

Measuring Research and Experimental Development (Part 1)

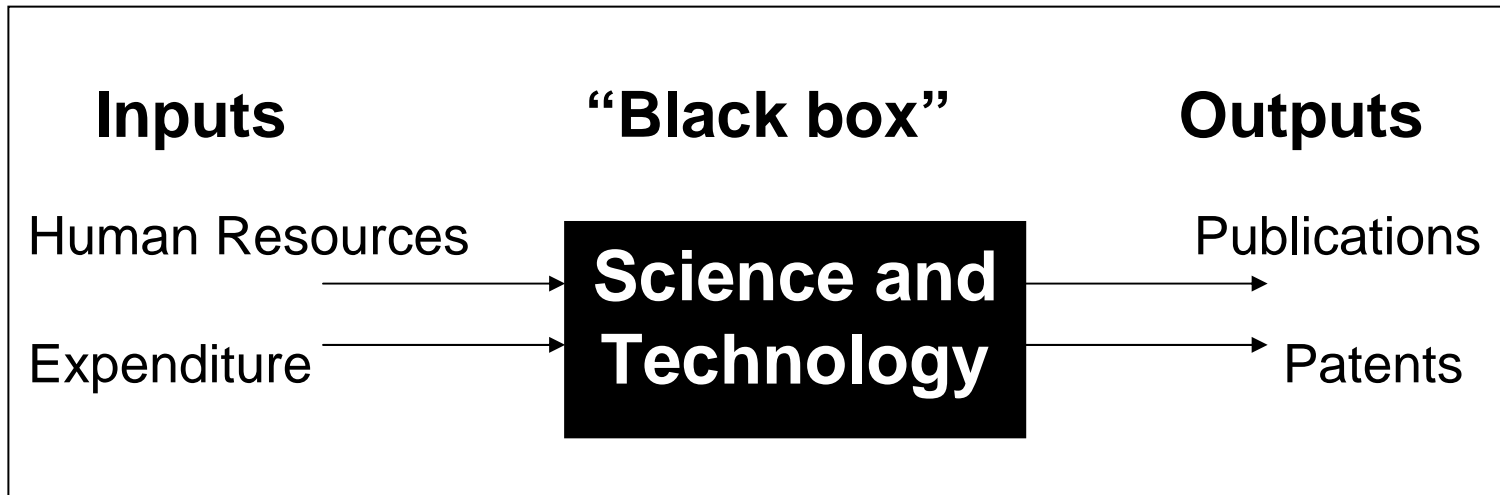
***SEMINAR-WORKSHOP ON SCIENCE, TECHNOLOGY AND
INNOVATION INDICATORS: TRENDS AND CHALLENGES***

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Types of S&T indicators

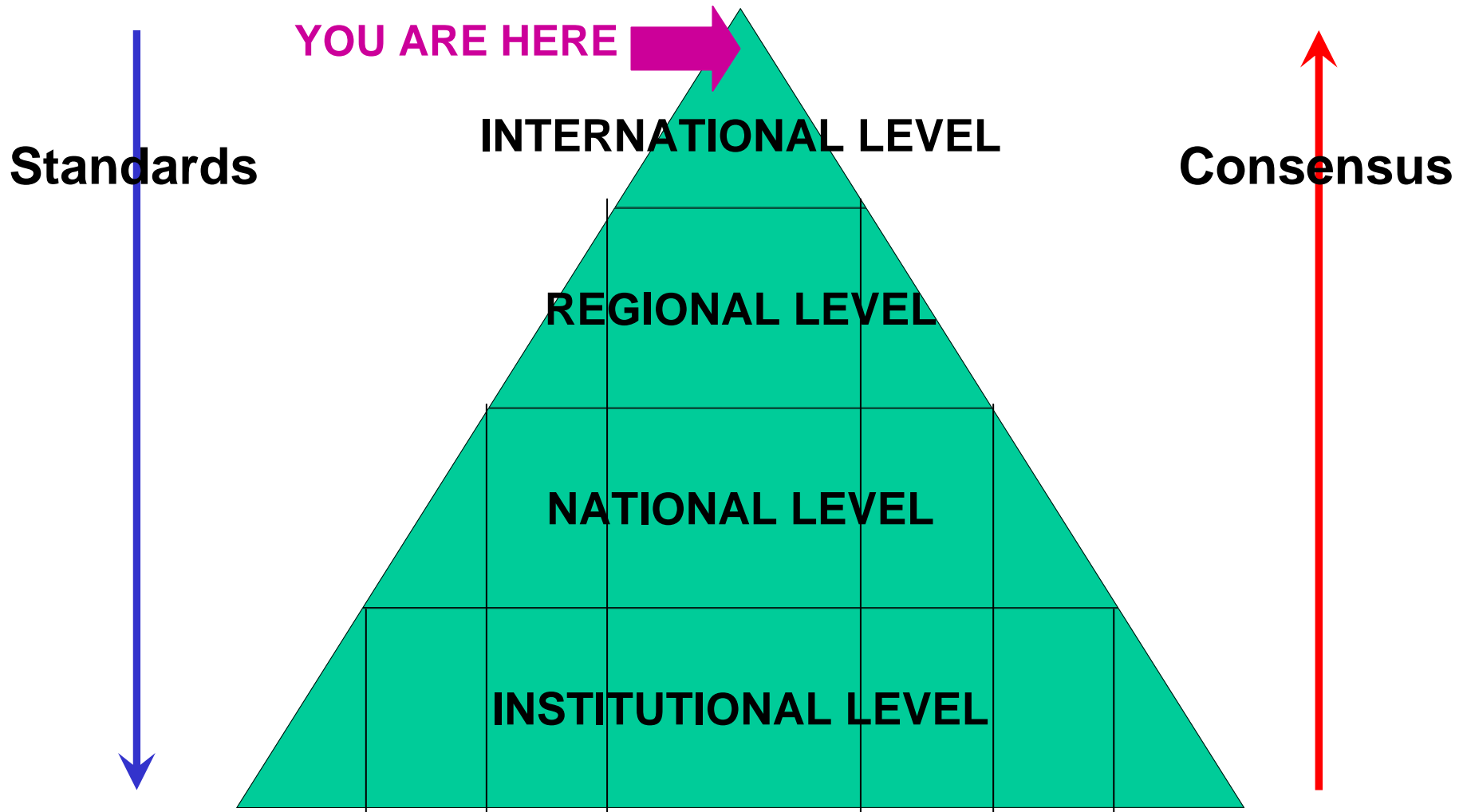
- We cannot measure S&T directly. Therefore we measure proxies:
 - Input indicators
 - Output indicators
 - Impact indicators



What is in the “black box”?

- We need to define clearly WHAT we are measuring.
- Science and Technology?
- Innovation?
- Research and Experimental Development (R&D)?

Chris Freeman's pyramid revisited



“Frascati family” of OECD Manuals

The Measurement of Scientific and Technological Activities

Type of data	Title
R&D	<i>Frascati Manual: Proposed Standard Practice for Surveys of Research and Experimental Development (6th Edition, 2002)</i> <i>R&D Statistics and Output Measurement in the Higher Education Sector. “Frascati Manual Supplement” (1989)</i>
Technology balance of payments	<i>“Manual for the Measurement and Interpretation of Technology Balance of Payments Data – TBP Manual” (1990)</i>
Innovation	<i>OECD Proposed Guidelines for Collecting and Interpreting Technological Innovation Data – Oslo Manual (3rd Edition, 2005)</i>
Patents	<i>“Using Patent Data as Science and Technology Indicators – Patent Manual 1994”</i>
S&T personnel	<i>The Measurement of Human Resources Devoted to Science and Technology – Canberra Manual (1995)</i>

Other relevant OECD frameworks

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	<i>Handbook of Economic Globalisation Indicators (2005)</i>
Information Society	<i>Guide for Information Society Measurements and Analysis (2005)</i>
Biotechnology	<i>Framework for Biotechnology Statistics (2005).</i>
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

STA: Definition

For statistical purposes,
Scientific and Technological Activities (STA)
can be defined as 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, that is the natural
sciences, engineering and technology, the medical
and the agricultural sciences (NS), as well as the
social sciences and humanities (SSH).

R&D: 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.

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, 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.

STET: Definition

Scientific and technological education and training at broadly the third level (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

	Education and training at level 6	R&D	Other activities
Teachers	<ol style="list-style-type: none"> 1. Teaching students at level 6. 2. Training students at level 6 in R&D methodology, laboratory work, etc. 	<ol style="list-style-type: none"> 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 	<ol style="list-style-type: none"> 5. Teaching at levels lower than level 6 6. Other activities
Post-graduate students	<ol style="list-style-type: none"> 1. Course work for formal qualification. 	<ol style="list-style-type: none"> 2. Performing and writing up independent studies (R&D projects) required for formal qualification 3. Any other R&D activities 	<ol style="list-style-type: none"> 4. Teaching at levels lower than level 6 5. Other activities

STS: Definition

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.

STS: detailed activities

- 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.

STS: detailed activities (continued)

- 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.

An

innovation

is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations.

Innovation activities

are all scientific, technological, organisational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations. Some innovation activities are themselves innovative, others are not novel activities but are necessary for the implementation of innovations. Innovation activities also include R&D that is not directly related to the development of a specific innovation.

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.

Some cases at the borderline between R&D and other industrial activities (cont.)

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	

Examples of R&D activities

- In the field of medicine, routine autopsy on the causes of death is the practice of medical care and is not R&D; special investigation of a particular mortality to establish the side effects of certain cancer treatments is R&D. Similarly, routine tests such as blood and bacteriological tests carried out for doctors are not R&D, whereas a special programme of blood tests in connection with the introduction of a new drug is R&D.
- The keeping of daily records of temperatures or of atmospheric pressure is not R&D but the operation of a weather forecasting service or general data collection. The investigation of new methods of measuring temperature is R&D, as are the study and development of new systems and techniques for interpreting the data.

Examples of R&D (contd.)

- R&D activities in the mechanical engineering industry often have a close connection with design and drawing work. In small and medium-size enterprises (SMEs) in this industry, there is usually no special R&D department, and R&D problems are mostly dealt with under the general heading “design and drawing”. If calculations, designs, working drawings and operating instructions are made for the setting up and operating of pilot plants and prototypes, they should be included in R&D. If they are carried out for the preparation, execution and maintenance of production standardisation (e.g. jigs, machine tools) or to promote the sale of products (e.g. offers, leaflets, catalogues of spare parts), they should be excluded from R&D.

Examples of R&D in software

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

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 banking and insurance

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

Examples of R&D in 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.