Neglected Scientific Activities:
The (Non) Measurement of Related Scientific Activities

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Abstract

The measurement of science and technology is now fifty years old. However, few studies have studied the historical and sociological roots of S&T statistics. The paper looks at one aspect of the construction of the OECD Frascati manual: the concepts and methodologies used to define and measure R&D. The paper analyses the suggested definitions and measurements of R&D as a case of boundary-work. The OECD standards exclude what is called related scientific activities (RSA) from R&D. These activities are important activities, both quantitatively and qualitatively, but are not considered as such by most surveys.

The paper shows that one of the main reasons for exclusion is ideology: R&D is perceived as a higher order of research. Some countries, however, have an interest for these activities. It is shown that it is generally motivated by political considerations, such as the need for presenting a misleadingly high science and technology performance or for simply displaying one's methodological competence in the statistics of science and technology.

The measurement of scientific and technological activities (STA) is generally limited to research and development (R&D). However, scientific and technological activities comprise more than just R&D. In fact, in 1978 UNESCO drafted an international recommendation defining scientific and technological activities as composed of three broad types of activities: [1]

> 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. These include such activities as R&D, scientific and technical training and education (STET), scientific and technological services (STS) (p. 2).

A few years later, in a new chapter added to the Frascati Manual, the OECD appropriated the concept of STA. [2] The purpose, however, was not to measure STA as a whole, but "to distinguish R&D, which is being measured, from STET and STS which are not" (p. 15).

[1] UNESCO*, Recommendation Concerning the International Standardization of Statistics on Science and Technology*, Paris, 1978.

[2] OECD, *The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of Research and Experimental Development* (Frascati Manual), Paris, 1981: chapter 1.

This paper will focus on scientific and technological services (STS), often called related scientific activities (RSA), in order to understand why they are rarely measured.

RSAs are important scientific and technological activities. [3] They are concerned with the generation, dissemination and application of scientific and technical knowledge. Without these activities, several R&D activities would not be possible, or at least not possible in their current form: “the optimal use of scientific and technological information depends on the way it is generated, processed, stored, disseminated, and used” (p. 5). [4] In some countries, like Canada for example, RSAs amount to over a third of all scientific and technological activities.

As early as 1963, the first edition of the Frascati Manual recognized the centrality of these activities for a country: [5]

> R&D activities are only one part of a broad spectrum of scientific activities which include scientific information activities, training and education, general purpose data collection, and (general purpose) testing and standardization. Indeed, in some countries one or more of these related scientific activities may claim a larger share of material and human resources than R&D. It may well be desirable for such countries to begin their statistical inquiries by surveying one or more of these areas rather than R&D (p. 13).

However, numbers on RSA are not available in OECD statistical repertoires, which concentrates on R&D. In fact, numbers on RSA are almost completely unavailable because so few countries collect data on them. Besides Canada and Ireland - among OECD Member Countries - and some developing countries - mainly in Latin-America -, no country measures RSA today. These activities have nevertheless been discussed at length in each edition of the Frascati Manual since 1963.

[3] K. Messman (1975), *A Study of Key Concepts and Norms for the International Collection and Presentation of Science Statistics*, COM-75/WS/26, UNESCO: 33-34.
[4] UNESCO, *Guide to Statistics on Scientific and Technological Information and Documentation (STID)*, ST-84/WS/18, Paris, 1984.
[5] OECD, *The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of Research and Development*, Paris, 1963.

The paper attempts to explain why there is so little interest in measuring RSA. Discussions about RSA are rarely concerned with the measurement of these activities *per se*, but rather with how to better exclude them from the measurement of R&D. This is a perfect case of boundary-work: erecting boundaries in order to exclude things considered outside the field. Two theses will be discussed. First, and besides methodological difficulties, one of the main reasons why RSA were excluded from R&D is ideology: R&D was perceived as a higher order of research. No argument was needed to convince people of this hierarchy. It was taken for granted by almost everybody that "soft" activities like market studies or design, for example, were not R&D. This was the general understanding of the time. It explains, for example, why the social sciences and humanities would not be included in the Frascati manual before 1976. Such a community of views put the present study apart from those on the literature on boundary-work. These usually study how two (or more) groups are arguing about which one would dominate the field. [6]

The second thesis of the paper is that the little interest that does exist for RSA is generally motivated by political considerations, such as the need for presenting a misleadingly high science and technology performance or for simply displaying one's methodological competence in the statistics of science and technology. Again, this is different from previous studies. The groups that had an interest in RSA numbers did not tried to convince others. They went their own way, ignoring dominant trends. They failed, in the end, for reasons that have nothing to do with their case however. External factors prevented them to continue the work. But they did not totally fail. Most governments would soon start to measure intensively one type of RSA: innovation activities.

[6] R.G.A. Dolby (1982), On The Autonomy of Pure Science: The Construction and Maintenance of Barriers Between Scientific Establishments and Popular Culture, in N. Elias, H. Martins and R. Whitley (eds.), *Scientific Establishments and Hierarchies*, Dordrecht: Reidel Publishing: 267-292; D. Fisher (1990), Boundary Work and Science: The Relation Between Power and Knowledge, in S. Cozzens, T.F. Gieryn (eds.), *Theories of Science in Society*, Bloomington: Indiana University Press: 98-119; A. Holmquest (1990), The Rhetorical Strategy of Boundary-Work, *Argumentation*, 4: 235-258; T.F. Gieryn (1983), Boundary-Work and the Demarcation of Science From Non-Science: Strains and Interests in Professional Ideologies of Scientists, *American Sociological Review*, 48: 781-795; T.F. Gieryn (1999), *Cultural Boundaries of Science: Credibility on the Line*, Chicago: University of Chicago Press.

The paper is both a contribution to the sociology of measurement and a contribution to the boundary-work literature. As regard the first, it looks at how groups, here official statisticians – construct categories and numbers in order to respond essentially to the needs of the policy-makers. Boundaries were erected without much work or conflicts. [7] In the present case, this is because the field had been prepared decades ago by scientists and philosophers. [8] We have here an example of positivism on (government) statistics. As a contribution to the boundary-work literature, the paper shows how, with time, boundaries can evolve to the point where original demarcations collapse. [9]

The paper is part of a project on the history of science and technology statistics. It uses two methodologies. First, the main source of information comes from archival material. The main institutions involved in official science measurement in recent history - OECD, Unesco, the European Union – have all accepted to open their files to me from 1950 to 2000. This constitutes the core of the documents studied. To this, national sources were added when needed. For example, the NSF (and the National Science Board - NSB), as well as Canadian and British official publications were systematically studied over the same period. [10] Second, interviews were conducted with the main actors of the field. To date, nearly twenty persons have been interviewed from United States, United Kingdom, France, Canada, as well as the above three intergovernmental institutions. [11]

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[7] The thesis is in the same spirit as Barnes et al.'s comment: "scientists do not engage in the "social" activity of making boundaries. (…) [T]hey create and sustain boundaries in the course of, as part of the business of, doing science": B. Barnes, D. Bloor, J. Henry (1996), Drawing Boundaries, in *Scientific Knowledge: A Sociological Analysis*, Chicago: University of Chicago Press, p. 155.

[8] L. Laudan (1996), The Demise of the Demarcation Problem, in *Beyond Positivism and Relativism*, Boulder: Westview Press; C.A. Taylor (1996), *Defining Science: A Rhetoric of Demarcation*, Madison: University of Wisconsin Press.

[9] S.G. Kohlstedt (1976), The Nineteenth-Century Amateur Tradition: The Case of the Boston Society of Natural History, in G. Holton and A. Blanpied (eds.), *Science and Its Public*, Dordrecht: Reidel Publishing: 173-190.

[10] I want to thank Mary-Ann Grosset from the OECD Documentation Center in Paris and Mary Carr from the Institute of European Studies in Florence. Also, the Canadian delegation at OECD, the personnel of the Institute of Statistics of Unesco, among them Denyse Levesley and Shiu-Kee Chu, as well as Rolf Lehming (Science Resources Studies Division) and Stephanie Bianci (Center of Documentation) from the NSF, and the personnel of the National Science Board (D.E. Chubin and S.E. Fannoney) deserves many thanks for their collaboration in helping for access to documents.

[11] I want to thank sincerely the following persons for having accepted to spend some time with me and for commenting on previous drafts of the present paper: A. King, C. Freeman, A. Young, G. Westrom, J.-J. Salomon, C.Falk, K. Arnow, P. Hemily, D. Gass, J. Bond, G. McColm, H. Stead, Al Seymour, H. Brooks, K. Smith, G. Muzart, M. Beckler, A. Wycoff, K. Pavitt, G. Sirilli.

The first part of the paper deals with the way RSAs were introduced in the first edition of the Frascati Manual. It shows that RSAs were considered an integral aspect of what ought to be measured in statistics of science and technology. The second part explains the origins of the concept. It would appear that Canada and the U.S. National Science Foundation (NSF) were the forerunners in developing it. They had few imitators among other OECD countries however. The third part argues that UNESCO replaced the OECD in the early 1980s in the development of standards for collecting RSA statistics. UNESCO's efforts were short-lived however. Finally, the last part of the paper describes how a specific kind of RSA, the kind performed by firms, gained recent political attention and became a measurement priority under the banner of innovation activities.

How to Define R&D?

One surprising aspect of the first edition of the Frascati Manual is the absence of a specific definition of the concept of research. [12] Categories or types of research activities were defined in precise terms (basic, applied, and development), but the following definition of R&D would not appear until the second edition of the Manual (1970): "creative work undertaken on a systematic basis to increase the stock of scientific and technical knowledge and to use this stock of knowledge to devise new applications" (p. 8). In the 1963 edition, research was essentially contrasted with routinized work:

> The guiding line to distinguish R&D activity from non-research activity is the presence or absence of an element of novelty or innovation. Insofar as the activity follows an established routine pattern it is not R&D. Insofar as it departs from routine and breaks new ground, it qualifies as R&D (p. 16).

As early as 1963, the Manual dealt extensively with boundaries (frontiers) between routinized work and R&D: "Definitions are not sufficient in themselves. It is necessary to amplify them by standard conventions, which demarcate precisely the borders between

[12] This was the standard practice in UK and France at the time. See J.C. Gerritsen et al., *Government Expenditures on R&D in the United States of America and Canada: Comparisons with France and the United Kingdom on Definitions Scope and Methods Concerning Measurement*, OECD: Paris, DAS/PD/63.23.

research and non-research activities" (p. 12). The Manual distinguishes R&D from two other types of activities: related scientific activities and non-scientific activities (of which industrial production is perhaps the most important). It is here that the main differences are said to exist between Member countries. [13]

According to the 1963 Frascati Manual, related scientific activities fall into four classes: 1) scientific information (including publications), 2) training and education, 3) data collection, and 4) testing and standardization (p. 15). Non-scientific activities are of three kinds: 1) legal and administrative work for patents, 2) testing and analysis, 3) other technical services (p. 16).

The Manual stated that RSAs must be excluded from R&D unless they serve R&D directly (p. 16), and adds that: "It is not possible here to make a detailed standard recommendation for related scientific activities (…). The objective of this manual is to attain international comparability in the narrower field of R&D (…). Arising from this experience, further international standards can be elaborated by the OECD for related activities" (pp. 14-15). The Manual nevertheless recommended that:

> All calculation of deductions for non-research activities of research organizations, and of additions for R&D activities of non-research organizations should be made explicit, that is to say, recorded both by individual respondents and by those compiling national totals from the data furnished by individual respondents. Furthermore, whenever possible, related scientific activities such as documentation and routine testing, should be measured simultaneously with R&D and reported separately (p. 14).

The recommendation was soon abandoned. In 1967 OECD concluded that: "these activities necessitate the formation of an *ad hoc* study group to elucidate the main problems which arise in measuring these activities". [14] Consequently, the suggestion to measure RSA was dropped. The second edition of the Manual (1970) concentrated on R&D and no study group was ever created: "We are not concerned here with the problem

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[13] Concerning the difficulties before the OECD standard, see for example: National Resources Committee (1938), *Research: A National Resource*, New York: Arno Press, 1980, vol. 1: pp. 6, 61-65; volume 2: 5-8, 173; Steelman, J.R. (1947), *Science and Public Policy*, New York: Arno Press, 1980: pp. 73, 300-302; National Science Foundation (1959), *Methodological Aspects of Statistics on R&D Costs and Manpower*, Washington.

[14] OECD, SP(67)16, p. 9.

of measuring R&D related activities but with the conventions to be used to exclude them when measuring R&D activities" (p. 14).

The second edition of the Frascati Manual was in fact the first step in a long series of boundary work. In 1970, the list of RSAs excluded from R&D extended to seven classes (pp. 14-15): 1) scientific education, 2) scientific and technical information (itself subdivided into six subclasses, and into eight in 1976), 3) general purpose data collection, 4) testing and standardization, 5) feasibility studies for engineering projects, 6) specialized medical care, 7) patent and license work. Policy related studies were added in the 1976 edition, and routine software development in 1993 (Annex 1 provides the list of activities and boundaries drawn in the five editions of the OECD Frascati Manual).

Over this period, the OECD nevertheless adopted the UNESCO concept of scientific and technological activities (STA). The 1981 edition of the Frascati Manual evoked the UNESCO recommendation on scientific and technological activities (STA), and suggested modifications: the OECD's list of STAs is composed of seven classes instead of the nine as recommended by UNESCO (Figure 1). [15]

The adoption of the concept of scientific and technological activities in the OECD Manual in 1981 appeared only in the introductory chapter "addressed principally to non-experts and (…) designed to put them in the picture" (p. 13). It had correspondingly few consequences on measurement. One novelty, however, had profound effects: the definition of innovation. The OECD added the concept of innovation to the three classes of activities defining STA. Before turning to the concept, however, we will examine the origins of the concepts of STA and RSA.

[15] OECD (1981) includes museums in R&D rather that in RSA, for example, because they often perform R&D (p. 15).

What Are Scientific Activities?

The concept of research or scientific activities dates from 1938, whereas the precursor to the concept of RSA – background research - appeared in 1947. Before that time, people spoke simply of research or science, or increasingly of R&D.

Figure 1.
Related Scientific Activities According to UNESCO and OECD

UNESCO (1978)	OECD (1981)
Libraries	S&T information services
Translation, editing	
Data collection	General purpose data collection
Testing and standardization	Testing and standardization
Patent and license activities	Patent and license work
Surveying	
Prospecting	
Counceling	
Museums	
	Policy related studies
	Feasibility studies
	Specialized medical care

In 1938, the U.S. National Research Council (NRC) that introduced the concept of research <u>activities</u> in 1938 in its report on government science entitled *Research: A National Resource*. [16] The report defined research activities as "investigations in both the natural and social sciences, and their applications, including the <u>collection, compilation, and analysis of statistical, mapping, and other data</u> that will probably result in new knowledge of wider usefulness" (p.62). The report recognized that: "the principal conflicts of opinion about the definition used in this study have revolved around the inclusion of the following activities as research" (p. 62): collection and tabulation of

[16] National Resources Committee (1938), *Research: A National Resource*, New York: Arno Press, 1980.

basic data, economic and social studies, mapping and surveying, library and archival services. But it concluded that: "part of the difficulty with the adopted definition of research is due to attempts to distinguish between what might be designated as the "higher" and "lower" orders of research without admitting the use of those concepts" (p. 62). It added: "it would probably be instructive to obtain separate estimates for these two "orders" (…). However, such a separation has proven impractical because of the budgetary indivisibility of the two types of research processes" (p. 62).

Ten years later, the Steelman report *Science and Public Policy*, written at the request of U.S. President H. Truman, borrowed the term <u>background</u> research from J. Huxley to define the activities identified by the NRC: "background research is the systematic <u>observation, collection, organization, and presentation of facts</u>, using known principles to reach objectives that are clearly defined before the research is undertaken, to provide a foundation for subsequent research or to provide standard reference data" (p. 300). [17] This kind of activities was identified as such because the survey was concerned with government research: background activities are "proper fields for Government action" (p. 312), as already observed in the Bush report (p. 82). [18] Since then, RSAs have been measured, during the few times that they were measured, for government activities only.

For both the NRC and Steelman, the identification of specific activities besides R&D served only to define what was to be included in the measurement of research. There was no breakdown of data according to the different types of activities. We owe to Canada and the NSF the first measurements of related scientific activities.

As early as 1947, the Canadian Department of Reconstruction and Supply, in a survey on government research conducted with the Canadian NRC, defined <u>scientific activities</u> as the sum of three broad types of activities: research (itself composed of pure, background, and applied), development, analysis and testing (p. 13). [19] Again, as in the Steelman

[17] J.R. Steelman (1947), *Science and Public Policy*, New York: Arno Press, 1980.
[18] V. Bush (1945), *Science: The Endless Frontier*, North Stratford: Ayer Co., 1995.
[19] Department of Reconstruction and Supply, *Research and Scientific Activity: Canadian Federal Expenditures 1938-1946*, Government of Canada: Ottawa, 1947.

report, the background category served only to specify what goes into the measurement of research expenditures. No specific numbers were produced "because of the close inter-relationship of the various types of research undertaken by the Dominion Government" (p. 16), that is: because of the difficulty of separating R&D and RSA in available statistics. However, numbers were produced for a new category of activities: it was reported that 12% of scientific activities in Canada were devoted to (routine) analysis and testing (p. 25), activities usually not measured in R&D surveys but excluded. [20]

The NSF continued to innovate, while Canada performed no further surveys of government R&D until 1960, by which time the Canadian Dominion Bureau of Statistics had assimilated the NSF definitions.

From the beginning of the 1950s, the NSF conducted regular surveys of government research. The results were published in a document titled *Federal Funds for Science*. [21] R&D data included "other scientific activities" (or RSA), as did most surveys conducted at the time in other countries. [22] But they were not separated from R&D. Then in 1958, the NSF published *Funds for Scientific <u>Activities</u> in the Federal Government*. [23] The publication was, among other things, a reanalysis of the 1953-54 data. Scientific activities were discussed and defined as the "creation of new knowledge, new applications of knowledge to useful purposes, or <u>the furtherance of the creation of new knowledge or new applications</u>" (no page number). The activities were broken down into seven classes, the first three defining R&D and the last four defining "other scientific activities": [24] R&D, planning and administration, plant, data collection, dissemination of scientific information, training, testing and standardization. It was estimated that "other scientific activities" amounted to $199 million, or 7,8% of all scientific activities. Of these, data

[20] See for example: Work Projects Administration, *Reemployment Opportunities and Recent Changes in Industrial Techniques*, National Research Project, Report no. 4, Pennsylvania : Philadelphia, 1940, p. 2.
[21] National Science Foundation, *Federal Funds for Science*, Government Printing Office: Washington, 1953.
[22] See: J.C. Gerritsen, *op. cit*.
[23] National Science Foundation, *Funds for Scientific Activities in the Federal Government, Fiscal Years 1953 and 195*4, NSF-58-14, Washington, 1958.
[24] These are the four activities later included in the first edition of the Frascati Manual.

collection was responsible for nearly 70%, but information (6,5%) was said to be largely underestimated by a factor of at least three.

Subsequent editions of *Federal Funds for Science* (renamed *Federal Funds for R&D and Other Scientific Activities* in 1964) thereafter included data on "other scientific activities". But these were restricted to only two categories: scientific and technical information, and, for a shorter period, general purpose data collection. Over time, detailed sub-classes were developed for each of these categories, reaching a zenith in 1978 when scientific and technical information (STI) alone had four subclasses, which were in turn subdivided into eleven other subclasses (p. 43) (Figure 2). [25]

Figure 2.
Scientific and Technical Information (STI)
According to NSF (1978)

Publication and distribution
- Primary publication
- Patent examination
- Secondary and tertiary publication
- Support of publication

Documentation, reference and information services
- Library and reference
- Networking for libraries
- Specialized information centers
- Networking for specialized information centers
- Translations

Symposia and audiovisual media
- Symposia
- Audiovisual media

R&D in information sciences

[25] National Science Foundation, *Federal Funds for R&D and Other Scientific Activities: Fiscal Years 1976, 1977, 1978*, 78-300, Washington, 1978.

The NSF stopped publishing data on "other scientific activities" with the 1978 edition of *Federal Funds*. It measured these activities for the last time in a three-volume report entitled *Statistical Indicators for Scientific and Technical Communication* written by King Research Inc. and published by its Division of Scientific Information. [26] That was NSF's testament, although the research was initially contracted "to develop and initiate a system of statistical indicators of scientific and technical communication" (p. V). [27] Why did NSF abandoned the measurement of RSAs?

The first reason has to do with the <u>magnitude of the activities</u>. Over the period 1958-1978, the surveys reported that information and data collection represented only about 1% to 2% of the Federal Government scientific activities. A survey of such a low volume of activities was not considered worth the effort. [28]

Not worth the effort considering that, secondly, the NSF began publishing *Science Indicators (SI)* in 1973. [29] Everyone applauded the publication, including Congress and the press. Among the indicators that soon appeared in *SI* were what were considered to be good statistics on scientific information - at least as far as the United States was concerned: <u>bibliometric indicators</u>. For fifteen years, the United States was indeed the only country to produce such statistics regularly. [30] For the NSF, the counting of publications became the main indicator for measuring scientific information.

Thirdly, over time people became more interested in <u>technologies</u> associated with information and communication activities. Despite work by Bell, Porat and Machlup on the information society, surveys increasingly focused on infrastructure and hardware. Over time, indicators on information technologies began replacing indicators on

[26] National Science Foundation, *Statistical Indicators of Scientific and Technical Communication: 1960-1980*, three volumes, Washington, 1976.
[27] Some of the statistics from the report were included in NSF, *Science and Engineering Indicators* (1976), Washington, 1977, 59-63.
[28] A survey on STI in industry was also planned as early as 1964 but was never, to the best of my knowledge, conducted. In 1961, however, the NSF conducted the first survey on publication practices in industry. But the survey was more concerned with measuring basic research that RSA. See: NSF (1961), *Publication of Basic Research Findings in Industry, 1957-59*, NSF 61-62, Washington.
[29] National Science Foundation, *Science Indicators: 1972*, Washington, 1973.
[30] F. Narin et al., The Development of Science Indicators in the United States, in B. Cronin and H.B. Atkins, *The Web of Knowledge: A Festschrift in Honor of Eugene Garfield*, Medford: Information Today Inc, 2000: 337-360.

information activities (see for example the last two editions of the NSF's *S&E Indicators*, which include a whole chapter on information technologies).

This was also the case for the OECD. The OECD concerns with STI goes back to 1949 when the OEEC – the predecessor of OECD – set up a working party on scientific and technical information. The group was concerned mainly with exchange of scientific information between countries, including the USSR, and conducted, under the coordination of the British Central Office of Information, an international inquiry on the use made of scientific and technical information by more than 2 000 small and medium firms. [31] In 1962, the newly created OECD set up an *ad hoc* group of experts on STI, chaired by a NSF representative. The group performed pilot surveys on STI facilities in 1963-1964, [32] and recommended that data on resources devoted to STI be collected as part of subsequent R&D surveys. [33] An Information Policy Group (IPG) was created in 1964 that reported again on the need for data. [34]

These desiderata were finally heard by the Directorate of Scientific Affairs. In 1968, it recommended that governments should give high priority to the task of measuring STI and offered proposals for a specific survey "to supply governments with a solid statistical foundation on which to build their national policy". [35] To that end, the Heidelberg Studiengruppe fur Systemsforschung was contracted to developed a methodological document on STI statistics. [36] STI activities were extensively defined in line with the NSF definition discussed above - and not yet concerned, as we will see shortly with later surveys, exclusively with technologies.

[31] EPA (1958), *Technical Information and the Smaller Firm: Facts amnd Figures on Practices in European and American Industry*, Paris; EPA (1959), *Technical Information and Small and Medium Sized Firms: Methods Available in Europe and the United States, Numbers and Facts*. The survey was followed by another one in 1960 concerned with suppliers of information: EPA (1960), *Technical Services to the Smaller Firm by Basic Suppliers: Case Studies of European and American Industry*, Paris.
[32] OECD, SR(64)38.
[33] OECD, SR/M(63)2; OECD, SR(65)15.
[34] OECD, SR(65)51.
[35] OECD (1968), *Survey of STI Activities*, DAS/SPR/68.35, p. 2.
[36] OECD (1969), *The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of STI Activities*, DAS/STINDO/69.9, Paris.

Early on, the manual was tested in Norway and vehemently criticized at a meeting in Oslo in 1971, [37] particularly by countries where surveys were already conducted. The manual was qualified as too complicated and too clumsy and not providing governments with enough basic statistical data to formulate an STI policy. [38] In 1973, the policy group on STI concluded that "before fixing on such a methodology, it is necessary to identify the essential data and to define the indicators that are needed". [39]

To this end, the IPG set up a steering committee on indicators for STI in 1974. Adopting, again, the NSF definition then in vogue for measuring information and communication, the committee soon proposed a list of five classes of indicators, some of them already collected, "to assist countries to manage their information policy" (p.3): 1) financial resources allocated to STI, 2) manpower, 3) information produced (publications, services, libraries, congress) and used, 4) computers and communication, and 5) potential users. [40]

The two instruments – the methodological manual and the list of indicators - produced by the OECD were never used to add statistics for measuring science and technology in general or RSA in particular. First, as it developed, the IPG gained autonomy and distanced itself from R&D policies. The Piganiol report criticized the tendency as early as 1971: "The scope of the IPG has been too narrow, for it has focused primarily on mechanisms and interfaces between components of the international network and has not given sufficient attention to broader issues (…)". [41] The IPG was concerned mainly with information policy *per se* - that is with government support to STI. In line with this direction, and beginning in the early 1970s, the OECD started publishing a series of *Reviews of National Scientific and Technical Information Policy* (Ireland, Canada, Spain, and Germany). The reviews were qualitative rather than quantitative in nature.

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[37] OECD (1972), *Notes on the Meeting of Countries Collecting Statistics on Resources Devoted to STI*, DAS/STINFO/72.22.
[38] OECD (1973), *Collection of Statistical Data on STI*, DAS/SPR/73.94 (A); OECD (1973), *Economics of Information*, DAS/STINFO/73.18.
[39] OECD (1973), *Economics of Information*, DAS/STINFO/73.18, p. 3. In that same year, the result of a study on information needs and resources conducted with bilbiometric data was published by the IPG: G. Anderla (1973), *Information in 1985: A Forecasting Study of Information Needs and Resources*, Paris: OECD.
[40] OECD, DAS/STINFO/74.28.
[41] OECD, *Information for a Changing Society*, Paris, 1971.

Second, the OECD was increasingly concerned with a very large definition of information, a definition covering all sectors of the "information society", not just science and technology. In the first statistical survey of information and communication conducted in nine Member Countries, the definition of information included teachers, managers, journalists, arts, etc. [42] (These were specifically excluded from the OECD manual on STI in 1969). It was shown that a third of the active population worked in these professions.

Third, the study for information as an activity rapidly became the study of information as a commodity and gave rise to a new fad for measuring technologies associated with information and communication. [43] The interest in these matters goes back to 1969, i.e. when the DSA set up an expert group to conduct a survey on computer utilization. [44] Few years later, a program of work in the Information, Computers and Telecommunications field was set up, [45] and a committee on information, computer and communication policy (ICCP) was created in 1977. From then on, the OECD performed several quantitative studies on information and telecommunication technologies and, starting in 1979, published a whole series of documents concerned, among other things, with the statistical aspects of information and communication technologies (see Annex 2).

Among OECD countries, only Ireland and Canada pursued the measurement of STI. Canada had, since 1960, always measured RSA in its surveys of government scientific activities. Similarly, Ireland still collects information on RSA, and even developed specific statistics on STI in the early seventies, [46] statistics that became a *de facto* standard for Unesco when it contracted the development of its STI guide to an Irish consultant.

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[42] OECD, *Information Activities, Electronics and Telecommunications Technologies*, volume 1, Paris: 1981, Table 1.
[43] This tendency was criticized as early as 1968 by the Canadian delegate for example. See OECD, C(68)147, annex II.
[44] OECD (1969), *Expert Group on Computer Utilization: Outline of the Study*, DAS/SPR/69.1.
[45] OECD (1975), *Information, Computers and Telecommunications: A New Approach to Future Work*, DSTI/STINFO/75.22.
[46] National Science Council, *Scientific and Technical Information in Ireland: A Review*, Dublin, 1972; National Science Council, *Scientific and Technical Information in Ireland: Financial Resources Devoted to STID in Ireland, 1975*, Dublin, 1978.

The International Politics of Numbers

Despite the OECD's retreat from the field of RSA, statistical innovations continued to appear and UNESCO took over as the main player in RSA measurement. Not only did UNESCO resurrect the concept of scientific activities in 1978, at least at the international level, but it also published reflections on RSAs and imitated the OECD practice of dedicated manuals.

Why did UNESCO get involved in the measurement of RSA? The official argument offered in document after document is the contribution of these activities to science and technology:

> The priority given to R&D in data collection is only a matter of expediency, and does not mean that the importance of an integrated approach to R&D seen within a full context of educational and other services is underestimated. One may even argue that it is only in close conjunction with these services that R&D can be meaningfully measured – because they are indispensable for research efficiency (…) and should precede rather than follow the emergence of R&D in a country. [47]

According to UNESCO, surveying national scientific and technological potential (STP) "should not be limited to R&D but should cover related scientific and technological activities (…). Such activities play an essential part in the scientific and technological development of a nation. Their omission from the survey would correspond to a too restricted view of the STP and would constitute an obstacle to the pursuance of a systematic policy of applying science and technology to development" (p.21). [48] The obstacle was perceived to be bigger in developing countries because of their reliance on knowledge produced elsewhere, that is: on knowledge transfer.

> What would be the use of transfer of technology or knowledge derived from R&D if the countries to which they were passed lacked the infrastructure necessary to make them operational? [49]
>
> Programmes of R&D in the developing countries are not sufficient to guarantee a rise in the scientific and technological activities of a country. In addition to those important activities it has been found necessary to create an infrastructure of scientific and

[47] Z. Gostkowski, *Integrated Approach to Indicators for Science and Technology*, CSR-S-21, Paris: UNESCO, 1986, p. 2.
[48] UNESCO, *Manual for Surveying National Scientific and Technological Potential*, NS/SPS/15, Paris, 1970.
[49] J.-C. Bochet, *The Quantitative Measurement of Scientific and Technological Activities Related to R&D Development: Feasibility Study*, CSR-S-4, Paris: UNESCO, 1977, p. 5.

> technological services which, on the one hand, support and aid R&D proper, and on the other hand, serve to bring the results of R&D into the service of the economy and the society as a whole. [50]

It was therefore essential to assess the activities involved in the collecting and diffusing of scientific information. The *World Plan for Action for the Application of Science and Technology to Development* indeed stressed the need for such a survey as early as 1971. [51]

But there were other reasons why UNESCO became interested in RSAs. First, the OECD surprised UNESCO when, in 1963, it published a standard practice for conducting R&D surveys. [52] As early as 1960, UNESCO was trying to assess resources devoted to science and technology in developing countries. [53] It was also aware of the difficulties of comparing data from different countries. Was is not UNESCO's role to deal with international standards? [54]

If UNESCO wanted to get into the field of science and technology measurement, it needed to distinguish itself. It did so by taking the concept of scientific and technical activities (STA) more seriously than did the OECD. This led to the 1978 recommendation, but also to manuals on scientific and technological potential (STP), [55] on the social sciences, [56] and on education and training. [57]

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[50] J.-C. Bochet, *The Quantitative Measurement of Scientific and Technological Activities Related to R&D Development*, CSR-S-2, Paris: UNESCO, 1974, p. I.
[51] UNESCO, *World Plan for Action for the Application of Science and Technology to Development*, New York, 1971.
[52] According to C. Freeman, "UNESCO was a bit miffed" (personal conversation).
[53] UNESCO (1968), *General Surveys Conducted by UNESCO in the Field of Science and Technology*, NS/ROU/132, Paris; W. Brand, *Requirements and Resources of Scientific and Technical Personnel in Ten Asian Counties*, ST/S/6A, Paris: UNESCO, 1960. See also: UNESCO, *Provisional Guide to the Collection of Science Statistics*, COM/MD/3, Paris: 1968, chapter 1.
[54] By 1958, UNESCO had already produced standards for education and was working on further standards for periodicals (1964) and library (1970).
[55] UNESCO, *Manual for Surveying National Scientific and Technological Potential*, NS/SPS/15, Paris, 1970.
[56] UNESCO, *The Measurement of Scientific Activities in the Social Sciences and the Humanities*, CSR-S-1, Paris, 1971.
[57] UNESCO, *Proposal for a Methodology of Data Collection on Scientific and Technological Education and Training at the Third Level*, CSR-S-15, Paris, 1982.

These manuals were supported by a series of reflections on RSA in the mid seventies. UNESCO produced two studies on RSA. [58] In a perceptive comment, the author noted that "there does not seem to be any positive criterion by which activities related to R&D (are) defined" (p. 2). The OECD definition currently in use was based on a negative criterion: RSA consisted in scientific and technological activities that were not innovatory in nature. J.-C. Bochet suggested three other definitions, more positive in nature (p. 2). He defined RSAs as:

1. Activities which, whilst not being actually innovatory in character, form the infrastructure necessary for the effectiveness of R&D;

2. Activities which, within the framework of science and technology, maintain the continuity of the routine competence necessary for R&D activity, although not playing a direct part in it;

3. Activities which, whilst not being innovatory in character, have, in varying degrees, connections with R&D activities, created according to circumstances, either internally or externally to R&D.

From these reflections came a guide on scientific and technical information and documentation (STID) drafted in 1982, tested in seven countries, and published in provisional version in 1984. [59] The guide was based on a study written for UNESCO in 1979 by D. Murphy from the Irish National Science Council. [60] The guide defined STID as "the collection, processing, storage and analysis of quantitative data concerning information activities (…)" (p. 5). The principal items to be measured were the institutions and individuals performing these activities, the amount of financial resources and physical facilities available, and the quantity of users" (p. 5). Three types of respondents were identified: 1) producers, 2) collectors, processors and disseminators,

[58] J.-C. Bochet, *op. cit*.
[59] UNESCO, *Guide to Statistics on Scientific and Technological Information and Documentation (STID)*, ST-84/WS/18, Paris, 1984.
[60] D. Murphy, *Statistics on Scientific and Technical Information and Documentation*, PGI-79/WS/5, Paris: UNESCO, 1979.

and 3) users (p. 6). The first stage of measurement was to collect information on the second type of institutions only (pp. 8-10):

- specialized libraries and centres,
- national libraries and libraries of higher education, referral centres,
- editing, publishing, printing, consulting and advisory services and enterprises.

From this brief history, one can see that UNESCO recommended and worked for the measurement of RSAs, but at the same time restricted the range of RSAs to only one item: STI. One reason for this decision was the availability of data on these activities: other divisions of the UNESCO Institute of Statistics collected information on communication. [61]

There was without doubt a second reason why UNESCO got involved in RSA methodology, however. Its interest in RSA was in fact the consequence of its basic goal of extending standardization beyond industrialized (OECD) nations. The first step in that program, initiated in 1967, was Eastern Europe. As early as 1969, UNESCO published a paper titled *The Measurement of Scientific and Technical Activities*. [62] The document was concerned with the standardization of data between Western and Eastern Europe (p. 7) and with the necessity of measuring RSA (p. 10): [63] "La R&D ne constitue qu'un des éléments de la gamme continue d'activités scientifiques et techniques (…). Il est essentiel, à notre avis, de concevoir dès le départ l'ensemble du système comme un tout et de commencer à mettre en place le cadre nécessaire à l'établissement d'un système viable de rassemblement des données qui embrasse tout le domaine de la science et de la technique » (p. i). The document led to a guide [64] and a manual on S&T statistics. [65] The UNESCO manual was in fact a duplicate of the Frascati Manual. Indeed, the following

[61] See Z. Gostkowski, *op. cit*, pp. 11-17.
[62] C. Freeman, *The Measurement of Scientific and Technical Activities*, ST/S/15, Paris: UNESCO, 1969.
[63] The English version of the document is lost.
[64] UNESCO, *Guide to Statistics on Science and Technology* (third edition), ST.84/WS/19, Paris, 1984.
[65] UNESCO, *Manual for Statistics on Scientific and Technological Activities*, ST-84/WS/12, Paris: 1984: p. 6.

statement appeared in the manual's provisional edition (1980): "differences arising from this wider scope have very little effect on the key fundamental concepts (…)" (p. 13).

What was peculiar to Eastern countries at the time was the fact that R&D was not designated as such. The USSR, for example, put all its statistics on science and technology under the heading "science". [66] Moreover, government science, for example, included training, design, and museums. UNESCO thus had to choose between two options for standardization: follow the OECD and concentrate on R&D, or measure as in Eastern Europe, both R&D and RSA. The last option prevailed.

In attempting to statistically accommodate Eastern Europe, UNESCO's efforts were guided as much by the desire to generate a large range of standardization than the OECD as by an interest in RSA *per se*. But the program for including Eastern Europe failed, [67] and UNESCO never collected data on RSA. Why? The reasons are many.

First, UNESCO itself concentrated on R&D. The activity was said to be easier to locate and to measure, and had the virtue of being an <u>exceptional contribution</u> to science and technology. Hence, while UNESCO pushed for the concept of RSA, it simultaneously argued for the centrality of R&D. Here is one example, among many, of the rhetoric used:

> Because of the <u>unique ("exceptionnel"</u> in the French version) contributions that R&D activities make to knowledge, technology, and economic development, the human and financial resources devoted to R&D, which might be called the <u>core</u> of science and technology, are usually studied in greater detail (p. 6). [68]

Consequently, in 1978, the measurement of RSA was postponed to a second stage, still to come, of the measurement of science and technology: "Due to considerable costs and organizational difficulties, the establishment of a system of data collection covering at once the full scope of STS and STET in a country has been considered not practical.

[66] C. Freeman and A. Young, *The R&D Effort in Western Europe, North America and the Soviet Union*, OECD: Paris, 1965, pp. 27-30, 99-152; C. Freeman, *The Measurement of Scientific and Technical Activities*, ST/S/15, Paris: Unesco, 1969, pp. 7, 11-12.
[67] OECD took over the task at the beginning of the 1990s with a series of seminars, workshops and conferences held in 1993, 1995 and 1997.
[68] UNESCO, *Provisional Guide to the Collection of Science Statistics*, COM/MD/3, Paris: 1968, p. 6.

Some priorities have, thus, to be adopted for a selective and piecemeal extension of coverage of certain types of STS and STET". [69]

> First stage : during this stage, i.e. during the years immediately following the adoption of this recommendation (1978), international statistics should cover only R&D activities in all sectors of performance, together with the stock of SET and/or the economically active SET (…). Second stage: during that stage, the international statistics should be extended to cover STS and STET. Subsequently, the international statistics relating to STS and STET should be progressively extended to the integrated units in the productive sector. [70]

The second reason why UNESCO never collected data on RSA was related to the fact that few countries were interested in these activities. [71] A meeting of experts on the methodology of data collection on STID activities was held in 1985 to assess the lessons learned from the pilot surveys. [72] It was reported that STID activities were not deemed all that important or urgent, that the purpose for measuring them was not obvious, and that there were difficulties in interpreting the definition (pp. 26-29).

But the main reason why UNESCO failed in its efforts to measure RSA was because the United States left the organization in 1984. The decision had a considerably impact on the UNESCO Institute of Statistics in terms of financial and human resources. It led to the decline, almost disappearance, of UNESCO's in the measurement of science and technology.

The "Autonomisation" of RSA

In 1992, the OECD draft manual on human resources in science and technology (what would become known as the Canberra manual) suggested that the Frascati manual and UNESCO definitions of science and technology activities were too limited. As a result of the discussions during the workshop on the draft manual, it was decided that production activities should be included in statistics on human resources in science and technology.

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[69] Z. Gostkowski, *op. cit*, p. 1.
[70] UNESCO, *Recommendation Concerning the International Standardization of Statistics on Science and Technology*, Paris, 1978, pp. 10-13.
[71] The OECD first Users' Group (Silver Group) showed the opposite in 1973: a majority of countries were interested in RSAs. See: OECD (1973), *Report of the Ad Hoc Review Group on R&D Statistics*, SPT(73)14, Paris: pp.22-23.
[72] UNESCO, *Meeting of Experts on the Methodology of Data Collection on STID Activities*, 1-3 October 1985, Background Paper, ST-85/CONF.603/COL.1, Paris: 1985.

[73] This was only the first amendment to the historical exclusion of RSA from statistics on science and technology.

Since its first edition, the Frascati Manual dealt with another type of activity for which boundaries had to be drawn to distinguish it from R&D: non-scientific activities. According to the 1963 edition, non-scientific activities were composed of three items: legal and administrative work for patents, routine testing and analysis, and other technical services (p. 16). These activities had to be excluded from R&D.

The first two (patent work, routine testing and analysis) are the kinds of work that can be considered the industry equivalent of government RSA (indeed, patent work, for example, was transferred from non-scientific activities to RSA in the 1970 edition of the Frascati manual). These activities are "related activities which are required during the realization of an innovation" (p. 16). [74] That was, in fact, what the OECD formalized in 1981 when it introduced the concept of innovation in the introductory chapter of the Frascati Manual. Innovation was defined as:

> Transformation of an idea into a new or improved saleable product or operational process (p. 15). It involved all those activities, technical, commercial, and financial steps, other than R&D, necessary for the successful development and marketing of a manufactured product and the commercial use of the processes and equipment (p. 28).

More specifically, innovation was defined as an activity itself composed of the following six activities (p. 15-16):

1. new product marketing,
2. patent work,
3. financial and organization changes,
4. final product or design engineering,
5. tooling and industrial engineering,
6. manufacturing start-up.

[73] OECD (1993), Summary Record of the Workshop on the Measurement of S&T Human Resources, DSTI/EAS/M (93) 4, p. 5.
[74] OECD, *The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of Research and Experimental Development* (Frascati Manual), Paris, 1981.

Of all RSAs, these activities are the only ones in the history of OECD statistics on science and technology that were given a certain autonomy and a status equivalent to R&D (Figure 3): in 1992, in collaboration with the European Union (Eurostat), the OECD wrote a manual devoted specifically to the measurement of innovation – the Oslo Manual [75] (other manuals exist, but are not official publications). Based on innovation surveys that were conducted using the Oslo Manual, it is now estimated that non-R&D activities account for about a quarter of product innovation activities in firms [76].

The reasons for the interest of OECD and Member Countries in the measurement of innovation are obvious. Beginning in the mid seventies, scientific and technological policies were becoming increasingly interested in innovation rather than in support for science *per se*. Consequently, the current policy agenda of OECD Member Countries is mainly economic, where technological innovation is believed to be a key factor, if not the main one, contributing to economic growth.

Conclusion

As early as 1963, the OECD defined R&D in terms of the exclusion of routine activities. This was the main reason why RSA were dealt with at length in the Manual (other reasons are the methodological difficulties of separating R&D and RSA and the discrepancies in data between countries). There was no interest in RSA *per se*. It took fifteen years before a conceptual definition of RSA appeared in the Manual. Indeed, before the UNESCO recommendation, RSA were defined only as a list of activities, and there were abundant examples, and still are, for instructing the Manual's user on how not to include and measure RSA.

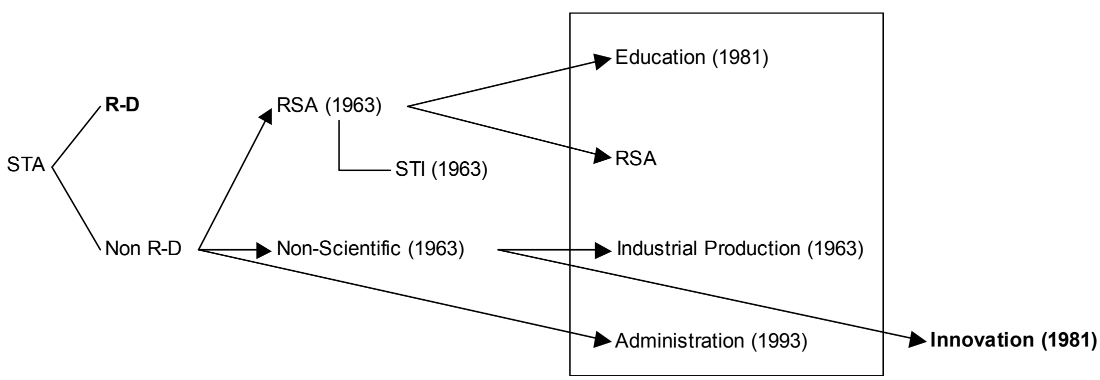
UNESCO was the last organization to invest in defining and measuring RSA in a systematic way. But its interest was, no more than that of OECD, in the activities themselves. Unesco had to find a niche where it could become a credible player in the

[75] OECD/Eurostat, *Proposed Guidelines for Collecting and Interpreting Technological Innovation Data* (Oslo Manual), Paris, 1997. Other manuals exist, but they are not official publications.
[76] Brouwer, E., and A. Kleinknecht, Measuring the Unmeasurable: A Country's Non-R&D Expenditure on Product and Service Innovation, *Research Policy*, 25, 1997: p. 1239.

methodology of science and technology statistics. Moreover, Unesco simply followed Eastern Europe's experience because that was the easiest way to standardize statistics beyond OECD countries.

The very few countries that measure RSA today do so for multiple reasons. Perhaps, the main one is to display greater science and technology activities. This is evident in the case of Latin-American countries, where RSAs contribute to over 77% of the region's scientific and technological activities. [77] But it is also the case for developed countries, like Canada for instance: it allows certain government agencies and departments with no R&D to be included in the S&T envelope, or helps to increase a region's performance in the statistics.

Figure 3.
Scientific and Technological Activities (STA)
According to OECD [78]



For example, the relevant Canadian statistics on RSAs appear in the main publication concerned with the Federal government's activities on science and technology. [79] Some numbers are also present in another publication: the annual issue of the monthly bulletin

[77] RICYT, *Science and Technology Indicators: 1997*, Buenos Aires, 1998.
[78] Dates refer to the first apparition of the categories in the Frascati Manual, while the box corresponds to the current typology of STA. Activities in bold characters are those for which there exists a manual.
[79] Statistics Canada, *Federal Scientific Activities*, 88-204.

on science statistics that deals with the distribution of federal expenditures by provinces. [80] The bulletin gives data on R&D expenditures on the one hand, and total S&T data on the other hand. RSA can only be obtained if the reader subtracts R&D from S&T. There is a table, nevertheless, in which statistics on RSA are explicitly given: the one on the National Capital Region (NCR). The aim is to display more federal activities in Quebec. [81] On the Quebec side of the NCR, Federal R&D expenditures amount to only $16 million, but the federal government is shown to spend $198 million on RSA in Quebec.

To sum up, in the past fifty years RSA have rarely been collected in the measurement of science and technology or been discussed as activities in their own right. First, they were dealt with at length in OECD manuals only in order to better exclude them from the measurement of R&D. Second, they served, above all, political ends: promoting a field (statistics) judged by an organization (UNESCO) to be strategically important, or displaying greater scientific and technological activities (Canada).

One area of further investigation would be to show how the measurement of the social sciences and humanities suffered from the neglect of measuring RSA. In the seventies, when government surveys began to cover the social sciences and humanities, [82] the conventions designed for the natural sciences in the previous decade were strictly applied to these new disciplines. Therefore, activities such as data collection and STI - among them statistics - which are the raw material of the social sciences and humanities and which are an integral part of research in these disciplines were excluded because they were considered as RSA; similarly, economic studies and market research were never considered as research activities in industrial surveys. [83]

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[80] Statistics Canada, *Service Bulletin: Science Statistics*, 88-001, December 1999.
[81] For an analysis of the politicization of S&T statistics in Canada, see B. Godin, The Measure of Science and the Construction of a Statistical Territory: The Case of the National Capital Region (NCR), *Canadian Journal of Political Scien*ce, 33 (2), 2000: 333-358.
[82] Today, nine OECD countries still do not include the social sciences and humanities in their survey.
[83] P. Lefer (1971), *The Measurement of Scientific Activities in the Social Sciences and Humanities*, UNESCO: Paris, CSR-S-1; OECD (1970), *The Measurement of Scientific Activities: Notes on a Proposed Standard Practice for Surveys of Research in the Social Sciences and Humanities*, DAS/SPR/70.40, Paris.

The exclusion of RSA from R&D surveys is, finally, one more example of the principle of hierarchy behind the measurement of science. [84] Indeed, the exclusion is convergent with the long held belief that only experimentation defines research. In the case of the social sciences and humanities, it meant that these disciplines were not measured at all until the seventies, when they are. A residue of that historical decision is the non-measurement today of a large part of research in the social sciences and humanities: RSA.

[84] Godin, B. (2001), Outlines for a History of Science Measurement, *Science, Technology and Human Values*, in press.

Annex 1.

Activities to be Excluded from R&D

(Frascati Manual)

1963

1) Related activities
2) Non-scientific activities

1970

1) related activities
2) industrial production and distribution of goods and services and the various allied technical services

1976

3) activities using the disciplines of the social sciences such as market studies

1981

1) education and training
2) other related scientific and technological activities
3) other industrial activities

1993

4) R&D administration and indirect support activities

Related activities

1963

1) scientific information
2) training and education
3) data collection
4) testing and standardization

1970

1) scientific education
2) scientific and technical information
3) general purpose data collection

4) testing and standardization
5) feasibility studies for engineering projects
6) specialized medical care
7) patent and license work

1976

8) policy related studies

1981

1) scientific and technical information services
2) general purpose data collection
3) testing and standardization
4) feasibility studies
5) specialized medical care
6) patent and license work
7) policy related studies

1993

8) routine software development

Non-scientific activities

1963

1) legal and administrative work for patents
2) routine testing and analysis,
3) other technical services

Industrial production

1963

1) prototypes and trial production
2) design and drawing
3) pilot plant

1970

1) prototypes
2) pilot plant
3) trial production, trouble-shooting and engineering follow-through

1976

4) prototypes
5) pilot plant
6) trial production, trouble-shooting and engineering follow-through

1981

1) innovation
2) production and related technical services (see specific cases)

1993

1) innovation
2) production and related technical services (see specific cases)

Innovation

1981

1) R&D
2) new product marketing
3) patent work
4) financial and organizational changes
5) final product or design engineering
6) tooling and industrial engineering
7) manufacturing start-up
8) demonstration

1993

1) R&D
2) tooling-up and industrial engineering
3) manufacturing start-up and preproduction development
4) marketing for new products
5) acquisition of disembodied technology
6) acquisition of embodied technology
7) design
8) demonstration

Specific cases

1981

1) prototypes
2) pilot plants
3) very costly pilot plants and prototypes
4) trial production
5) trouble-shooting
6) feed-back R&D

1993

7) industrial design
8) tooling up and industrial engineering

Administration and other supporting activities

1993

1) purely R&D financing activities
2) indirect supporting activities

Annex 2.

ICCP Publications

1. Transborder Data Flows of the Protection of Privacy, 1979
2. The Usage of International Data Networks in Europe, 1979
3. Policy Implications of Data Network Developments in the OECD Area, 1980
4. Handbook of Information, Computer and Communications Activities of Major International Organisations, 1980
5. Microelectronics Productivity and Employment, 1981
6. Information Activities , Electronics and Telecommunications Technologies, Volume 1: Impact on Employment , Growth and Trade, 1981 : Volume 2: Expert's Report's ("Background Papers" Series)
7. Microelectronics, Robotics and Jobs, 198 2
8. An Exploration of Legal Issues in Information and Communication Technologies, 1983
9. Software: An Emerging Industry, 1985
10. Computer-Related Crime, Analysis of Legal Policy, 1986
11. Trends in Information Economy, 1986
12. Information Technology and Economic Prospects, 1987
13. Trends in Change in Telecommunications Policy, 1987
14. The Telecommunications Industry: The Challenges of Structural Change, 1988
15. Satellites and Fibre Optics - Competition Complementarity, 1988
16. New Telecommunications Services - Videotex Development Strategies, 1989
17. The Internationalization of Software and Computer Services, 1989
18. Telecommunication Network - Based Services: Policy Implications, 1989
19. Information Technology and New Growth Opportunities, 1989
20. Major R&D Programmes for Information Technology, 1989
21. Trade in Information, Computers and Communications Services, 1990
22. Performance Indicators for Public Telecommunications Operators, 1990
23. Universal Service and Rate Restructuring in Telecommunications, 1991
24. Telecommunications Equipment: Changing Materials and Trade Structures, 1991
25. Information Technology Standards: The Economic Dimension, 1991
26. Software Engineering: The Policy Challenge, 1991
27. Telecommunications Type Approval: Policies and Procedures for Material Access, 1992
28. Convergence Between Communications Technologies: Case Studies for North America and Western Europe, 1992
29. Telecommunications and Broadcasting: Convergence or Collision?, 1992
30. Information Networks and New Technologies: Opportunities and Policy Implications for the 1990s, 1992
31. Usage Indicators: A New Foundation for Information Technology Policies, 1993
32. Economy and Trade Issues in the Computerized Database Market, 1993

33. The Economics of Radio Frequency Allocation, 1993
34. International Telecommunications Tariffs: Charging Practices and Procedures, 1994
35. Telecommunications Infrastructure: The Benefits of Competition, 1995
36. International Telecommunications Pricing Practices and Principles: A Progress Review, 1995
37. Price Caps for Telecommunications: Policies and Experiences, 1995
38. Universal Service Obligations in a Competitive Telecommunications Environment, 1995
39. Mobile Cellular Communication: Pricing Strategies and Competition, 1996

Annex 3.
UNESCO Documents on S&T Statistics

1960 Requirements and Resources of Scientific and Technical Personnel in Ten Asian Countries, ST/S/6 A
1968 Provisional Guide to the Collection of Science Statistics, COM/MD/3
1969 La mesure des activités scientifiques et techniques : propositions visant à la normalisation des statistiques relatives à la science et à la technologie, ST/S/15
1970 World Summary of Statistics on Science and Technology, ST/S/17
1970 Measurement of Output of Research and Experimental Development, ST/S/16
1970 Manual for Surveying National Scientific and Technological Potential, NS/SPS/15
1971 The Measurement of Scientific Activities in the Social Sciences and the Humanities, CSR-S-1
1974 The Quantitative Measurement of Scientific and Technological Activities Related to Research and Experimental Development, CSR-S-2
197? R&D Activities in International Organizations, CSR-S-3
1976 Statistics on Science and Technology in Latin America: Experience with UNESCO Pilot Projects 1972-1974
1977 The Statistical Measurement of Scientific and Technological Activities Related to Research and Experimental Development: Feasibility Study, CSR-S-4
1977 Guide to the Collection of Statistics on Science and Technology (second edition), ST.77/WS/4
1978 Development in Human and Financial Resources for Science and Technology, CSR-S-5
1978 Recommendation Concerning the International Standardization of Statistics on Science and Technology
1979 Statistics on Research and Experimental Development in the European and North American Region, CSR-S-6
1979 Estimation of Human and Financial Resources Devoted to R&D at the World and Regional Level, CSR-S-7
1980 National Statistics Systems for Collection of Data on Scientific and Technological Activities in the Countries of Latin America, Part I: Venezuela, Colombia, Mexico and Cuba, ST-80/WS/18
1980 National Statistics Systems for Collection of Data on Scientific and Technological Activities in the Countries of Latin America, Part II: Brazil and Peru, ST-80/WS/29
1981 National Statistics Systems for Collection of Data on Scientific and Technological Activities in the Countries of Latin America, Part III: Uruguay, Argentina and Chile, ST-81/WS/14
1980 Statistics on Science and Technology, CSR-S-8
1980 Participation of Women in R&D: A Statistical Study, CSR-S-9
1980 Statistics on Science and Technology, CSR-S-10
1980 Manual for Statistics on Scientific and Technological Activities (provisional), ST-80/WS/38
1981 Statistics on Science and Technology, CSR-S-11

1982 Human and Financial Resources for Research and Experimental Development in the Productive Sector, CSR-S-12
1982 Trends in Human and Financial Resources for Research and Experimental Development, CSR-S-13
1982 Statistics on Science and Technology, CSR-S-14
1982 Proposal for a Methodology of Data Collection on Scientific and Technological Education and Training at the Third Level, CSR-S-15
1983 Human and Financial Resources for Research and Experimental Development in Agriculture, CSR-S-16
1984 Estimated World Resources for Research and Experimental Development: 1970-1980, CSR-S-17
1984 Manual for Statistics on Scientific and Technological Activities, ST-84/WS/12
1984 Guide to Statistics on Science and Technology (third edition), ST.84/WS/19
1984 Guide to Statistics on Scientific and Technological Information and Documentation (STID), ST-84/WS/18
1984 Manual on the National Budgeting of Scientific and Technological Activities, Science and Policy Studies and Documents no. 48
1985 Estimate of Potential Qualified Graduates from Higher Education, CSR-S-19 (ST-85/WS/16)
1986 Science and Technology for Development: Scandinavian Efforts to Foster Development Research and Transfer Resources for Research and Experimental Development to Developing Countries, CSR-S-20 (ST-86/WS/7)
1986 Integrated Approach to Indicators for Science and Technology, CSR-S-21 (ST-86/WS/8)
1986 Human and Financial Resources for Research and Experimental Development in the Medical Sciences, CSR-S-22
1988 Financial Resources for Fundamental Research, CSR-S-23 (ST-88/WS/4)
1988 Human and Financial Resources for Research and Experimental Development in the Higher Education Sector, CSR-S-24 (ST-89/WS/1)
1990 Manual For Surveying National Scientific and Technological Potential (Revised Edition)
1991 Estimation of World Resources Devoted to Research and Experimental Development: 1980 and 1985, CSR-S-25 (ST-90/WS/9)