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ASSESSMENT OF THE BELGIAN S&T STATISTICAL SYSTEM AND PRIORITIES FOR DEVELOPMENT WORK: AN OECD PERSPECTIVE

Bruno van Pottelsberghe de la Potterie

The objective of this report is to make recommendations regarding the most important S&T statistical information required by the DSTI to enable it to include Belgian indicators more frequently in its official reports and publications. The suggested priority areas are defined with respect to OECD's most important S&T statistics and indicators, recent progress in Belgian institutions and OECD future prospects in terms of new indicators. The main recommendations are: i) the methodological framework implemented to compute the ANBERD database provides strong foundations that would allow for the construction of other basic S&T statistics and analytical indicators; ii) Belgium should join the group of core countries for which a feasibility study on the mobility of human resources is to be launched; iii) the R&D survey sampling procedure could be improved by implementing it in the light of the CIS questionnaires and extended to comprehend complementary information related to new projects; iv) the information contained in various Belgian databases and surveys could be used as the starting point for a new firm-level database, providing a unique tool for policy analysis and academic research; and v) closer collaboration between the regions would ensure fully homogenous regional data in Belgium.

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ASSESSMENT OF THE BELGIAN S&T STATISTICAL SYSTEM AND PRIORITIES FOR DEVELOPMENT WORK: AN OECD PERSPECTIVE

by Bruno van Pottelsberghe de la Potterie

The objective of this report is to make recommendations regarding the most important S&T statistical information required by the DSTI to enable it to include Belgian indicators more frequently in its official reports and publications. The suggested priority areas are defined with respect to OECD's most important S&T statistics and indicators, recent progress in Belgian institutions and OECD future prospects in terms of new indicators. The main recommendations are: *i)* the methodological framework implemented to compute the ANBERD database provides strong foundations that would allow for the construction of other basic S&T statistics and analytical indicators; *ii)* Belgium should join the group of core countries for which a feasibility study on the mobility of human resources is to be launched; *iii)* the R&D survey sampling procedure could be improved by implementing it in the light of the CIS questionnaires and extended to comprehend complementary information related to new projects; *iv)* the information contained in various Belgian databases and surveys could be used as the starting point for a new firm-level database, providing a unique tool for policy analysis and academic research; and *v)* closer collaboration between the regions would ensure fully homogenous regional data in Belgium.

L'objectif de ce rapport est de proposer des recommandations concernant les principales statistiques de S&T requises par la DSTI pour lui permettre d'inclure les indicateurs belges plus fréquemment au sein de ses rapports officiels et publications. Les priorités sont définies par rapport aux indicateurs de S&T les plus couramment utilisés au sein de l'OCDE, aux avancées récentes des institutions belges et au développement futur de nouveaux indicateurs à l'OCDE. Les recommandations principales sont les suivantes : *i)* le cadre méthodologique utilisé pour la construction de la banque de données ANBERD pourrait être exploité pour la construction de statistiques de base de S&T et d'indicateurs analytiques ; *ii)* la Belgique devrait se joindre au groupe de pays pour lesquels une étude de faisabilité sur la mobilité des ressources humaines est réalisée ; *iii)* la procédure d'échantillonnage des enquêtes R&D pourrait être améliorée à la lumière des questionnaires CIS et élargie de manière à fournir des informations nouvelles liées à de nouveaux projets ; *iv)* l'information statistique contenue dans différentes banques de données belges ainsi que dans les questionnaires pourrait constituer le point de départ d'une banque de données sur les entreprises, fournissant un outil unique pour l'analyse des politiques économiques et la recherche académique ; et *v)* une collaboration plus étroite entre les régions assurerait l'homogénéité des données construites au niveau régional.

Introduction

As developed economies become increasingly knowledge-based, science and technology (S&T) policies are placed higher on the agenda. To be effective, these policies must be rooted in a thorough understanding of the nature and likely effect of innovation activities. This understanding obviously requires a wide set of qualitative and quantitative data on science and technology. In this respect, one of the roles of the OECD Secretariat, and more particularly of the Directorate for Science, Technology and Industry (DSTI), is to define a methodological framework in which economic concepts related to innovation are translated into S&T indicators. This involves designing, collecting and analysing statistics and indicators which can throw light on trends in S&T activities and their links with the economy and society. Well-reputed examples of such methodological frameworks are the *Frascati Manual* on the measurement of S&T activities, the *Oslo Manual* on the collection and interpretation of technological innovation data, and the *Canberra Manual* on the measurement of human resources devoted to S&T. Once these methodologies are established, DSTI's work consists in transforming the data provided by Member countries into homogenous and internationally comparable data sets. In certain cases, estimates are performed so as to provide analytical series at a high level of industry disaggregation.

As in other fields of economic and social statistics, the need for internationally comparable data in the S&T area calls for the development of harmonized concepts. The OECD is the lead international organisation for the development of harmonized S&T standards and the compilation of policy relevant internationally comparable statistics and indicators. The reliability of these user-driven and policy-oriented databases for economic analysis, such as that on National Innovation Systems (NIS), increases as the country coverage is extended. In carrying out its work the OECD co-operates very closely with the national agencies responsible for using and/or collecting these statistics. The quality and coverage of these indicators is evidently dependent on the Member countries' ministries and statistical institutes, and more specifically on the quality and consistency of their responses.

This report surveys the availability of S&T statistics and economic indicators for Belgium used in various DSTI publications. The objective is to make recommendations regarding the most important statistical information required by the DSTI to enable it to include Belgian indicators more frequently in its official reports and publications.

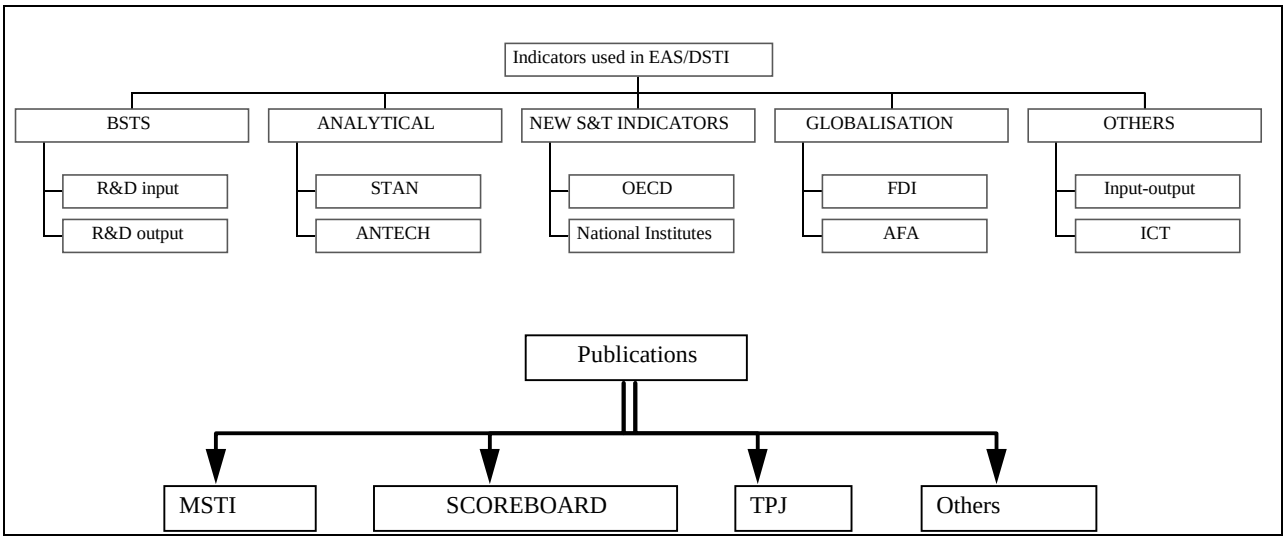
The report is structured as follows. The next section describes the indicators used in DSTI, classified into five groups, and indicates their availability for Belgium. The third section suggests priority areas for future statistical development according to the usefulness of the indicators and the recent progress made by Belgian institutions in this respect. The fourth section tackles the issue of regionality and the fifth section concludes. The abbreviations used in the report are listed in Annex 1.

Presentation of the main indicators used in DSTI

The statistics and indicators produced and/or extensively used by DSTI can be classified into five different groups (Chart 1). The first group, by far the most important in size, is published in *Basic Science and Technology Statistics* (BSTS). It covers statistics related to the resources devoted to R&D (expenditures and personnel engaged in R&D) and to the output of S&T activities (patent data and technology balance of payments). The second group, industry-level statistics, is composed of the STAN database for industrial analysis, the ANBERD series on business R&D, the ANRSE series on scientists and researchers, and the ANPAT database on patent count data. The third group covers the statistics that are to be produced under the activities on "new S&T indicators". So far, the work has focused on HRST (human resources in S&T)

mobility, government support to R&D, high-tech trade, innovation survey and patent data. The fourth group contains some indicators which are not always produced by DSTI and which are often used for the analysis of globalisation. These statistics relate to the internationalisation of R&D, inward and outward foreign direct investment (FDI) and the activities of foreign affiliates (AFA). The fifth group includes indicators related to science, technology and industry that are not produced on a regular basis (for all years and/or countries), such as those derived from input/output matrices.

Chart 1. Schematical view of indicators produced and/or used in DSTI



Basic Science and Technology Statistics (BSTS)

The BSTS publication is prepared by the Economic Analysis and Statistics Division (EAS) with figures provided by the group of National Experts on Science and Technology Indicators (NESTI). It contains 26 tables presenting selected series from the OECD "Science and Technology Databases", of which 22 concern resources devoted to research and experimental development (R&D) and four are indicators of the output of scientific and technological activities.

A large share of the data on resources devoted to research activities deals with the standard expenditure measure, ***Gross Domestic Expenditure on Research and Experimental Development (GERD),*** which covers all R&D carried out on national territory in the year concerned. It is broken down by sector of performance, source of funds, type of costs, type of activity, socio-economic objective and by main scientific field.[1] Resources devoted to R&D are also measured in labour terms; ***total R&D personnel*** by sector of employment is broken down by occupation, formal qualification and main scientific field. Such R&D personnel data should be expressed in full-time equivalent (FTE) on R&D or as person-years.

Similar sets of data are provided for R&D carried out in the ***Business Enterprise Sector*** with detailed data ***by industry,*** and the ***Higher Education Sector*** with detailed data ***by field of science***. Further information on government objectives when committing money to R&D can be derived from budgets such as ***government R&D appropriations or outlays*** and broken down ***by socio-economic objective***.

As yet, there are no direct measures of the output of Scientific and Technological (S&T) activities, only proxy indicators based on data collected for other purposes. Two such types of statistics are published in the BSTS publication: the technology balance of payments and patents. The ***Technology Balance of***

Payments (TBP) series are data extracted from national balance of payments sources and/or surveys, with the aim of measuring the flow of proprietary technology and know-how into and out of the country concerned. Data collected to date are not always compiled according to international standards, but the series generally comprise fees paid or received for the use of patents, licences, trademarks, designs, inventions, know-how and closely related technical services. ***Patent data applications*** can be considered as partial proxy measures of the output of R&D in the form of inventions. The number of patents applied for by country, beginning with total applications on ***national*** territory, distinguishes applications by ***residents*** of the country concerned and applications by ***non-residents***. Information on the country concerned is completed by data on ***external*** applications by residents of the country for patents in other countries. The data cover applications processed through national and international patent offices. Finally, this information is completed by data on the country of origin of applications by non-residents in the country concerned and data on the countries where external applications were filed by residents of the country involved.

Table 1 summarises the available data for Belgium. Data are available or partially available for only 12 of the 26 tables corresponding to R&D input at the aggregate level and to measures of R&D output. Of the 14 tables for which no data is available, three types of statistics are of major importance for the economic analysis of innovation: R&D by type of activity (Table 3); R&D by industry and source of funds (Tables 10.1 to 10.4); and R&D personnel (Tables 12 and 13).

Table 1. **Availability of BSTS data for Belgium (1990-95)**

1. Gross domestic expenditures on R&D — *GERD — by sector of performance and source of funds*	**x**
2. Gross domestic expenditure on R&D — *GERD — by sector of performance and type of costs*	**-**
3. Current domestic expenditure on R&D *by sector of performance and type of activity*	**-**
4. Gross domestic expenditure on R&D — *GERD — by sector of performance and socio-economic objective*	**-**
5. Total R&D personnel *by sector of employment and occupation*	**x**
6. Total R&D personnel *by sector of employment and formal qualification*	**x**
7. Gross domestic expenditure on R&D — *GERD — by sector of performance and main scientific field*	**-**
8. Total R&D personnel *by sector of employment and main scientific field*	**-**
9. Total business enterprise intramural expenditure on R&D — *BERD — by industry*	**x**
10. Business enterprise intramural expenditure on R&D — *BERD — by industry and source of funds*	
10.1 *Business enterprise*	**-**
10.2 *Government*	**-**
10.3 *Other national funds*	**-**
10.4 *Funds from abroad*	**-**
11. Business enterprise intramural expenditure on R&D — *BERD — by industry and type of costs*	
11.1 *Current expenditure*	**-**
11.2 *Capital expenditure*	**-**
12. Total business enterprise R&D personnel — *BEMP – by industry*	**-**
13. Research scientists and engineers - *RSE* - (or university graduates) *in the business sector by industry*	**-**
14. Higher education intramural expenditure on R&D – *HERD – by field of science*	**x**
15. Higher education intramural expenditure on R&D – *HERD – by field of science and type of costs*	**-**
16. Higher education intramural expenditure on R&D – *HERD – by field of science and source of funds*	**x**
17. Higher education R&D personnel – *HEMP – by field of science and occupation or formal qualification*	***I***
18. Government budget appropriations or outlays for R&D – *GBAORD – by socio-economic objective*	**x**
19. Technological balance of payments *by type of transfer*	***I***
20. Number of patent applications according to the relationship of patentee to patent office	**x**
21. Number of non-resident patent applications *by country of origin*	**x**
22. Number of external patent applications *by country of application*	**x**

X Data available (for 1993, 1994 or 1995 at least).
/ Data partially available (incomplete breakdown or data previous to 1993).
- Data not available. The corresponding table has been suppressed if there is no other information on the page.

It is worth noting that one of the recent improvements of ISIC Revision 3, which meets the recommendations of the *Frascati Manual* (1993), is the extended coverage of the service sector. These improvements mainly concern the BSTS indicators on R&D expenditures by industry and the ANBERD database. According to a recent mini-questionnaire implemented by the Secretariat, Belgium is among nine OECD countries that were not satisfied with the coverage of R&D in the service sector (5.8 per cent in 1991).

Industry-level analytical statistics: STAN and ANTECH

STAN (structural analysis database) was created to solve a problem of homogeneity induced by the gap between the detailed data collected through business surveys which have limited international comparability, and National Accounts data which are more internationally comparable but which are only available at fairly aggregated levels. Through the use of established estimation techniques, the OECD Secretariat has created a database that is compatible with National Accounts for 22 countries. It covers 49 manufacturing industries for six variables with annual data from 1970 onwards. STAN permits the construction of a wide range of industry- and aggregate-level indicators of industrial structure and the evolution of performance (*e.g.* import penetration, investment per employee, export market shares). The variables covered by the STAN database are:

Q. *Production* is national accounts compatible production (gross output) in current prices.

V. *Value added* is national accounts compatible value added and represents the contribution of each industry to national GDP. It is available in both current and constant (1990) prices

K. *Gross fixed capital formation* is current price, national accounts compatible gross fixed capital formation (land, buildings, machinery and equipment)

L. *Number engaged* includes number of employees as well as self-employed, owner proprietors and unpaid family workers.

W. *Labour compensation* is current price national accounts compatible labour costs which include wages as well as the costs of supplements such as employer's compulsory pension, medical payments, etc.

X. *Export and import data* are derived from the OECD's Foreign Trade by Commodities database. The data are converted from the Standard International Trade Classification (SITC), Rev. 1, 2 and 3 (depending on the year concerned).

The STAN industrial database has parented four other databases, so a wide array of indicators and models can be constructed at a detailed industrial level. The following compatible databases are also available from the OECD: Analytical Business Enterprise R&D database (ANBERD); Analytical Researchers, Scientists and Engineers (ANRSE) and Analytical Patents (ANPAT); Bilateral Trade database (BTD); and Input-Output (I/O) database.

ANTECH encompasses a set of technology indicators designed to be used in an integrated fashion with STAN and other databases. The three components of ANTECH are **ANBERD** (Analytical Business Enterprise Research and Development), **ANRSE** (Analytical Researchers, Scientists and Engineers), and **ANPAT** (Analytical Patents), of which the last two are still being extended.

The ANBERD database provides a consistent data set that overcomes the problems of international comparability and breaks in the time series of the official business enterprise R&D provided to the OECD by its Member countries through the OECD's R&D survey. Through the use of established estimation techniques partly based on the STAN indicators, the OECD Secretariat has created a database for 15 of the largest R&D performing countries for the 1973-95 period.

Similarly to the ANBERD database, the ANRSE database was constructed with the objective of creating a consistent data set on human resources working on R&D in the business enterprise sector. ANRSE overcomes the problems of international comparability and time discontinuity associated with the official business enterprise labour forces engaged in R&D data (OFFRSE) provided to the OECD by Member countries. It is designed to supply analysts with a comprehensive and internationally comparable data set on business enterprise RSE. Seven countries are currently covered.

The ANPAT database is derived from the International Technology Indicators database computed by CHI Research. The available indicators are computed from data on patents granted by the USPTO. The basic data is submitted every two years to CHI, and concerns exclusively patents granted (no applications). Six main indicators are available. They are computed for 25 industrial sectors (ISIC Rev. 2) by the OECD Secretariat. The database will also include the patent-related indicators computed through the "new S&T indicators" project.

Table 2 summarises the degree of data availability for Belgium. In the case of STAN, the time series are complete for more than two-thirds of the manufacturing industries. However, the missing sectors are either high-tech industries (such as aerospace and pharmaceuticals); or sectors related to information and communication technologies (such as electronic products); or medium-tech industries (such as electrical machinery). These missing data prevent any structural analysis of R&D-intensive sectors, such as those presented in the *Scoreboard of Indicators* and the report on *Technology, Productivity and Job Creation – Best Policy Practices*.

Table 2. **Availability of STAN and ANTECH data for Belgium (1971-95), ISIC Rev. 3**

Database / variables		Missing industries
STAN		
Q.	Gross output	10 missing sectors (high-tech, medium-tech, ICT)
V.	Value added	10 missing sectors (high-tech, medium-tech, ICT)
K.	Gross fixed capital formation	15 missing sectors (high-tech, medium-tech, ICT)
L.	Number engaged	12 missing sectors (high-tech, medium-tech, ICT)
W.	Labour compensation	10 missing sectors (high-tech, medium-tech, ICT)
X.	Exports and imports	All data available
ANBERD		All data missing/to be completed soon (ULB-RUCA)
ANRSE		All data missing
ANPAT		All data available for USPTO, see new S&T indicators for EPO patent data.

Source: OECD Secretariat.

The "new S&T indicators" project

The "new S&T indicators" activity was launched following a request by the CSTP at its meeting at ministerial level held in October 1995. Ministers agreed that "*there is a need for Member countries to collaborate to develop a new generation of indicators which can measure innovative performance and other related outputs of a knowledge-based economy*" and that "*special attention should be given to the data required for assessment, monitoring and policy-making purposes"*. Five priority areas have been selected for the development of new indicators: the mobility of human resources, patents, innovative and absorptive capabilities of firms, internationalisation of R&D, and government support to industrial R&D. The expected outcome of the "new S&T indicators" activity consists in a set of methods and data sources

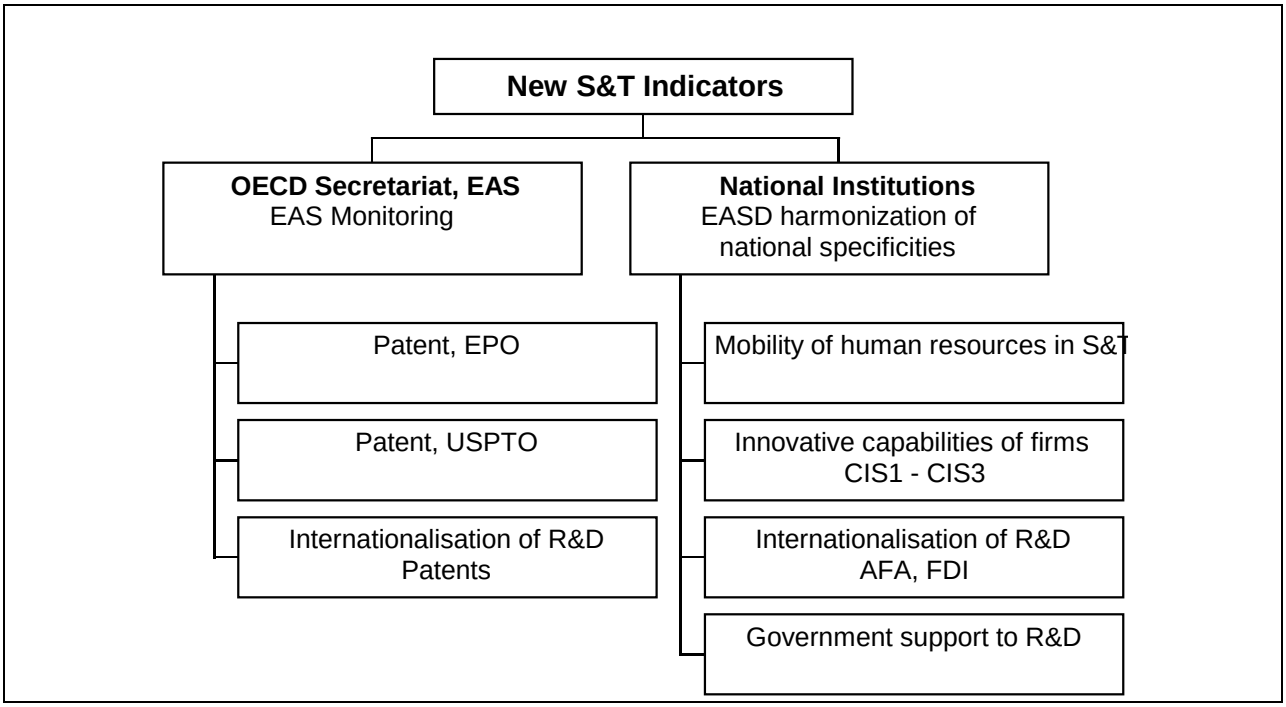
allowing the selected indicators to be calculated on an internationally comparable basis. More precisely, two kinds of products are expected:

- The first consists of indicators and data which can be either calculated directly or monitored by the Secretariat. This is the case when basic data are directly accessible at an international level, in a harmonized form for all countries, and when a robust methodology can be developed and applied. It is the case, for example, for most indicators based on patents.

- The second consists of indicators and data which can be calculated by the countries concerned and harmonized by the Secretariat. Many data are accessible at a national level only, due for instance to confidentiality rules, or require a good knowledge of national specificities.

The "new S&T indicators" activity aims at using existing data in new ways, or at using new data, or at implementing full-scale methods which are still at the research stage. It is a time-consuming innovative endeavour with uncertain results.

Chart 2. Structure of the new S&T indicators



Source: OECD.

The project on **mobility of human resources in S&T** aims at mapping the circulation of highly skilled workers (an element of the circulation of embodied knowledge) between the public and private sectors, between industries and between firms. Under the lead of Sweden, indicators of mobility have been calculated in the Nordic countries (a joint project with the NIS, carried out by NUTEK and other Nordic organisations), where uniquely accurate data, drawn from administrative registers, are available. Statistics

Sweden has carried out a study of which the main outcome is a list of suggestions for interesting indicators and lists of available data sources in various countries.

Patents: The aim of this project is to measure inventive output (economic value of inventions) and the circulation of knowledge based on patents. Extracting more information from these data than has been done hitherto and correcting patent statistics for various biases draws largely on methods developed in academic research. A third line of work is to construct a database of patent families (a family is a patent taken out in parallel in several countries), with the idea that family size is related to the value of the invention.

Innovative capabilities of firms: The objective here is to map innovative and absorptive behaviour of firms and improve knowledge of the determinants of innovation at the firm level. Innovation surveys, carried out in most OECD countries since 1990, provide the basic data. Although innovation surveys are a unique source of information on the innovative behaviour of firms, the qualitative nature of much of the data collected raises difficult issues when it comes to aggregating firm-level data to obtain industry- or country-wide indicators. The purpose of this project is to identify and test various solutions to these issues. A methodological study has analysed these issues in detail and proposed a range of solutions based on statistical and econometric techniques.

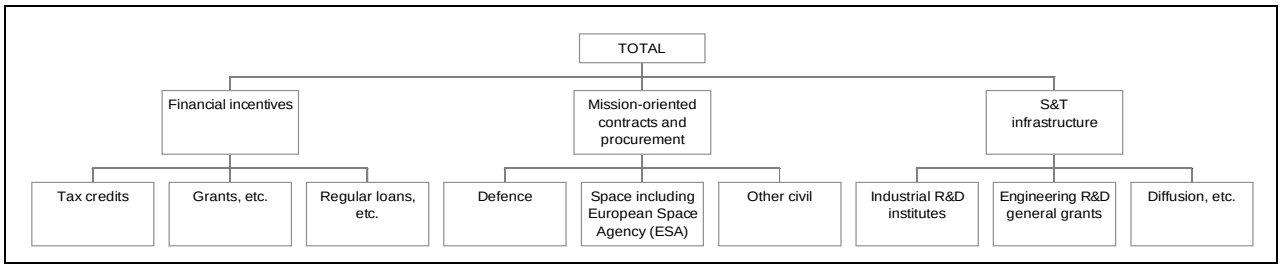
Internationalisation of R&D: This project consists in mapping international aspects of R&D and innovation, including international flows of investment in R&D and trade of high-tech goods. Work on foreign direct investment in R&D (expenditures of foreign affiliates, see AFA), conducted by the Secretariat in liaison with the Statistical Working Party of the Industry Committee (SWIC) and NESTI, has provided new indicators which were published in 1998. In a complementary approach aiming at mapping the location of R&D facilities of multinational firms, a matrix of patents by country of ownership/country of invention has been calculated. Indicators have been calculated to assess the competitive position of countries in trade of high-tech goods, with the aim of characterising them in terms of price versus quality. At this stage these indicators do not meet statistical quality standards, and further testing will be carried out in 1999 to determine whether this approach deserves to be followed or not.

Government support to R&D: This project focuses on the development of internationally comparable statistics reflecting research and technology government policies. This is a necessary input in any exercise aiming at comparing policies across countries. Two complementary tracks have been followed. One is to construct a global, synthetic indicator of government indirect support to R&D, based on the same approach as that used for tax relief ("B-index"). A method has been set up and applied to four countries, with good results.

The second project is to set up a new, internationally agreed, classification of government support to industrial R&D. Data currently available from standard R&D sources do not give a complete picture of government support for industrial technology. Experimental work has been performed by the OECD Secretariat, which could lead to an update of the *Frascati Manual*. Sets of data have been compiled for ten Member countries for the analysis on *Technology, Productivity and Job Creation: Best Policy Practices* (OECD, 1998) to examine the level and structure of such funding as well as trends over the last few years. Government support is broken down into three categories: financial incentives; mission-oriented contracts, procurement (paid to industrial firms); S&T infrastructure and diffusion (see Chart 3). The first category includes all programmes designed to encourage industrial firms to carry out R&D (or other innovation activities) by reducing the cost through grants, loans, fiscal incentives, etc. The second covers government payments to industrial firms to carry out R&D to meet government needs, notably for defence or space objectives. The third covers ways in which governments can assist firms without giving them R&D money: by financing R&D activities aimed at industrial development in institutes and universities;

by supporting technological research in academic and similar units; and by funding non-R&D programmes in support of either post-R&D stages of the innovation process or diffusion and extension programmes.

Chart 3. Structure of government funding of industrial technology



Source: OECD.

The data required to analyse funding in this way are not readily available from OECD sources. However, they can be obtained by combining data from the database on public support to manufacturing industry (PSI database, see also OECD, 1998*d*), from tables supplied via the regular OECD R&D survey and from national sources. The analysis of the overall pattern of support for industrial technology, mission-oriented contracts and procurement, and infrastructure items was based on data for the period 1989-95 for ten countries, six from the G7: [the United States, Japan, Germany (to 1993 only), the United Kingdom, France, Canada], plus four smaller ones (Australia, Finland, Mexico and the Netherlands), using series supplied by countries and/or compiled by the Secretariat. The PSI data were also used for an OECD-wide analysis of financial incentives for RDI.

Table 3 presents the work in progress for each new S&T indicator. Those monitored by the OECD Secretariat, such as patent-related statistics, will include Belgium. The human capital mobility project is to be launched in the very near future with a set of five to seven core countries, which do not include Belgium. The project on innovative capabilities of firms is also to be implemented by the Secretariat since the Community Innovation Surveys (round 1 and 2) are now available; Belgium provided the second round survey to Eurostat in September 1998. The work on the internationalisation of R&D depends partly on statistics related to foreign direct investments and the activities of foreign affiliates, which are rather scarce for Belgium. Regarding the project on government support to R&D, Belgium has not been taken into account, due to a lack of required data.

Globalisation and other indicators

R&D by size of firm is a new data set that was published in 1998, and will be possibly continued in the future. Its aim is to provide R&D investment by size of firm, both for the economy as a whole and at the sectoral level. In addition, total R&D investment will be disaggregated by source of funds, such as business-funded and government-funded R&D.

Other data, although not directly related to science and technology, are complementary for specific economic analysis. For instance, **foreign direct investment series** are often used in S&T-related documents. The series on inward and outward FDI are net flows by country of origin and destination, respectively, and are presented at both the macro level and at the sectoral level. The latter aggregation level allows to distinguish the trends of FDI within high-tech industries.

Table 3. **Next steps concerning the new S&T indicators**

Project	Stage of work	Duty
***HRST mobility*:**	The next stage is to extend the calculation of indicators to countries with less accurate data sources than those available in the Nordic countries. A set of core countries (5 to 7) will be selected and work will be conducted with an expert in co-ordination with countries. A feasibility study, based on the survey of data sources done by Statistics Sweden, should be completed by June 1999. In the second half of 1999 indicators will be calculated for a range of countries, where feasible.	SSTC / OECD
***Patents*:**	A first set of indicators will be published by the beginning of 1999: EPO applications counts (including transferred PCTs) by priority year until 1996 (it will be the first time that such timeliness is achieved for these statistics); and patent families will be available in the course of 1999. These indicators will be included in regular STI publications. The work on patent families will be pursued in order to have weighted counts reflecting the economic value of patents (based on the number of countries in which the patent has been taken out and on renewals); techniques for estimating the number of patents granted in recent application years will be further investigated (previous work tends to show that grants are better correlated with TFP than applications). Regular production of these new indicators will require resources, in terms of databases (patents databases include millions of observations) and of Secretariat staff.	OECD - EAS
Innovative capabilities of firms:	The next stage is to implement country-wide indicators in European countries (CIS1: Community Innovation Surveys, round 1) in order to test their validity. Results will be available by the beginning of 1999. The selected solutions will then be applied on CIS2 data when they are available from Eurostat (possibly next spring), and on other countries (Australia, Canada, Japan). As innovation surveys are becoming regular in most OECD countries (every three years in Europe), the indicators drawn from them could be included in regular DSTI publications.	SSTC / OECD
***Internationalisation of R&D*:**	Work on R&D activities of foreign affiliates will be pursued, with the aim of measuring outward flows (in addition to the inward flows currently measured), and of regular updating. A new method will be tested for calculating the patents ownership/invention matrix. The use of these data in analytical work on international spillovers will allow further testing of their quality. In the future these indicators could be regularly published by the OECD.	BNB OECD - EAS
***Government support to R&D*:**	The synthetic indicator related to fiscal incentives will be extended to a broader set of countries by the middle of 1999. If results are deemed satisfactory, the index could be calculated on a regular basis. For the international classification of government support, this will be pursued to the limit that internal Secretariat resources are available. The outcome would be a set of indicators calculated on a regular basis (*e.g.* every two to five years). This could lead to a revision of the *Frascati Manual* which provides countries with guidelines for collecting information in comparable ways.	SSTC / OECD

The Activities of Foreign Affiliates (AFA) database provides detailed indicators on the presence of foreign affiliates in OECD countries (inward investment) and thus on the impact of international direct investment on their economies. The data indicate the increasing importance of foreign affiliates in the economies of host countries, particularly in production, employment, value added, research and exports, and provide vital backup for data on direct investment flows. These data are therefore highly complementary to the BSTS data on funds from abroad, which were until now the only indicator on internationalisation of R&D activities. The data relate to majority foreign-owned (+50 per cent) or minority foreign-owned (between 10 and 50 per cent) firms. The database contains 18 variables broken down by partner countries. It covers 34 manufacturing sectors and 13 OECD countries for the 1985-94 period. Data availability varies according to country. The sectoral breakdown is ISIC Rev. 2 and 17 variables are required (Number of enterprises/establishments; Number of employees; Gross output; Turnover; Wages and salaries; R&D expenditure; Number of researchers; Gross fixed capital formation; Total exports; Total imports; Intra-firm exports; Intra-firm imports; Gross operating surplus; Technological payments; Technological receipts; Stock of foreign direct investment; Capital under foreign influence).

The Bilateral Trade database (BTD) shows detailed trade flows by manufacturing industry from one country (or geographic area) to another. These trade statistics are of prime importance for the evaluation of international competitiveness and the computation of specialisation indices for high-tech industries. For each declaring country, exports to and imports from corresponding partner countries are supplied for the years 1970-95. The data have been aggregated from the OECD Statistics Directorate's Foreign Trade Statistics database and are presented in thousands of US dollars at current prices. Currency conversion tables for US dollar exchange rates and US PPPs are also provided.

The OECD **Input-Output database** provides internationally comparable input-output tables in both current and constant prices for several time points from 1970 to 1990, and for ten OECD countries: Australia, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, the United Kingdom and the United States. The unique features of this database are: its international comparability based on the use of a common industrial classification (ISIC Rev. 2, 36 sectors), which distinguishes between high-technology, trade-oriented industries such as pharmaceuticals, computers, communication equipment, automobiles and aircraft; the separation of transaction flows of goods and services by domestically produced and imported ones; and the inclusion of consistent capital investment flow matrices as supporting tables. As far as the evaluation of inter-industry R&D spillovers is concerned, input-output matrices are the only reliable, and internationally comparable, statistical tool.

Among the five above-mentioned indicators, Belgium is included only in the Bilateral Trade database.

Statistical priorities for Belgium

The aim of this section is to define priority areas in terms of future statistical developments that should be undertaken by Belgium, and more particularly the SSTC. The priority is defined as a trade-off between analytical and policy needs (as reflected in Belgian and OECD priorities), and the feasibility (or relative costs) of collecting these statistics. OECD requires either statistics that have been used intensely over a long time period, or new and appropriate statistics that are to be developed in the near future. The computing feasibility is determined with respect to the link with existing statistics (*i.e.* exploiting economies of scale and availability of basic data) and/or prospects in SSTC or other Belgian institutions. The focus is therefore essentially on indicators that are not currently available for Belgium. Existing statistics, or those that will be computed under the aegis of the OECD, are not tackled here.

- First of all is the analytical series of R&D expenditures in the business enterprise sector (ANBERD), which is to be completed for the beginning of 1999 and provided to EAS by a team composed of SSTC, RUCA and ULB. Closely associated with this data set is the STAN database, which is absolutely necessary for any structural analysis as well as for the ANBERD estimates and the computation of important indicators such as the ratio of R&D intensity. The BNB will be able to provide, during 1999, new retrospective series, with no missing sectors at the ISIC Rev. 3 disaggregation level, for the entire period covered in the STAN database (1970-97). In addition, the INS has launched a new survey that provides, from 1995 onwards, information similar to that included in the ANBERD and STAN databases, at a more disaggregated level. Although these series do not cover the period preceding 1995, they can be useful for methodological and comparison purposes.

- The current methodology developed by the Belgian teams (SSTC-RUCA-ULB) for the computation of the ANBERD series could be used to much greater advantage. Indeed, the raw micro-level databases have been cleaned of various errors (such as encoding errors and inconsistent replies) and include data on researchers and scientists, as well as on sources of finance. In addition, the R&D and value-added data is classified by firm size. In this respect, a second priority area would be the development of the ANRSE indicator (analytical series on researchers and scientists), which already exists for the G7 countries. In a similar vein, the BSTS data on researchers and scientists and on financing sources of R&D at the sectoral level (Tables 10.1 to 10.4; 12; and 13) could be at least partially completed. Finally, both the available data and the present EAS work on R&D investment by size of firm are significant factors which would benefit from the development of these series, at least at the macroeconomic level and by source of finance.

- The project on human resource mobility, although still at a preliminary stage, will most probably lead to new indicators that are expected to be highly appropriate for the analysis of S&T policies. A team composed of staff from ULB and KUL is currently investigating the available administrative databases and their suitability for such a project. Belgium would therefore be greatly advantaged by joining the group of core OECD countries for which a feasibility study is to be launched and co-ordinated by an expert.

Other priority areas, although less urgent than those listed above, are, along with the human resource mobility project, of prime importance in the framework of a long-term strategy. They can be divided into two separate, but closely linked, parts.

- The first is the project on government support to R&D, for which a pioneering analysis (see Young, 1988) has already been implemented. The next data collection exercise for this project might not be undertaken for a few years, therefore joining the exercise would not be particularly burdensome for the time being. Nonetheless, the gathering of the needed information is likely to be time-consuming, requiring more attention in the near future, especially regarding government support to infrastructure and the amount of actual R&D tax credits.

- The second part of this longer-term priority area relates to the firm-level database. If some of the most important tables of the *Basic Science and Technology Statistics* (BSTS) are to be filled over the forthcoming years, this will mean that the “micro questionnaire” will have to be adapted in terms of content and sampling coverage. An effective adjustment would allow information to be collected on the type of R&D (basic, applied, development) and the different sources of funding (private, government, international organisation, non-profit

institution, and funds from abroad). Second, new types of information could be added in order to meet the requirements of other projects. In this respect, three types of extension are worth noting. First, the firm-level questionnaire could be implemented in close conjunction with the Community Innovation Surveys (CIS). For instance, the CIS, which targets a large number of firms, could be used to improve the design of the sampling procedure for the R&D survey.[2] Second, data on the amount of R&D tax credit actually perceived would be useful for the project on government support to R&D. Third, information on foreign affiliates or on technology-based alliances would contribute to the project on internationalisation of R&D.

A possible outcome of these adjustments would be the construction of a new firm-level database that could be complemented with other data sources (such as balance sheets in BNB). Provided that this database covers a sufficiently large number of firms of different sizes over a long period, it would become a unique tool for policy analysis and academic research.

Table 4. **Statistical priorities**

	Short-term implementation	**To be set in motion**
SSTC	ANBERD => • ANRSE • BSTS (10.1-10.4, 12, 13) • R&D by size of firm	Human resource mobility Government support Micro questionnaire => • other tables of BSTS • CIS3 • Other
Bureau Fédéral du Plan	Input-output (1985)	
BNB	STAN FDI (sectoral breakdown)	AFA

Finally, some indicators regularly used for DSTI analyses are of lesser priority for SSTC because they are computed elsewhere. This is the case for data on foreign direct investment (FDI) by sector and the activities of foreign affiliates (AFA). Both databases are to be compiled under the aegis of the Belgian National Bank. The former will become available during 1999, while the latter will be partially completed in the medium term. Data concerning input-output matrices will also be made available on the Web site of the Bureau Fédéral du Plan by November 1998.

The regional dimension

As is the case for other OECD countries, Belgian science and technology policy competencies are regionalised. However, the S&T indicators computed from firm-level surveys are generally performed in co-ordination. A co-ordination group (*Groupe Fédéral de Concertation*) ensures homogeneity with respect to the sampling procedure in each region (*Inventaire permanent du potentiel scientifique*) and with respect to the basic questions to be asked. Some regional divergences might appear for complementary information.

Whether or not the micro-level questionnaire is modified (for instance with respect to new statistics and a new sampling process), a concerted approach should be maintained for three main reasons. First, it would secure regional comparability and hence allow for macro-level aggregated data of high quality. Second, the range of indicators would be more similar and allow Belgium to better participate in international statistical bodies, such as the OECD. Third, closer co-ordination would lead to positive interaction

between federal and regional teams. Since the regional authorities need and produce regional S&T statistics, it might be appropriate to strengthen a collaborative frame for the construction of aggregate and regional statistics. The required homogenous regional data would be more easily achieved in a top-down structure. Indeed, a bottom-up approach is more likely to cause inconsistencies across regions, such as those that could arise from the use of different data processing and extrapolation techniques.

Concluding remarks and recommendations

Belgian S&T indicators produced or used in the OECD Directorate for Science, Technology, and Industry are missing from some important databases. For instance, less than 40 per cent of the Basic Science and Technology Statistics are available, and then often only partially. In the STAN database, 15 high- to medium-tech sectors out of about 40 industrial sectors are missing, while no data whatsoever are available in the analytical databases on business R&D expenditures and researchers and scientists (ANBERD and ANRSE). The situation is similar for specific databases or ongoing projects such as input-output matrices, data on foreign direct investments and activities of foreign affiliates.

This report inventories the availability of the main Belgian S&T indicators and suggests priority areas that would allow Belgium to catch up with respect to the main OECD countries. These priority areas are defined with respect to: *i)* OECD's most important S&T statistics and indicators; *ii)* recent progress in SSTC and other Belgian institutions; and *iii)* OECD future plans in terms of new indicators.

The main observations and recommendations are:

- The number of available statistics and indicators for Belgium will be much higher from 1999 onwards since the SSTC and other Belgian institutions will be able to provide complete data for the STAN and ANBERD databases, foreign direct investments by sectors, and an input-output matrix.
- The data sets and methodological framework developed to compute the ANBERD database provide a strong foundation that would allow, at relatively low cost, the construction of the ANRSE database, some of the BSTS tables, and series on R&D by size of firms.
- Belgium should join the group of core countries for which a feasibility study on the mobility of human resources is to be launched. The indicators that are likely to be produced through this project are expected to be highly useful for economic policy analysis. Similarly, substantial attention should be devoted to indicators related to government support to industrial R&D. This latter project might take its second step in the near future.
- The "micro questionnaire" (R&D survey) sampling procedure could be implemented in the light of the CIS questionnaires and extended to comprehend complementary information related to new projects (such as government support to R&D). The synergy between the two questionnaires would lead to an improvement in the response rate.
- The information contained in the "micro questionnaire", the Community Innovation Surveys and other Belgian databases could be used as the starting point for a new firm-level database. Over time this database would build up a rich and diversified data set, providing a unique tool for policy analysis and academic research.
- Closer collaboration between the regions would ensure fully homogenous regional data in Belgium.

NOTES

1. The sectors of performance are: business enterprise, government, higher education, and private non-profit; the sources of funds: business enterprises, direct government, higher education, private non-profit, and funds from abroad; the types of costs: labour costs, other current costs, land and buildings, and instruments and equipment, the types of activity: basic research, applied research, experimental development, and not specified; the socio-economic objectives: 14 objectives such as agriculture, energy, Earth atmosphere, and defence; and the main scientific fields: natural sciences and engineering and social sciences and the humanities.

2. Although the sampling methodology has improved twice since 1993, a well-defined and steady sampling procedure should be established.

Annex 1

ABBREVIATIONS

AFA	Activities of Foreign Affiliates database
ANBERD	Analytical Business Enterprise R&D database
ANPAT	Analytical Patents database
ANRSE	Analytical Researchers and Scientists database
ANTECH	Analytical Technology databases (ANBERD + ANRSE + ANPAT)
BE	Business enterprise sector
BEMP	Business enterprise R&D personnel
BERD	Expenditure on R&D in the business enterprise sector
BNB	Banque Nationale de Belgique
BSTS	Basic Science and Technology Statistics
DSTI	Directorate for Science, Technology and Industry
EAS	Economic Analysis and Statistics Division
FDI	Foreign direct investment
FTE	Full-time equivalent (on R&D)
GBAORD	Government budget appropriations or outlays for R&D
GDP	Gross domestic product
GERD	Gross domestic expenditure on R&D
GOVERD	Government intramural R&D expenditure
GUF	General university funds
HE	Higher education
HEMP	Higher education R&D personnel
HERD	Expenditure on R&D in the higher education sector
HRM	Human resource mobility
ICT	Information and Communication technology
INS	Institut National de Statistique
ISIC	International standard industrial classification
KUL	Katholiek Universiteit van Leuven
MSTI	Main science and technology indicators
NIS	National innovation system
NSE	Natural sciences and engineering
PNP	Private non-profit sector
R&D	Research and experimental development
RSE	R&D scientists and engineers, researchers
RUCA	Rijks Universitair Centrum Antwerpen
SSH	Social sciences and humanities
SSTC	Services fédéraux de la Politique Scientifique, Technologique et Culturelle
STAN	Structural Analysis database
TBP	Technology balance of payments
ULB	Université Libre de Bruxelles

For further explanations of the above terms, see the standard OECD methodology for the collection of R&D statistics, *The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of Research and Experimental Development— Frascati Manual 1993*, known simply as the "Frascati Manual".

REFERENCES

OECD (1993), *Frascati Manual: Proposed Standard Practice for Surveys of Research and Experimental Development*, Paris.

OECD (1995), "Canberra Manual: Manual on the Measurement of Human Resources Devoted to S&T", Paris, < http://www.oecd.org/dsti/sti/stat-ana/prod/eas_hrst.htm>.

OECD(1997*a*), "Oslo Manual: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data", Paris.

OECD (1997*b*), *Science, Technology and Industry, Scoreboard of Indicators*, Paris.

OECD (1997*c*), *The OECD STAN Database for Industrial Analysis*, Paris.

OECD (1998*a*), *Basic Science and Technology Statistics*, Paris.

OECD (1998*b*), *Technology, Productivity and Job Creation - Best Policy Practices*, Paris.

OECD (1998*c*), *Main Science and Technology Indicators, 1998/1*, Paris.

OECD (1998*d*), *Spotlight on Public Support to Industry*, Paris.

Rosengren, M. (1998), "The Circulation of Knowledge Embodied in Human Resources", mimeo, Paris.

Young, A. (1998), "Measuring Government Support for Industrial Technology", OECD working document, Paris.