other natural sciences
<b>2. Engineering and Technology</b>	2.1 Civil engineering 2.2 Electrical engineering, electronics 2.3 Other engineering sciences	2.1 Civil engineering 2.2 Electrical engineering, electronic engineering, information engineering 2.3 Mechanical engineering 2.4 Chemical engineering 2.5 Materials engineering 2.6 Medical engineering 2.7 Environmental engineering 2.8 Environmental biotechnology 2.9 Industrial Biotechnology 2.10 Nano-technology 2.11 Other engineering and technologies
<b>3. Medical and Health Sciences</b>	3.1 Basic medicine 3.2 Clinical medicine 3.3 Health sciences	3.1 Basic medicine 3.2 Clinical medicine 3.3 Health sciences 3.4 Health biotechnology 3.5 Other medical sciences
<b>4. Agricultural Sciences</b>	4.1 Agriculture, forestry, fisheries and allied sciences 4.2 Veterinary medicine	4.1 Agriculture, forestry, and fisheries 4.2 Animal and dairy science 4.3 Veterinary science 4.4 Agricultural biotechnology 4.5 Other agricultural sciences



<b>5. Social Sciences</b>	5.1 Psychology 5.2 Economics 5.3 Educational sciences 5.4 Other social sciences	5.1 Psychology 5.2 Economics and business 5.3 Educational sciences 5.3 Sociology 5.5 Law 5.6 Political Science 5.7 Social and economic geography 5.8 Media and communications 5.7 Other social sciences
<b>6. Humanities</b>	6.1 History 6.2 Languages and literature 6.3 Other humanities	6.1 History and archaeology 6.2 Languages and literature 6.3 Philosophy, ethics and religion 6.4 Art (arts, history of arts, performing arts, music) 6.5 Other humanities



# 1. Natural sciences



## *1.1 Mathematics*

Pure mathematics, Applied mathematics; Statistics and probability<sup>1</sup>;

## *1.2 Computer and information sciences*

Computer sciences, information science and bioinformatics (*hardware development to be 2.2, social aspect to be 5.8*);

## *1.3 Physical sciences*

Atomic, molecular and chemical physics (physics of atoms and molecules including collision, interaction with radiation; magnetic resonances; Moessbauer effect); Condensed matter physics (including formerly solid state physics, superconductivity); Particles and fields physics; Nuclear physics; Fluids and plasma physics (including surface physics); Optics (including laser optics and quantum optics), Acoustics; Astronomy (including astrophysics, space science);

## *1.4 Chemical sciences*

Organic chemistry; Inorganic and nuclear chemistry; Physical chemistry, Polymer science, Electrochemistry (dry cells, batteries, fuel cells, corrosion metals, electrolysis); Colloid chemistry; Analytical chemistry;

## *1.5 Earth and related Environmental sciences*

Geosciences, multidisciplinary; Mineralogy; Palaeontology; Geochemistry and geophysics; Physical geography; Geology; Volcanology; Environmental sciences (*social aspects to be 5.7*); Meteorology and atmospheric sciences; climatic research; Oceanography, Hydrology, Water resources

## Scientific and Technological Activities (STA)



**Research and experimental development (R&D)**

**Scientific and technological education and training at broadly the third level (STET)**

**Scientific and technological services (STS)**

## **Scientific and Technological Activities (STA)**



### **Research and experimental development (R&D)**

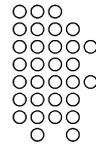
Comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

### **Research and experimental development (R&D)**



#### **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.

**Research and experimental development (R&D)****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.

**Research and experimental development (R&D)****Experimental development**

is systematic work, drawing on existing knowledge gained from research and/or practical experience, which 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.

## Scientific and Technological Activities (STA)



### Scientific and technological education and training (STET)

can be defined as all activities comprising specialized non-university higher education and training, higher education and training leading to a university degree, post-graduate and further training and organized lifelong training for scientists and engineers.

### Limits between R&D and teaching and training



In institutions of higher education, research and teaching are always very closely linked, as most academic staff do both, and many buildings, as well as much equipment, serve both purposes.

Because the results of research feed into teaching, and because information and experience gained in teaching can often result in an input to research, it is difficult to define where the education and training activities of higher education staff and their students end and R&D activities begin, and *vice versa*. Its elements of novelty distinguish R&D from routine teaching and other work-related activities.

**Example: Borderline between R&D and education and training at ISCED level 6**



	<b>Education and training at level 6</b>	<b>R&amp;D</b>	<b>Other activities</b>
<b>Teachers</b>	1. Teaching students at level 6.  2. Training students at level 6 in R&D methodology, laboratory work, etc.	3. Supervision of R&D projects required for student qualification at level 6  4. Supervision of other R&D projects and performance of own R&D projects	5. Teaching at levels lower than level 6  6. Other activities
<b>Post-graduate students</b>	1. Course work for formal qualification.	2. Performing and writing up independent studies (R&D projects) required for formal qualification  3. Any other R&D activities	4. Teaching at levels lower than level 6  5. Other activities

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**Scientific and Technological Activities (STA)**



**Scientific and technological services (STS)**

can be defined as any activities concerned with scientific research and experimental development and contributing to the generation, dissemination and application of scientific and technical knowledge.



S&T services provided by libraries, archives, information and documentation centres, reference departments, scientific congress centres, data banks and information-processing departments.

S&T services provided by museums of science or technology, botanical and zoological gardens and other S&T collections (anthropological, archaeological, geological, etc.).

Systematic work on the translation and editing of S&T books and periodicals.

Topographical, geological and hydrological surveying; meteorological and seismological observations; surveying of soils and of plants; fish and wildlife resources; routine soil, atmosphere and water testing; the routine checking and monitoring of radioactivity levels.

Prospecting and related activities designed to locate and identify oil and mineral resources.



The gathering of information on human, social, economic and cultural phenomena, usually for the purpose of compiling routine statistics, e.g. population censuses; production, distribution and consumption statistics; market studies; social and cultural statistics, etc.

Testing, standardization, metrology and quality control; regular routine work relating to the analysis, checking and testing, by recognized methods, of materials, products, devices and processes, together with the setting up and maintenance of standards and standards of measurement.

Regular routine work on the counselling of clients, other sections of an organization or independent users, designed to help them to make use of scientific, technological and management information.

Activities relating to patents and licences.

### Some cases at the borderline 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	As 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. Exclude all other associated activities.
After-sales service & troubleshooting	Exclude	Except "feedback" R&D.

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Item	Treatment	Remarks
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	

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### **This is not to be counted as R&D**



Business application software and information system development using known methods and existing software tools.

Support for existing systems.

Converting and/or translating computer languages.

Adding user functionality to application programmes.

Debugging of systems.

Adaptation of existing software.

Preparation of user documentation.

### **Criteria for identifying R&D in services**



Links with public research laboratories.

The involvement of staff with PhDs, or PhD students.

The publication of research findings in scientific journals, organisation of scientific conferences or involvement in scientific reviews.

The construction of prototypes or pilot plants.

### Examples of R&D in other service activities



Analysis of the effects of economic and social change on consumption and leisure activities.

Development of new methods for measuring consumer expectations and preferences.

Development of new survey methods and instruments.

Development of tracking and tracing procedures (logistics).

Research into new travel and holiday concepts.

Launch of prototype and pilot stores.

### R&D



### Targeted population within a country

Business enterprise sector,

Government sector,

Private non-profit sector and

Higher education sector.

## R&D



R&D survey conforms to the basic principles of information management, so that the information is:

Relevant,  
Accurate,  
Timely,  
Complete,  
Maintainable and  
Interpretable.

**THANK YOU**

