The Number Makers:
A Short History of International Science and Technology Statistics

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The Number Makers:
A Short History of Official Science and Technology Statistics

We owe a large part of the measurement of science and technology in Western countries to the United States. It is there that the first experiments emerged in the thirties. Two factors were at work that explained the phenomenon: the need to manage industrial laboratories and plan government scientific activities. Canada followed a decade later, and Great Britain the next one. All in all, it seems that before the Organization for Economic Co-operation Development (OECD) entered the scene in the early sixties, science and technology statistics was mainly an anglo-saxon phenomenon. [1] It diffused elsewhere in the world principally through the OECD's involvement in the standardization of definitions and methods. This paper is concerned with these early experiments (1930-1960) and with the OECD's subsequent involvement in science and technology statistics (1960-2000).

The first part of this paper presents the early experiments in the measurement of science and technology – that is before 1960 – in three countries: the United States, Canada, and Great Britain (Annex 1). The American and Canadian governments began building repertories of scientists and surveying the activities of industrial laboratories in case the event that they might be needed for Wars (mobilization of scientists). Whether the governments succeeded in using numbers to that end still requires more careful study, but the evidence I have gathered so far points towards failure.

The second part deals with an international organization that played a key role in the field: the OECD. [2] The reason why the OECD constructed statistics on science and technology has to do with science policy. From the beginning, the OECD aligned its reflections on

[1] At least in major Western countries. France only entered the field in 1961. Sporadic experiences existed before the late 1960s in the Netherlands and Japan, for example, but rarely in a systematic way. Only Germany had (partial) annual industrial R&D statistics going back to 1948, but other sectors were surveyed after the sixties only. C. Freeman made a similar analysis in the 1960s, although he forgot Canada among the list of pioneers: C. Freeman (1966), Research, Technical Change and Manpower, in B.G. Roberts and J.H. Harold, *Mapower Policy and Employemnt Trends*, London: Bell, p. 53.

[2] Unesco and the European Union will be dealt with in another paper.

science policy towards economics. To better understand the relations between science and the economy, it developed a program of study on the economy of research in which the main tool was statistics.

The interest in economic matters is a direct consequence of the main issue of the time: the reconstruction of Europe. Productivity was seen as a way of putting Europe back on track and was on the agenda of several governments, including the British government, and of European organizations like the OEEC [3] – the predecessor to the OECD. Although the discussions on productivity explicitly dismissed scientific research as a solution to immediate economic problems, the methods developed during these debates influenced the measurement of science and technology.

The OECD's efforts in the field of measurement coalesced very rapidly into a methodological manual in 1962 on the standardization of research and development (R&D) statistics. Inspired by the National Science Foundation (NSF), the manual would be approved by Member countries and applied in sixteen countries the following year. From then on, the measurement of science and technology at the OECD followed three stages: 1) R&D statistics (1962 to 1977), 2) new indicators (1978-1990), and 3) politicization (1991 and after).

The Forerunners

The development of science and technology statistics in the United States falls into three periods. The first, before World War II, was focused on measuring industrial R&D. These measurements were a spin-off of the National Research Council (NRC) campaign to promote research in industry. The second period, from World War II to 1953, saw several government departments getting involved in different kind of data collection for their own purposes. In addition to industrial R&D, government R&D was measured with increasing frequency. The third period began with the National Science Foundation's (NSF) entry into

[3] Organization for European Economic Co-operation.

the field. From then on, regular surveys of all economic sectors (industry, government, university, non-profit) were periodically conducted.

The Research Information Service (NRC)

During World War I, the US National Academy of Sciences (NAS) convinced the Federal Government to give scientists a voice in the War effort. The NRC was thus created in 1916 as an advisory body to the government. [4] Rapidly, a research information committee, then a Research Information Service (RIS), was put into place. The service was concerned with the inter-allied exchange of scientific information. [5] The RIS began "as a vehicle for the exchange of scientific information through diplomatic channels with the counterparts of the Research Council abroad". [6] The Service looked, via its scientific *attachés* in London, Paris and Rome, to the progress of research in various parts of the world and disseminated the information in the country. After the War however, these activities were closed and the RIS reoriented its work to other ends. The RIS became "a national center of information concerning American research work and research workers, engaged in preparing a series of comprehensive card catalogs of research laboratories in this country, of current investigations, research personnel, sources of research information, scientific and technical societies, and of data in the foreign reports it received". [7] It is among these activities that the RIS built the first repertories on R&D.

Social researchers have shown how social statistics began with calculations performed on registers of population. [8] Similarly, the measurement of science and technology also began with repertories (Annex 2). Beginning in 1920, the RIS regularly compiled five types of repertory, the raw data of which were published extensively in the Bulletin of the NRC,

[4] A.H. Dupree (1957), *Science in the Federal Government: A History of Policies and Activities to 1940*, New York: Harper and Row.
[5] R.C. Cochrane (1978), *The National Academy of Sciences: The First Hundred Years 1863-1963*, Washington: National Academy of Sciences, pp. 240-241; R. MacLeod (1999), Secrets among Friends: The Research Information Service and the Special Relationship in Allied Scientific Information and Intelligence, 1916-18, *Minerva*, 37 (3), pp. 201-233.
[6] *Ibid*, p. 250.
[7] *Ibid*.
[8] A. Desrosières (1993), *La politique des grands nombres*, Paris : La Découverte, p. 34.

sometimes accompanied by statistical distributions. One was concerned with industrial R&D laboratories. [9] The first edition listed approximately 300 laboratories and contained information on fields of work and research personnel. A second repertory dealt with doctorate recipients. [10] A third was devoted to sources of funds available for research, [11] a fourth with fellowships and scholarships, [12] and a fifth with societies, association and institutions (universities) and covered both the United States and Canada. [13]

NRC repertories served to conduct the first statistical analyses of R&D, particularly industrial R&D. The NRC itself performed two such surveys. One in 1933, by the Division of Engineering and Industrial Research which tried to assess the effect of the Great Depression on industrial laboratories, [14] the other in 1941 for the National Resources Planning Board (NRPB). [15] The survey, assisted by the cooperation of the National Association of Manufacturers, reported that "the median expenditure of the companies for industrial research was (…) 2 percent of gross sales income". [16] This was the only number on money expenditure in the report, because the questionnaire had concentrated on personnel data (man-years) that were easier to obtain from companies. Besides the NRC itself, government departments and institutions also used NRC industrial repertories to survey research, among them the Work Progress Administration (WPA) in 1940 that

[9] National Research Council, *Research Laboratories in Industrial Establishments of the United States of America*, Bulletin of the NRC, vol. 1, part 2, March 1920.
[10] National Research Council, *Doctorates Conferred in the Sciences in 1920 by American Universities*, Reprint and Circular Series, November 1920.
[11] National Research Council, *Funds Available in 1920 in the United States of America for the Encouragement of Scientific Research*, Bulletin of the NRC, vol. 2, part I, no. 9, 1921.
[12] National Research Council, *Fellowships and scholarships for Advanced Work in Science and Technology*, Bulletin of the NRC, November 1923.
[13] National Research Council, *Handbook of Scientific and Technical Societies and Institutions of the United States and Canada*, Bulletin of the NRC, no. 58, May 1927.
[14] M. Holland and W. Spraragen (1933), *Research in Hard Times*, Division of Engineering and Industrial Research, National Research Council, Washington.
[15] National Resources Planning Board (1941), *Research: A National Resource (II): Industrial Research*, Washington: USGPO.
[16] *Ibid*, p. 124.

looked at the impact of new industrial technologies on employment, [17] the Steelman report. [18], the Office of Education, [19] and the NSF. [20]

The Government's Advisers

It was not long before the Federal government began conducting its own surveys. All but one of these appeared after World War II. These measurements were again preceded by repertories. At the suggestion of the NRC, an important roster was created on scientific and specialized personnel during World War II. It was intended to facilitate the recruitment of specialists for war research. The NRPB established the plan for the national roster in 1940. "The task was an enormous one – to compile a list of all Americans with special technical competence, to record what those qualifications were, and to keep a current address and occupation for each person. (…) Questionnaires were sent out, using the memberships lists of professional societies and subscription lists of technical journals, and the data were coded and placed on punched cards for quick reference". [21] By 1944, the roster had detailed punch-card data on 690 000 individuals. [22] Considered of little use by many, [23] it was transferred to the NSF in 1953 and abandoned in 1971. [24] By that time, surveys began systematically replacing repertories.

The Federal government effort with R&D surveys began in 1938 when the National Resources Committee, the successor to the National Resources Board, published the first systematic analysis of government research intended to document how to plan and

[17] G. Perazich and P.M. Field (1940), *Industrial Research and Changing Technology*, Work Projects Administration, National Research Project, report no. M-4, Pennsylvania: Philadelphia.
[18] J.R. Steelman (1947), *Science and Public Policy*, President's Scientific Research Board, Washington: USGPO.
[19] National Research Council (1951), *Research and Development Personnel in Industrial Laboratories – 1950*, Report to the National Scientific Register, Office of Education.
[20] NSF (1957), *Growth of Scientific Research in Industry, 1945-1960*, Report prepared by Galaxy Inc., Washington.
[21] C. Pursell (1979), Science Agencies in World, War II: The OSRD and its Challenges, in N. Reingold, *The Sciences in the American Context*, Washington: Smithsonian, p. 367-368.
[22] R.C. Cochrane (1978), *op. cit.*, p. 406.
[23] "Those charged with recruiting chemists and physicists for OSRD and its contractors knew the outstanding men in each field already and through them got in touch with many young men of brilliant promise". J.P. Baxter (1946), *Scientists Against Time*, Boston: Little, Brown and Co., p. 127.

coordinate government scientific activities. [25] The report, concluding that research - particularly academic research - could help the nation emerge from the Depression, was based on a survey of government R&D, including universities. For the first time, a survey of research included the social sciences, and this would later become the practice for surveys of government R&D in all OECD countries (Two years later, the National Resources Committee – now called the National Resources Planning Board – published a study by the Social Science Research Council (SSRC) that look at social research in industry – but without statistics). [26]

People had to wait until 1945 to see new measurements of research in the United States. Two of which deserve special mention. First, V. Bush offered some data on research in *Science: The Endless Frontier*, the blueprint for science policy in the United States. [27] But these were either based on previously published numbers, like those from the NRC, or of dubious quality, like his estimates on basic research. [28] Slightly better were the numbers included in a second experiment, the Steelman report. [29] The President's adviser tried, to some extent, to measure R&D in every sector of the economy: industry, government, and university. To estimate the importance of research in the economy at large, he collected statistics wherever he could find them – and whatever their quality –, adding very few numbers of his own – as Bush has done. [30] There was no time for an original survey since the report had to be delivered to the President ten months after the executive order. Steelman innovated, however, on several fronts: definition of research categories, GERD/GDP as an indicator of R&D effort, original estimates on the work force manpower

[24] National Science Board, *Minutes of the 142nd meeting*, 14-15 November 1971.
[25] National Resources Committee (1938), *Research: A National Resource (I): Relation of the Federal Government to Research*, Washington: USGPO.
[26] National Resources Planning Board (1941), *Research: A National Resources (III): Business Research*, Washington: USGPO.
[27] V. Bush (1945), *Science: The Endless Frontier*, North Stratford: Ayer Co. Publishers, 1995, pp. 85-89.
[28] B. Godin (2001), *Defining R&D: Is Research Always Systematic?*, Project on the History and Sociology of S&T Statistics, Paper no. 7, OST: Montreal.
[29] J.R. Steelman (1947), *Science and Public Policy*, New York: Arno Press, 1980.
[30] Most of new numbers concern university research. See also: Bush (1945), *op. cit*., pp. 122-134.

for discussing shortages. He also suggested numerical targets for science policy for the next ten years. [31]

Other compilations were of better quality, but limited to government R&D. Senator H.M. Kilgore estimated the wartime effort (1940-1944) in research for a Committee of Congress, [32] and the Office of Scientific Research and Development (OSRD) measured its own activities for the period 1940-1946. [33] Finally, the Bureau of Budget (BoB) started compiling a government "research and development budget" in 1950. [34]

The R&D Board (DoD)

The US Department of Defense (DoD) was at the heart of the modern R&D survey in the United States, and in the Western World. In the early fifties, its Research and Development Board (RDB) asked the Harvard Business School and the Bureau of Labor Statistics to conduct a survey of industrial R&D. Both institutions coordinated their efforts and conducted three surveys. The results were published in 1953. [35] The surveys collected numbers on R&D, but also information on the effect of military affairs on personnel, the factors affecting R&D, and the rate of return on investments, all kinds of information often no more collected today in R&D surveys.

What was the rationale behind these surveys? There were two. Firstly, industries were entering a phase of growth in R&D expenses and needed to know how to manage the new research laboratories. The corporate associates of Harvard University, as well as the

[31] See: B. Godin (2000), *Measuring Science: Is There Basic Research without Statistics?*, Project on the History and Sociology of S&T Statistics, Paper no. 3, OST: Montreal.
[32] H.M. Kilgore (1945), *The Government's Wartime Research and Development, 1940-44: Survey of Government Agencies*, Subcommittee on War Mobilization, Committee on Military Affairs, Washington.
[33] OSRD (1947), *Cost Analysis of R&D Work and Related Fiscal Information*, Budget and Finance Office, Washington.
[34] Bureau of Budget (1950), *R&D Estimated Obligations and Expenditures*, 1951 Budget (9 January 1950), Washington. Data from 1940 through 1949 can also be found in *The Annual Report of the Secretary on the State of the Finances for the Fiscal Year ended June 30, 1951*, Washington, p. 687.
[35] D.C. Dearborn, R.W. Kneznek and R.N. Anthony (1953), *Spending for Industrial Research, 1951-1952*, Division of Research, Graduate School of Business Administration, Harvard University; US Department of

Industrial Research Institute (IRI), were in fact partners in the Business School survey. C.E.K. Mees and J.A. Leermakers, in an influential book, summarized the problem as follows: [36]

> In the early days of industrial research, these laboratories were organized into departments on the model of the factory organization. (…) The departments themselves were analogous to the departments of a university (…). As the organization of industrial research has developed, however, the academic department system has been largely displaced by an organization based on function. The departments include men trained in different branches of science but applying their knowledge so that their work converges upon one field of work.

The authors then distinguished problems of organization in industrial research from academic ones – team rather than individual work, applied rather than fundamental research – and examined factors that ought to determine the form of the organization, such as objectives, time, and costs.

For R.N. Anthony, author of the Harvard Business School study, statistics were a tool for managing by comparison: "There seems to be no way for measuring quantitatively the performance of a research laboratory", he wrote. But "a comparison of figures for one laboratory with figures for some other laboratory (…) may lead the laboratory administrator to ask questions about his own laboratory". [37] While Anthony dealt at length with limitations of such comparisons and made several caveats, he nevertheless suggested a series of ratios and breakdowns of data as yardsticks for assessing the performance of laboratories.

The second rationale behind the industrial survey was to enable the government to locate available resources in the event of war. [38] After the roster in 1944, this objective was reiterated year after year. But the statistics never really served the purpose they had been

Labor, Bureau of Labor Statistics, Department of Defense (1953), *Scientific R&D in American Industry: A Study of Manpower and Costs*, Bulletin no. 1148, Washington.

[36] C.E.K. Mees and J.A. Leermakers (1950), *The Organization of Industrial Scientific Research*, New York: McGraw-Hill, p. 35.

[37] R.N. Anthony and J.S. Day (1952), *Management Controls in Industrial Research Organizations*, Boston: Harvard University Press, p. 288.

[38] Bureau of Labor Statistics (1953), *op. cit*., pp. 1, 51-52.

designed for. [39] What was certainly desired, however, was to know what happened to government investments in R&D. Indeed, the Bureau of Labor Statistics survey showed that 50% of industrial R&D was financed by the Federal Government. [40] Assessing the returns on these investments is a mandate that would be assigned to the NSF.

The Office of Special Studies (NSF)

The peculiarity of science and technology statistics in the United States since 1950 is that these measurements were not located in a statistical agency. It is the NSF, the organization responsible for funding university research, that conducted or sponsored most surveys within its Office of Special Research (OSR). [41]

When the NSF entered the scene in the early fifties, statistics on R&D in the United States had been available since the 1920s. [42] But difficulties were increasingly encountered as soon as one wanted to compare the data from different sources or to develop a historical series. [43] Definitions of research differed, as well as the methodologies for collecting data. The NSF standardized the R&D survey by monopolizing the official measurement of R&D and imposing its own criteria. The Harvard Business School and the Bureau of Labor surveys were influential here. They developed concepts and definitions that the NSF reproduced – like those of research, basic research, and non-research activities – as well as methodologies.

The NSF began measuring science and technology in 1953 (Table 1). [44] At the beginning, it used existing expertise, be it in the Bureau of Labor Statistics, the Bureau of Budget, or the Office of Education. Over the years, however, the NSF chose its partners, like the Bureau

[39] See: J.P. Baxter (1946), *op. cit*., pp. 126-135.
[40] Bureau of Labor Statistics (1953), *op. cit*., p. 3.
[41] Renamed the Division of Science Resources Studies in the early sixties.
[42] K. Sanow (1963), *Survey of Industrial R&D in the United States: Its History, Character, Problems, and Analytical Uses of Data*, OECD, DAS/PD/63.38, p. 2.
[43] US Department of Commerce and Bureau of Census (1957), Research and Development: 1940 to 1957, in *Historical Statistics of the United States*, pp. 609-614.
[44] National Science Foundation (1953), *Federal Funds for Science: Federal Funds for Scientific R&D at Nonprofit Institutions 1950-1951 and 1951-1952*, Washington.

of Census instead of the Bureau of Labor Statistics, [45] or developed its own expertise. By 1956, it had already surveyed all economic sectors at least once: government, (federal funds to) universities and non-profit institutions, and industry. Surveys of doctorate recipients were added at the end of the fifties (Annex 3).

Table 1.
NSF Surveys and Census

Survey	Frequency	First year for which data are available
Survey of Federal Support to Universities, Colleges, and Non profit Institutions	Annual	1950
Survey of Industrial Research and Development	Annual	1953
Survey of Federal Funds for Research and Development	Annual	1955
Survey of Earned Doctorates	Annual	1957
National Survey of College Graduates	Biennial	1962
Survey of Graduate Students and Post-doctorates in Science and Engineering	Annual	1966
Integrated Postsecondary Education Data System Completions Survey	Annual	1966
Immigrant Scientists and Engineers	Annual	1968
Survey of Scientific and Engineering Expenditures at Universities and Colleges (R&D Expenditures)	Annual	1972
Survey of Doctorate Recipients	Biennial	1973
National Survey of Recent College Graduates	Biennial	1976
Occupational Employment Statistics Survey	Triennial	1977
Survey of Public Attitudes	Biennial	1979
National Survey of Academic Research Instruments and Instrumentation Needs [46]	Triennial	1983
Survey of Academic Research Facilities	Biennial	1988
Survey of innovation in ITC		199?

For the NSF, the decade ended with two reflexive exercises. Firstly, the NSF invited people from the United States, Canada and the United Kingdom to attend a session on R&D

[45] This change was motivated, according to K. Sanow, to the need to relate R&D to other economic statistics. K. Sanow (1959), Development of Statistics Relating to R&D Activities in Private Industry, in NSF (1959), *The Methodology of Statistics on R&D* (NSF 59-36), Washington: 22.
[46] This survey and the following one were abandoned in the early nineties.

statistics at the 1958 Meeting of the American Statistical Association. [47] The aim was to discuss the limitations and difficulties of measurement and future methodological work for improving statistics. [48] Secondly, the NSF produced its first (?) policy-oriented document: *Basic Research: A National Resource*. [49] The report used R&D statistics for the first time and in a way that disclosed NSF philosophy for the following decades. The document made a plea for basic research in the name of a balance (and an explicit contrast) between applications of science and basic science. According to the NSF, the numbers showed that "basic research [was] underemphasized in the United States" (p. 47) and, for this reason, needed to be better funded by both the Federal government and industry. This was the first part of the philosophy. The second was that "the returns [on basic research] are so large that it is hardly necessary to justify or evaluate the investment" (p. 61). Thereafter, numbers would become, for the NSF, a rhetorical tool for lobbying for university funds, but not for evaluating research.

Why was the measurement of S&T in the United States located at the NSF? This was not a planned decision since the science and technology measurement would probably have otherwise gone to the Bureau of Labor Statistics or the Bureau of Census. Indeed, it was these two organizations that conducted, and still conduct, regular surveys for the NSF.

The localization of science and technology measurement was in fact the result of a compromise for the Bureau of Budget (BoB). The Bureau had always been skeptical of science and technology funding by the Federal government, particularly the funding of basic research. [50] President H. Truman's adviser and director of the Bureau, Harold Smith,

[47] National Science Foundation (1959), *Methodological Aspects of Statistics on R&D: Costs and Manpower*, Papers presented at a session of the American Statistical Association Meetings, December 1958, NSF 59-36, Washington.

[48] For details, see: B. Godin (2001), *Metadata: How Footnotes Render Numbers Obsolete*, Project on the History and Sociology of S&T Statistics, Paper no. 10, OST: Montreal.

[49] National Science Foundation (1957), *Basic Research: A National Resource*, Washington.

[50] J.M. England (1982), *A Patron for Pure Science: The NSF'S Formative Years, 1945-1957*, Washington: NSF, p. 82; H.M. Sapolsky (1990), *Science and the Navy: The History of the Office of Naval Research*, Princeton: Princeton University Press, pp. 43, 52, chapter 4; L. Owens (1994), The Counterproductive Management of Science in the Second World War: Vannevar Bush and the OSRD, *Business History Review*, 68: pp. 533-537; National Resources Committee (1938), *op. cit*., pp. 18, 74; *Biomedical Science and its Administration*, Report to the President (Wooldridge report), 1965.

once argued that the real title of *Science: The Endless Frontier* should be *Science: The Endless Expenditure*. [51] In order to accept the degree of autonomy asked by the NSF, the Bureau required that the organization produce regular evaluations of the money spent. According to W.H. Shapley, of the Bureau, BoB was mainly interested in identifying overlap among agencies and programs. [52] In 1950, therefore, the law creating the NSF charged the organization with funding basic research, but it also gave it a role in science measurement. The NSF was directed to "evaluate scientific research programs undertaken by the Federal Government (…) [and] to maintain a current register of scientific and technical personnel, and in other ways provide a central clearinghouse for the collection, interpretation, and analysis of data on scientific and technical resources in the United States". [53] In 1954, the President specified in an executive order that the NSF should "make comprehensive studies and recommendations regarding the Nation's scientific research effort and its resources for scientific activities" and "study the effects upon educational institutions of Federal policies and administration of contracts and grants for scientific R&D". [54]

(More demands would follow. In 1968, Congress mandated the NSF "to evaluate the status and needs of the various sciences", to "initiate and maintain a program for the determination of the total amount of money for scientific research", and "to report on the status and health of science and technology". [55] The latter "shall include an assessment of such matters as national scientific resources and trained manpower, progress in selected areas of basic scientific research, and an indication of those aspects of such progress which might be applied to the needs of American society". Finally, in 1982, Congress asked for a report on science indicators every two years. [56] This served as confirmation of the reputed quality of *Science and Engineering Indicators*, first published in 1973).

[51] C.E. Barfield (1997), *Science for the 21st Century: The Bush Report Revisited*, Washington: AEI Press, p. 4.
[52] W.H. Shapley (1959), Problems of Definition, Concept, and Interpretation of R&D Statistics, NSF (1959), *The Methodology of Statistics on R&D* (NSF 59-36), Washington: 8.
[53] Public Law 507 (1950).
[54] Executive Order 19521 (1954).
[55] Public Law 90-407 (1968).
[56] Public Law 97-375 (1982).

Despite these demands, the NSF remained an autonomous agency and was guided by its own interests. [57] Measurement of science and technology became a measurement for the NSF to lobby for university funds. This explained, for example, the emphasis it put on the measurement of basic research, [58] its biased statistical view of the science system (focused mainly on university research), [59] and its discourses on the shortages of scientists and engineers. [60] This also explained the NSF's involvement in comparative statistics. In 1955, in collaboration with the NRC, the NSF started measuring communist investments in science, showing that the Soviet Union was producing two to three times more scientific and technical graduates yearly as the United States. [61] The impact of the study was, according to A.T. Waterman, first director of the NSF, enormous: [62]

> One result of these findings was that the Congress sharply increased Foundation funds for education in the sciences. The Foundation appropriation for fiscal year 1957, $40 million, more than doubled that of the preceding year. The next large increment came in 1959 when $130 million was appropriated in the wake of intense national concern over the Russian sputnik and all that it implied. Funds available for fiscal year 1960 total more than $159 million.

Throughout its history, the NSF had been an advocate of university research rather that a neutral statistical organization and, to that end, it needed and produced the appropriate numbers for persuading politicians.

[57] B. Godin (2000), *The Emergence of Science and Technology Indicators: Why Did Governments Supplement Statistics with Indicators?*, Project on the History and Sociology of S&T Statistics, Paper no. 8, OST: Montreal.
[58] See: B. Godin (2000), Measuring Science: Is There Basic Research without Statistics?, *op.cit.*
[59] S. Cozzens (1991), *Science Indicators: Description or Prescription?*, Office of Technology Assessment, Washington.
[60] See: B. Godin (2001), *Should We Believe in Shortages of Manpower*?, Project on the History and Sociology of S&T Statistics, Paper no. 11, OST: Montreal.
[61] N. De Witt (1955), *Soviet Professional Manpower: Its Education, Training, and Supply*, Washington: NSF; N. De Witt (1961), *Education and Professional Employment in the USSR*, NSF 61-40, Washington: NSF. L.A. Orleans (1961), *Professional Education in Communist China*, NSF 61-3, Washington: NSF; C-Y. Cheng (1965), *Scientific and Engineering Manpower in Communist China, 1949-1963*, NSF 65-14, Washington: NSF.

The Dominion Bureau of Statistics (Canada)

Canada was the second most active country in measuring science and technology before the 1960s. As early as 1917, the Canadian NRC conducted an influential survey of research in the country, in collaboration with five organizations: the Canadian Manufacturers' Association, the Canadian Society of Civil Engineers, the Canadian Mining Institute, the Society of the Chemical Industry, and the Toronto Joint Committee of Technical Organizations. [63] Four questionnaires were prepared for 1) universities, colleges and technical institutions; 2) government departments (federal and provincial); 3) industries; and 4) scientific, professional and technical societies.

Few archives exist, but we know that the survey determined science policy in Canada for the next fifty years: 2 400 questionnaires were returned, of which 37 reported research activity and a further 83 reported technical activity, largely routine quality control. [64] Briefly stated, the survey showed that there was very little research in the country, either in industry or in universities. The obvious lesson, so thought the NRC, was to fund universities that would produce graduates that would then be hired in industry. As Bruce Doern has shown, the NRC consequently developed programs to fund university research instead of industrial research as stipulated in its original mandate. [65]

The first real survey of R&D in Canada however was conducted by the NRC in 1939 and published in a Dominion Bureau of Statistics publication. [66] As was the case in the United States, the survey was concerned with industrial R&D. The declared aim was "to mobilize the resources of the Dominion for the prosecution of the war", that is to build a directory of

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[62] A.T. Waterman (1960), Introduction, V. Bush, *Science: The Endless Frontier*, New York: Ayer Co., p. xxv.
[63] Advisory Council for Scientific and Industrial Research, *Annual Report*, 1918, pp. 20-28; M. Thistle (1966), *The Inner Ring: The Early History of the National Research Council of Canada*, Toronto: University of Toronto Press, pp. 159-160.
[64] J.P. Hull and P.C. Enros (1988), Demythologizing Canadian Science and Technology: The History of Industrial R&D, in P.K. Kresl (ed.), *Topics on Canadian Business*, vol. X (3), Association for Canadian Studies, pp. 1-21.
[65] B. Doern (1982), *Science and Politics in Canada*, Toronto: Queens University Press.
[66] Dominion Bureau of Statistics (1941), *Survey of Scientific and Industrial Laboratories in Canada*, Ottawa.

potential contractors. [67] The survey asked for data on personnel and expenditures for research and testing. The report was accompanied with a directory of laboratories classified by province, by sector and by fields of research.

The survey was followed by a Department of Reconstruction and Supply survey on government R&D in 1947. [68] Three compilations were published: two for federal government activities (1938-46 and 1946-47) and one for provincial activities (1946-47). The survey did not consider, contrary to the US National Resources Committee, the social sciences but it did include "data collection and dissemination of information". This allowed the Department to develop the concept of "scientific activities", a concept that would be appropriated by the NSF in the 1960s and by Unesco in the 1970s. [69]

Regular and periodic surveys by the Dominion Bureau of Statistics resumed in 1955 on industrial R&D. [70] The survey of government research followed in 1960. [71] The industrial survey was evoked specifically because of complaints by industry (the *Financial Post* was the main vehicle of these criticisms) that the NRC spent too much of its funds in-house. [72]

In all of the Bureau's efforts, the NRC has been a precious collaborator, and sometimes the instigator, in the R&D surveys. From 1957, the NRC specifically dedicated a person - G.T. McColm - to advise, among other things, the Dominion Bureau on how to correct defects in the previous surveys. Only after the appearance of the OECD Frascati manual in 1963 did the Bureau continued on its own.

[67] I*bid*, p. 1.
[68] Department of Reconstruction and Supply (1947), *Research and Scientific Activity: Canadian Federal Expenditures 1938-1946*, Government of Canada: Ottawa.
[69] B. Godin (2000), *Neglected Scientific Activities: The (Non) Measurement of Related Scientific Activities*, Project on the History and Sociology of S&T Statistics, Paper no. 3, OST: Montreal.
[70] Dominion Bureau of Statistics (1956), *Industrial Research-Development Expenditures in Canada, 1955*, Ottawa.
[71] Dominion Bureau of Statistics (1960), *Federal Government Expenditures on Scientific Activities, Fiscal Year 1958-1959*, Ottawa.
[72] G.T. McColm, personal conversation, 13 October 2000.

Great Britain

As in the United States, the British measurement of science and technology first began with repertories. Indeed, the American roster was inspired by a similar experiment by the British Royal Society. [73] By 1939, the British register had collected some 80 000 names of scientists and would soon be taken over by the Ministry of Labor. A few years before, the Association of Scientific Workers (ASW) created, on the model of the US NRC, a repertory on industrial research laboratories. [74] It included details on field of work, character of research, personnel, floor space, publications and patents for over 120 units.

The British government had from the start been involved in estimating total R&D. From 1953-54, the Advisory Council on Science Policy (ACSP) published annual data on government funding of civil R&D, and from 1956-57 it undertook triennial surveys of national R&D expenditures. [75] It "built up from the results of several surveys each with its own questionnaire and slightly different specifications". [76] The government R&D data came from budget information of what constituted at the time the four "research councils" (DSIR, MRC, ARC, Natural Conservancy). Industrial R&D expenditures were taken from the Department of Scientific and Industrial Research (DSIR). The latter conducted the first official survey on industrial R&D in 1955, modeled on the NSF. [77]

The ACSP, through its committee on scientific manpower, also pioneered the collection of statistics on the supply of scientists and engineers in Britain, and worked on forecasting the demand for them. [78] Such numbers were published yearly until 1963-64. This work would

[73] C. Pursell, *op. cit*., p. 367.
[74] Association of Scientific Workers (1936), *Industrial Research Laboratories*, London: George Allen and Unwin.
[75] Appeared in the *Annual Reports of the ACSP* from 1956-57 to 1963-64, London: HMSO.
[76] D.L. Bosworth, R.A. Wilson and A. Young (1993), *Research and Development*, Reviews of United Kingdom Statistical Sources Series, vol. XXVI, London: Chapman and Hill, p. 29.
[77] DSIR (1958), *Estimates of Resources Devoted to Scientific and Engineering R&D in British Manufacturing Industry, 1955*, London.
[78] ACSP (1955), *Report on the Recruitment of Scientists and Engineers by the Engineering Industry,* Committee on Scientific Manpower, London: HMSO.

be vehemently criticized, [79] but the inquiries would have a considerable influence on the OEEC's work on the subject via Alexander King, the first secretary of the ACSP committee and later director of the OECD Directorate of Scientific Affairs.

All these measurements were preceded by those of the Federation of British Industries (FBI) which surveyed industries in 1947. [80] Fourteen years later, in 1961, the Federation conducted a second survey. [81] Christopher Freeman, from the National Institute of Economic and Social Research (London), was affected to the survey when E. Rudd, from the DSIR, sent him to the OECD to write what would become the Frascati manual.

The OECD

National surveys conducted in the 1950s collected few if any international statistics. Countries usually surveyed their own R&D effort and were not yet interested in benchmarking. We owe to the OECD the development of comparative R&D statistics between countries.

At the origin of OECD measurement activities were considerations with productivity issues. [82] What A. King called the "productivity movement" came from the United States and its Marshall Plan, [83] and was amplified in Great Britain. [84] In 1948, L. Rostas, a statistician in the British Board of Trade (Department of Trade and Industry) published an influential report comparing productivity of British and American industry and showed a

[79] K.G. Gannicott and M. Blaug (1969), Manpower Forecasting since Robbins: A Science Lobby in Action, *Higher Education Review*, 2 (1): 56-74.
[80] Federation of British Industries (1947), *Scientific and Technical Research in British Industry*, London.
[81] Federation of British Industries (1961), *Industrial Research in Manufacturing Industry: 1959-1960*, London.
[82] B. Boel (1997), *The European Productivity Agency: Politics of Productivity and Transatlantic Relations, 1953-61*, PhD Dissertation, Department of History, University of Copenhagen; B. Boel (1997), The European Productivity Agency, 1953-1961, in R.T. Griffiths (ed.), *Explorations in OEEC History*, Paris: 113-122; G.S. Papadopoulos, *Education* 1960-*1990: The OECD Perspective*, Paris: 21-37; OECD (1965), *Répertoire des activités de l'Agence européenne de productivité (1953-1961)*; A. King (1965), OECD and Science, introduction to OECD (1963), *Ministers Talk about Science*, Paris: 17-25; A. King (2001), Scientific Concerns in an Economic Environment: Science in OEEC-OECD, *Technology in Society*, 23, pp. 337-348.
[83] D.W. Ellwood (1990),
[84] A. King (1992), *The Productivity Movement in Post-War Europe*, 18 pages, unpublished.

very considerable disparity or gap in favor of the United States in most of the twenty or more industrial sectors studied. [85] At the same time, the newly created British ACSP set up a group of industrialists, trades union representatives, scientists and engineers to report on how science and technology could best contribute to increasing the nation's industrial productivity. The (Gibbs) report stated that in the short run, research could have little immediate effect on productivity levels. [86] The effort should be focused on inculcating a rational, scientific approach in industry, and by adapting operational research methods that had been so successful during the war. These would also be the solutions favored by the British Committee on Industrial Productivity. [87]

This was the context into which the OEEC – the predecessor to the OECD - was created in 1948 to participate in the reconstruction of Europe. The OEEC responded to the challenge as early as 1949 by setting up, among other things, a whole program of work centered around productivity issues that culminated in the establishment of the European Productivity Agency (EPA) as a semi-autonomous agency in 1953. One of the tasks the agency gave itself was the measurement of productivity and the improvement of methodologies to that end. In pursuance of these activities, the EPA conducted inter-firm surveys in several industrial sectors, participated in the elaboration of methodological manuals, operated a small expert advisory service on measurement and, from 1955 to 1965, published quarterly the *Productivity Measurement Review*. In all these activities, the EPA held a holistic and systemic approach, inspired by operational research, wherein the human factor was the most important element: [88]

> The high productivity in American firms was due to their operating conditions just as much as to their technical advances. (…) [The Agency then decided that it should] concentrate mainly on management problems and the improvement of co-operation between management and labour.

[85] L. Rostas (1948), *Comparative Productivity in British and American Industry*, National Institute of Economic and Social Research, Cambridge: Cambridge University Press.
[86] Advisory Council on Scientific Policy (1948), *First Annual Report*, Cmd 7465, London.
[87] See: *First Report of the Committee on Industrial Productivity*, Cmd. 7665, London: HMSO; *Second Report of the Committee on Industrial Productivity*, Cmd. 7991, London: HMSO
[88] OEEC (1959), *Report of the Working Party No. 26 of the Council*, C (59) 215, p. 5.

Such an approach was in line with the economic theory of the time whereby science and technology had not yet been integrated in economists' models of productivity and economic progress. A few years later however, at least at the policy level, research would be considered as a necessary ingredient of economic growth. [89] Indeed, Sputnik completely changed the ideas people held about science and technology. [90] In 1957, the OEEC became directly interested in science and technology measurement issues. By then, however, a model had already been established, centered around two characteristics: 1) an integrated (or holistic) approach to economic problems, as suggested by operational research and systems analysis; [91] 2) a preoccupation with international comparisons, among them a concern for gaps between Europe and the United States, as documented by the EPA. Four new types of statistics, to which we now turn, would soon be produced: scientific and technical manpower; R&D; technology; and science and technology indicators.

The Office of Scientific and Technical Personnel (OEEC)

It is often mentioned in the OECD literature that the OEEC started working on comparative R&D statistics in 1957. No archives remain to confirm or to document these claims. [92] What is certain, however, is that the OEEC got involved early on in several innovative activities regarding the measurement of qualified human resources and their shortages. For at the heart of productivity issues lie human resources.

On the initiative of the United States, recently shaken by Sputnik, the OEEC created the Office of Scientific and Technical Personnel (OSTP) in 1958 as part of the European Productivity Agency (EPA). The Office, pursuing the work of its predecessor - the

[89] D. Wilgress (1960), *Co-operation in Scientific and Technical Research*, Paris.
[90] R.L. Geiger (1997), What Happened after Sputnik? Shaping University Research in the United States, *Minerva*, 35: 349-367; A.J. Levine (1994), *The Missile and Space Race*, Westport: Praeger: 57-72.
[91] On the history of operational research and system analysis, see: A.C. Hughes and T.P. Hughes (2000), *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After*, Cambridge (Mass.): MIT Press.
[92] Certainly, the OEEC had several working groups and committees concerned with science and technology issues (Cooperation in Research, Scientific and Technical Information, Applied Research, Scientific and Technical Manpower), the work of which gave information on European shortages of manpower, equipment and money. But this information was mostly qualitative.

Scientific and Technical Personnel Committee - conducted three large surveys of scientific and technical personnel in Members countries. These activities were the first systematic international measurements of science and technology, and they were guided by what would become the repeated *lacunae* of current statistics: [93]

> Few member nations had adequate statistics on current manpower supply; fewer still on future manpower requirements. Furthermore, there were no international standards with regard to the statistical procedures required to produce such data.

The first survey on scientific and technical personnel concluded that "shortages do not at present seriously interfere with research or production", and specified that "quantity is not the only factor in assessing requirements. Quality is equally important in this field". [94] The second survey, two years later, would conclude the exact opposite: "universal shortage is striking", said the report with data of mediocre quality. [95] The third survey found a growing difference between the United States and Canada on the one hand, and European countries on the other, and projected bigger discrepancies for 1970. [96] In all three exercises, data were based on the educational qualifications of the population, as is still done in most surveys, and not on the occupations held by scientists and engineers. The Office recognized that the method was unsatisfactory, but data were missing to properly measure the phenomenon.

The Committee of Scientific and Technical Personnel (CSTP) of the OECD would continue the work of the OSTP in the sixties. In parallel to surveys on the shortages of qualified resources, the committee measured, for the first time in history, the migration of scientists and engineers between Member countries, the United States and Canada. [97] Brain drain was a highly popular topic in the sixties. [98] It took five years before the idea of the survey, first suggested in 1964, was turned into reality. [99] The report, two volumes and hundreds of

[93] OEEC (1960), *Forecasting Manpower Needs for the Age of Science*, Paris, p. 7.
[94] OECD (1955), *Shortages and Surpluses of Highly Qualified Scientists and Engineers in Western Europe*, Paris, p. 21.
[95] OECD (1957), *The Problem of Scientific and Technical Manpower in Western Europe, Canada and the United States*, Paris, p. 5.
[96] OECD (1963), *Resources of Scientific and Technical Personnel in the OECD Area*, Paris.
[97] OECD (1969), *The International Movement of Scientists and Engineers*, Paris, STP (69) 3.
[98] B. Godin (2001), Should We Believe in Shortages of Manpower?, *op. cit*.
[99] OECD (1964), *The International Movement of Scientific and Technical Manpower*, Paris, STP (64) 25.

pages long, would never be published (?), despite its quality. It estimated that migration affects only a small part of the total national stock of scientific and technical manpower: it is the elite who migrate.

Besides conducting surveys, the OECD also got involved in forecasting, a direct *relique* (and dream) of operational research. Several exercises in forecasting would be conducted from 1960 to mid 1980: scientific and technical information, technological assessment, and human resources. The latter was motivated by the realization that policy makers would be better guided by a more comprehensive and strategic approach than by mere numbers on the shortages of scientists and engineers for example. The OECD consequently organized different symposia on methods of forecasting specialized manpower. [100]

With the numbers generated within the OSTP and CSTP, the OECD developed a discourse that would become a trademark of the organization: gaps between Europe and the rest of the world. The organization identified a gap between the United States and Europe in term of specialized personnel, and gaps between Europe and the USSR in terms of science and engineering graduates. [101] These gaps were the second to be documented. More were soon to be measured.

The Science Resources Unit (OECD)

With the creation of the OECD in 1961, the organization increasingly turned to policy questions. Science was now definitely recognized as a factor of economic growth. In order that it may optimally contribute to progress, however, science and technology policies had to be invented. [102] And to inform the latter, statistics were essential. The OECD then launched a program of work on the economics of research. [103]

[100] See note 81.
[101] OEEC (1960), *Producing Scientists and Engineers: A Report on the Number of Graduate Scientists and Engineers produced in the OEEC Member Countries, Canada, the United States and the Soviet Union*, Paris, OSTP/60/414.
[102] OEEC (1960), Co-operation in Scientific and Technical Research, *op. cit*.
[103] The field was emerging mainly in the United States, at RAND and NBER; see: D.A. Hounshell, The Medium is the Message, or How Context Matters: the RAND Corporation Builds an Economics of

From the beginning, the OECD's statistical activities on science and technology were located in a policy division, the Directorate of Scientific Affairs (DSA). It was so because measurement of science and technology at the OECD developed as a tool for science and technology policies: "Informed policy decisions (…) must be based on accurate information about the extent and forms of investment in research, technological development, and scientific education", argued the Piganiol report. [104]

The OECD had initiated the Western reflections on science policy, [105] and these were, from the start, aligned to economic issues. In 1962, the Committee for Scientific Research (CSR) recommended that the Secretariat "give considerable emphasis in its future program to the economic aspects of scientific research and technology". [106] The orientation was in line with the 50% economic growth target advocated by the OECD for the decade. The CSR recommendation would be reiterated during the first ministerial conference in 1963 [107] and in the document *Government and Technical Innovation* that followed. [108]

The CSR proposal was based on the fact that there "is an increasing recognition of the role played by the so-called third factor [innovation] in explaining increases in GNP" (p. 2). But, so the CSR continued, "the economist is unable to integrate scientific considerations into his concepts and policies because science is based largely on a culture which is anti-economic" (p. 5). Thus, the OECD gave itself the task of filling the gap. The CSR document identified a series of policy questions:

Innovation, 1946-1962, in A.C. Hughes and T.P. Hughes (2000), *op.cit.*: 255-310; NBER (1962), *The Rate and Direction of Inventive Activity: Economic and Social Factors*, Princeton: Princeton University Press; N.E. Terleckyj (1980), What Do R&D Numbers Tell Us about Technological Change?, *American Economic Association*, 70 (2): 55-61.

[104] OECD (1963), *Science and the Policies of Government*, Paris: p. 24.

[105] See: B. Godin (2000), Outlines for a History of Science Measurement, *Science, Technology and Human Values*, in press; J.J. Salomon (2000), L'OCDE et les politiques scientifiques, *Revue pour l'histoire du CNRS*, 3: 40-58.

[106] OECD (1962), *Economics of Research and Technology*, SR (62) 15, p. 1.

[107] OECD (1963), *Ministers Talk about Science*, Paris: La Documentation française; OECD (1963), *Science, Economic Growth and Government Policy* (C. Freeman), Paris.

[108] OECD (1966), *Government and Technical Innovation*, Paris.

- through what political and administrative mechanisms can a harmonization of science and economic policies be achieved?
- by what criteria can decisions concerning the allocation of resources to research be arrived at?
- in what ways can research in the private sector be articulated and monitored?
- what should be the priorities in the public sector?

The document recommended three actions. [109] Firstly, that the OECD produces a statement on science and technology in relation to economic growth for a ministerial conference. The document was in fact produced as a background document for the first ministerial conference held in 1963. [110] Secondly, it recommended that the OECD assist countries in the development of science policies by way of annual reviews. The first review appeared in 1962 (Sweden), and pilot teams were created for less-developed countries in Europe. Thirdly, the CSR suggested that the OECD realizes studies on the relationships between investments in R&D and economic growth. Indeed, "comprehensive and comparable information on R&D activity are the key to 1) a clearer understanding of the links between science, technology and economic growth, 2) a more rational formulation of policy in government, industry and the universities, 3) useful comparisons, exchange of experience, and policy formation internationally". [111]

The main obstacle to the last suggestion, however, was identified as being the inadequacy of available data (p. 10). To support policies, the CSR thus recommended elaborating a methodological manual: [112]

> The main obstacle to a systematic study of the relationship between scientific research, innovation and economic growth is the inadequacy of available statistical data in Member countries on various aspects of scientific research and development. (…). The Secretariat is now preparing a draft manual containing recommendations defining the type of statistical data which should be collected, and suggesting methods by which it can be obtained.

[109] See also: SR (62) 39; C (62) 29; SR (63) 33; SR (64) 12.
[110] OECD (1963), Science, Economic Growth and Government Policy, *op.cit*.
[111] OECD (1963), *A Progress and Policy Report*, SR (63) 33, pp. 4-5.
[112] OECD (1962), *Draft 1963 Programme and Budget*, SR (62) 26, p. 19.

The manual was prepared by C. Freeman, adopted in 1962 and discussed at a meeting in Frascati (Italy) in 1963. [113] It proposed standardized definitions, concepts and methodologies for conducting R&D surveys (money spent and personnel). (The manual was restricted to the natural and engineering sciences until the third edition in 1976 which included the social and human sciences for the first time). It also conventionalized an indicator used for over twenty years in assessing R&D efforts: GERD/GDP. With time, the indicator acquired two functions: descriptive and prescriptive. For one, the indicator was a measure for comparing R&D effort between countries. But it was also a statistical tool used by every science department in every science policy document to justify or ask for increased funding. A country not investing the "normal" or average percentage of GERD/GDP always fixed itself highest ratios, generally those of the best performing country.

In line with the manual's conventions, an international survey on R&D was conducted in 1963, a survey in which 16 countries participated. [114] The results were published in 1967 and 1968. [115] In the meantime (1962-65), a study on R&D efforts in five countries based on existing statistics was realized. [116] The study was a catalyst for the continuation of the OECD's work in the field of measurement. It documented, for the third time in twenty years, gaps between America and Europe, this time in science and technology. It convinced – along with an important follow-up to the study [117] - member countries of the usefulness of statistical data for analyzing policy issues. In 1967, the Committee for Science Policy (CSP) of the DSA thus recommended that: « research and development accounting should

[113] OECD (1962), *The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of Research and Experimental Development*, Paris.
[114] It is worth keeping in mind that the OECD did not, neither then nor now, itself collect data but relied on Member countries surveys to send it their national statistics.
[115] OECD (1967), *A Study of Resources Devoted to R&D in OECD Member Countries in 1963/64: The Overall Level and Structure of R&D Efforts in OECD Member Countries*, Paris; OECD (1968), *A Study of Resources Devoted to R&D in OECD Member Countries in 1963/64: Statistical Tables and Notes*, Paris.
[116] C. Freeman and A. Young (1965), *The Research and Development Effort in Western Europe, North America and the Soviet Union: An Experimental International Comparison of Research Expenditures and Manpower in 1962*, Paris: OECD.

be established within OECD on a regular basis ». [118] This meant that international surveys on R&D would, in the future, be conducted periodically, and that the Frascati manual revised regularly in light of how the surveys performed. [119]

Despite the OECD's success in these early applications of statistics towards answering policy questions, the DSA proposed budget cuts in the Science Resources Unit (SRU) in 1972. The total resources employed in the SRU were about 112 man-months. The budget proposal for 1973 would have reduced these resources to slightly more than 55 man-months. [120] The proposed cuts were simply based on the assumption that SRU efforts were self-promoted for the sole needs of statisticians with little value to science officials. [121] But there was also a completely different argument: there was some reluctance on behalf of the United States that SRU would get too involved in comparative analysis (like *Gaps* studies) rather than collecting data, especially new data on output. [122]

As a consequence, a users group was created in 1972 following "reservations expressed by some Member countries about the suggestions that substantial cuts should be made in the budget for R&D statistics work in 1973 to free resources for new work". [123] The British delegate, Cyril Silver, chaired the group. He was probably the source of the controversial decision, according to the people I interviewed. The hypothesis that the UK Delegation was at the center of the proposed cuts is probably true since Silver wrote, in the introductory remarks to its report: [124]

> I started my task as a sceptic and completed it converted – converted that is, to the view that policy makers use and even depend on R&D statistics and particularly on those giving comparisons of national efforts in particular fields. What I beg leave to question now is whether perhaps too much reliance is placed on these all-too-fallible statistics.

[117] OECD (1968), *Gaps in Technology: General Report*, Paris. In line with the philosophy of system analysis espoused by the OEEC, the solution proposed was not more R&D but better management practices in industry and more support from government.
[118] OECD (1967), *Compte-rendu de la 4e session: 27-28 juin 1967*, SP/M (67) 2, p. 4.
[119] OECD (1967), *Future Work on R&D Statistics*, SR (67) 16.
[120] OECD (1973), *Report of the Ad Hoc Review Group on R&D Statistics*, SPT (73) 14, p. 12.
[121] Personal conversations with P. Hemily and J.-J. Salomon.
[122] Personal conversation with J.J. Salomon.
[123] OECD (1973), *op. cit*., p. 7.
[124] *Ibid*, p. 6.

Before arriving at this conclusion, however, the group studied different options, among them:

> The emphasis of the work of the Science Resources Unit has shifted from providing support to the remainder of the Science Affairs Directorate to providing much valued service to Member countries. We considered whether within OECD itself it might not in consequence now be more appropriate administratively for the Science Resources Unit to be associated with the general statistical services of the Organization.

The group finally formed the view that "on balance, the Science Resources Unit was best left administratively within the Science Affairs Directorate", but that "the liaison between the Science Resources Unit and the Divisions of the Scientific Affairs Directorate be improved by appointing each of the members of the Science Resources Unit as a liaison officer for one or more specialist activities within the Secretariat".[125]

The Science and Technology Indicators Unit

With the future of the statistical unit confirmed, work on the measurement of science and technology at the OECD expanded. Following the publication of the NSF's *Science Indicators* (*SI*) in 1973, a second users group, proposed by C. Falk from the NSF, was created to consider expanding the range of statistics used for measuring science and technology.[126] Indeed, in the seventies the SRU was still limiting itself to R&D statistics, whereas the Freeman and Young as well as the Gaps studies suggested using several indicators. The CSP also recommended new indicators as early as 1967.[127]

A major discussion during this period was on output indicators. Not long after the NSF published the second edition of *SI* (1975), the US Congress held hearings on the document.

[125] *Ibid*, p. 11.
[126] OECD (1978), *Report of the Second Ad Hoc Review Group on R&D Statistics*, SPT (78) 6. A third review group, created in 1984, gave the same message. See: OECD (1985), *Report of the Third Ad Hoc Review Group on Science and Technology Indicators*, STP (85) 3.
[127] OECD (1967), *Future Work on R&D Statistics, op. cit*, p. 5.

[128] The debates were entirely devoted to outputs. Congressmen asked the NSF what were the links between inputs and outputs, that is, whether outputs as measured with the indicators available were really outcomes of inputs. Clearly, politicians wanted output indicators while statisticians were satisfied with input indicators and with hypotheses and broad correlations between the two. Before the Committee of Congress, Robert Parke summarized the issue as follows: [129]

> " (…) we're asking questions about what happens as a result of all this activity [research] in terms of the output of science. We are going to be asking those questions in the year 2000, not just 1976. They are pervasive public concerns".

A similar demand for output indicators existed at the OECD. As early as 1963, the question of measuring outputs was on the agenda. [130] Thereafter, the statistical unit, mainly through its director Y. Fabian, tried year after year to convince national governments and their statisticians to extend the measurement of science and technology to outputs. They experienced some success, but also a lot of frustrations. National statisticians always hesitated, offering arguments about methodological difficulties or resources constraints. But a major factor beneath this hesitation was that outputs challenged State statisticians' monopoly of the field: the data imagined to measure outputs were not theirs, that is they were not based on surveys proper or came from administrative or bibliographic databases set up by other institutions.

While still continuing its work on inputs, the OECD gradually entered the field of output measurement in the 1980s. [131] It organized a series of workshops and conferences that led to the elaboration of new methodological manuals in the following decade:

[128] USGPO (1976), *Measuring and Evaluating the Results of Federally Supported R&D: Science Output Indicators*, Hearings Before the Committee of Congress on Science and Technology, Washington.
[129] *Ibid*, p. 72.
[130] Y. Fabian, *Note on the Measurement of the Output of R&D Activities*, DAS/PD/63.48.
[131] OECD (1983), *State of Work on R&D Output Indicators*, SPT (83) 12; OECD (1984), *Secretariat Work on Output Indicators*, SPT (84) 8.

1. Workshops and conferences:
    a. Outputs (1978, 1979, 1980).
    b. Technological Balance of Payments (1981, 1987).
    c. Innovation (1982, 1987, 1994).
    d. High Technology Trade (1983).
    e. Higher Education (1985).
    f. Human Resources (1981, 1992, 1993).

2. New methodological manuals:
    a. R&D in Higher Education (1989). [132]
    b. Technological Balance of Payments (1990). [133]
    c. Innovation (1992). [134]
    d. Patents (1994). [135]
    e. Human Resources (1995). [136]
    f. Globalization (1999). [137]

At about the same time the OECD started the publication of a regular series of statistics that owed their existence to a new database on indicators that began in1981. [138] Thereafter, the statistics produced by the SRU, renamed the Science and Technology Indicators Unit (STIU) in 1977, had two publics: the traditional one, that is, the policy-makers for whom

[132] OECD (1989), *The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of Research and Experimental Development* (Supplement to the Frascati Manual), Paris.
[133] OECD (1990), *The Measurement of Scientific and Technical Activities: Proposed Standard Practice for the Collection and Interpretation of Data on the Technological Balance of Payments*, Paris.
[134] OECD (1997), *Proposed Guidelines for Collecting and Interpreting Technological Innovation Data* (Oslo Manual), Paris.
[135] OECD (1994), *The Measurement of Scientific and Technical Activities: Data on Patents and Their Utilization as Science and Technology Indicators*, Paris.
[136] OECD (1995), *Manual on the Measurement of Human Resources in Science and Technology*, Paris.
[137] A whole chapter deals with the internationalization of technology. *Manual on Globalization Indicators*, DSTI/IND/STP/SWP/NESTI (99) 1/PART 1.
[138] OECD (1978), *General Background Document for the 1978 Meeting of NESTI*, DSTI/SPR/78.39; OECD (1981), *The Science and Technology Indicators Data Bank*, DSTI/SPR/81.38; OECD (1983), The *Science and Technology Indicators Data Bank: Progress Report*, DSTI/SPR/83.17.

the statistics would now be diffused more rapidly, [139] and the general public that could buy the paper or electronic version of the databases: [140]

1. *Science and Technology: Indicators Report*. Three editions appeared: 1984, 1986 and 1989. [141] The series was short-lived because it was considered too time-consuming. It was replaced by the followings.
2. *Main Science and Technology Indicators* (1988ss).
3. *Basic Science and Technology Statistics* (1991, 1997, 2000).
4. *R&D Expenditures in Industry* (1995, 1996, 1997, 1999).
5. *Science, Technology and Industry Scoreboard* (1995, 1997, 1999).

Faithful to the mission the DSA gave itself at the beginning of the 1960s, the STIU concentrated on a specific kind of output (and impacts) indicators: patents, technological balance of payments, and international trade in high-tech industries. What was peculiar about these indicators was the dimension they measured: all were concerned with economics. [142] This all happened after the DSA became the Directorate of Science, Technology and Industry (DSTI) in 1975.

Economic Analysis and Statistics Division

In the eighties, people began asking the STIU for more and more policy analyses and interpretations of the data collected. In the sixties, the work of the statistical unit was mainly methodological. In the following decade, the STIU began producing analyses of the data it collected, but with few real policy concerns. The analyses were mainly centered around the STIU's own interests, i.e. the results of the biennial R&D surveys:

[139] OECD (1976), *Methods of Accelerating the Collection and Circulation of R&D Data*, DSTI/SPR/76.52.
[140] To this list, we could add: the Science Resources Newsletter (published between 1976 and 1988) and the STI Review (launched in 1986 and still alive).
[141] A fourth edition was initiated, but never published.
[142] Despite the Brooks report which argue for more social considerations in science policies: OECD (1972), *Science, Growth and Society*, Paris. Indeed, this report is alone in all OECD reflections on science and technology.

- 1975: *Patterns of Resources Devoted to R&D in the OECD Area, 1963-1971*
- 1975: *Changing Priorities for Government R&D: An Experimental Study of Trends in the Objectives of Government R&D Funding in 12 OECD Member Countries, 1961-1972*
- 1979: *Trends in Industrial R&D in Selected OECD Countries, 1967-1975* (1979); *Trends in R&D in the Higher Education Sector in OECD Member Countries since 1965 and their Impact on Basic Research Efforts* (never published).

Thanks to its new database, the STIU began producing more analyses in the eighties. It published three reports on science and technology indicators with texts and analyzes, for example, but the national delegates, grouped under NESTI, [143] usually stressed the "importance of reports, not only because of the trends they revealed, but because their preparation highlighted problems with the quality and comparability of the data". [144] The situation changed considerably in the nineties. While the work on indicators was mainly framed, until then, in terms of inputs and outputs, that is, of categorizing the indicators according to the dimension of the scientific and technological activities they measured, the division increasingly contributed to policy problems with whatever indicators it had or could develop, be it input or output.

In 1987, as a contribution to the Secretary-General's technology initiative, an important project was launched by the DSTI entitled Technology/Economy Project (TEP). TEP was intended to define an integrated approach to technology. Ten conferences were held that resulted in *Technology in a Changing World* (1991) and *Technology and the Economy: The Key Relationships* (1992). The project was the occasion for the statistical unit to review its

[143] OECD work on science and technology statistics is undertaken by the STIU together with the Group of National Experts on Science and Technology Indicators (NESTI) of the DSTI, created in 1962. NESTI is a subsidiary body of the OECD Committee for scientific and technological policy (CSTP) and represents both users and producers of statistics with two-thirds of its principal delegates coming from ministries of science and technology or associated bodies, and one-third from central statistical offices or similar producer agencies. It holds annual meetings where each OECD country is represented, in addition to some observers.
[144] OECD (1987), *Summary of the Meeting of NESTI*, SPT (87) 8, p. 5.

work for the forth time in fifteen years. [145] In December 1990, the DSTI organized a TEP conference on indicators that brought users and producers together to discuss needs for new indicators and to set priorities. [146] As such, it was similar to the three Ad Hoc Reviews of science and technology indicators discussed above.

The director of the division stated that "TEP could be judged a success if it resulted in new indicators". [147] Indeed, an ambitious plan of work was outlined under eight new topics: [148]

- Technology and economic growth,
- Globalization,
- Competitiveness and structural adjustment,
- Investment, innovation and diffusion of technology,
- Technology and human resources,
- Innovation-related networks,
- Knowledge-based for technological innovation,
- Technology and the environment.

The new goal of the statistical unit was to "anticipate policy makers priorities rather than merely responding to them retrospectively". [149] To better align the STIU work toward policies, the DSTI made organizational changes. The Unit was transformed into a division. A Science, Technology and Industry Indicators Division (STIID) was created in 1986. The statisticians [150] finally got a formal recognition of their work, but a constrained one:

[145] The TEP can be seen as "continuing the tradition of the Brook's report [1971] and the study on science and technology in the new economic and social context [1980]": OECD (1992), *The Work of the CSTP Since the 1987 Meeting at Ministerial Level*, DSTI/STP/MIN (92) 9, p. 2.
[146] OECD (1991), *Summary Record of the Meeting of Experts on the Consequences of the TEP Indicators Conference*, DSTI/STII/IND/STP (91) 2.
[147] OECD (1991), *Summary Record of the Meeting of Experts on the Consequences of the TEP Indicators Conference*, DSTI/STII/IND/STP (91) 2, p. 2.
[148] OECD (1990), *A Draft Medium Term for the Work of the STIID*, DSTI/IP (90) 22; OECD (1990), *Demand for New and Improved Indicators: Summary of Suggestions for new Work for the STIID*, DSTI/IP (90) 30.
[149] OECD (1993), *Summary of the Meeting of NESTI*, SPT (93) 2, p. 4.
[150] I called people working with statis tics at the OECD "statisticians" although few of them were trained as such.

included were industry preoccupations that would indeed guide their future efforts. NESTI would still counsel the division on science and technology indicators, but would now have to collaborate more closely on a combined program of work with Working Party no. 9 of the Industry Committee and the Group of Experts on ICC (Informatics, Computers and Communication) statistics. [151] The explicit aim of the restructuring was to improve the policy relevance of statistics and the capability of DSTI to perform deeper quantitative analyses: "New activities should be planned in line with emerging policy needs, e.g. the outcome of the meeting of the CSTP at Ministerial level". [152] At the same time, it gave more visibility and relevance to the STIID: "in consequence [so said NESTI], the work of the group was becoming increasingly visible in policy terms". [153]

In parallel to these wishes, a coordinated project was launched in 1988 (Structural Analysis Program) on indicators of scientific, technological and industrial competitiveness and performance, with three broad goals: [154]

- To establish comprehensive, disaggregated, internationally comparable databases linking R&D, input-output, industrial and import/export data at the individual industry level.
- To construct a wide range of industry and aggregate-level indicators of the evolution of technological and economic performance.
- To undertake empirical studies of the role of technology in globalization, international competitiveness, productivity growth and structural change.

The main output of the project was a new database, STAN (Structural Analysis), implemented in 1992. [155] STAN was intended to cover the full data spectrum from basic

[151] OECD (1986), *Proposal for a Combined Statistical Working Party on Scientific, Technological, Industrial and ICC Indicators*, SPT (86) 10.
[152] OECD (1988), *Summary of the Meeting of NESTI*, SPT (88) 2, p. 3.
[153] OECD (1995), *Summary Record of the NESTI Meeting Held on 24-25 June 1995*, DSTI/EAS/STP/NESTI/M (95) 1, p. 4.
[154] OECD (1994), *Statistics and Indicators for Innovation and Technology*, DSTI/STP/TIP (94) 2, p. 8.
[155] OECD (1988), *Progress Report on STAN*, DSTI/IP/88.19; OECD (1994), *STAN Databases and Associated Analytical Work*, DSTI/EAS/STP/NESTI (94) 7.

research to trade indicators. It was designed specifically to underpin analyses of the connection between technology, structural adjustment and economic performance. Specifically, STAN was "intended to be an analytical tool on which much of the quantitative analysis and modeling carried out in the DSTI will be founded (…) and provide a scoreboard of indicators in order to monitor and evaluate the evolution of industrial structures and economic competitiveness and performance in the light of scientific and technological developments".[156] As a consequence, *Science, Technology and Industry Outlook*, a biennial quantitative review combining elements from the Industrial Review, the S&T Policy Outlook and the earlier S&T Indicators reports was published in 1996.[157] Also, a scoreboard of indicators became regularly available from 1995 as *Industry and Technology: Scoreboard of Indicators*.

From then on, the EAS Division (the STIID was renamed Economic Analysis and Statistics (EAS) in 1993) got involved in several policy exercises in the DSTI, as well as with other Directorates of the OECD, among them: growth project (new economy), knowledge-based economy, information society, intangible investments, globalization, national innovation systems, new technologies (biotechnology, ICT), highly qualified manpower (stocks and flows).[158]

What was peculiar of several of these projects was their focus on productivity, a topic, as we saw above, that was central to OEEC work in the 1950s, and was at the origins of economists' studies of R&D. Contrary to the OEEC however, the OECD intended to specifically measure the contribution of science and technology to economic growth. It was

[156] OECD (1987), *Review of the Committee's Work Since 1980*, DSTI/SPR/87.42, p. 18; OECD (1988), *Summary of the Meeting of NESTI*, SPT (88) 2, p. 10.
[157] OECD (1994), *Developing STI Reviews/Outlooks: A Proposal*, DSTI/IND/STP/ICCP (94) 4.
[158] A workshop and a conference on a new generation of indicators were also organized in 1996 and 1998 (Blue Sky Project). See: OECD (1996), Conference on *New Indicators for the Knowledge-Based Economy: Summary Record*, DSTI/STP/NESTI/GSS/TIP (96) 5; OECD (1997), *Progress Report on the "New S&T Indicators for the Knowledge-Based Economy" Activity*, DSTI/EAS/STP/NESTI (97) 6; OECD (1998), *Seminar on New Indicators for the Knowledge-Based Economy: Development Issues*, CCNM/DSTI/EAS (98) 63; OECD (1998), *New S&T Indicators for a Knowledge-Economy: Present Results and Future Work*, DSTI/STP/NESTI/GSS/TIP (98) 1; OECD (1999), *The Knowledge-Based Economy: A Set of Facts and Figures*, Paris; OECD (1999), *Science, Technology and Industry Scoreboard 1999: Benchmarking Knowledge-Based Economies*, Paris; OECD (2000), New Science and Technology Indicators, *STI Review*, 27.

an old project indeed. In the previous two decades, the DSTI had developed projects on structural adjustment and technology (1976-78), [159] and science, technology and competitiveness (1981-84). [160] It also organized an important international seminar on technology and productivity (1989) during the TEP exercise. [161] Now, the EAS Division was associated with several projects of the OECD devoted specifically to productivity. Analyses were conducted on productivity and job creation [162] and on the contribution of R&D, innovation and technologies to economic growth. [163] The premise of the OECD works on productivity was that although there was evidence of acceleration of industry's technological efforts in most member countries, this had not yet been reflected in an upturn in productivity. This is often called the productivity paradox, pretty well documented in science and technology studies, [164] but only recently discussed in the economic literature. [165]

One of the most important outputs of the decade for the EAS Division was certainly the Oslo manual on innovation. [166] Innovation surveys were first suggested, at least for the OECD, by K. Pavitt in 1976, [167] but had to wait until the 1990s before they were widely conducted. The idea was largely supported by Scandinavian countries that had a "project to organize coordinated surveys of innovation activities in four Nordic countries and to develop a conceptual framework for the development of indicators of innovation". [168] The

[159] OECD (1978), *Technology and The Structural Adaptation of Industry*, DSTI/SPR/78.25 and 78.26.
[160] OECD (1984), *Technology and International Competitiveness*, DSTI/SPR/84.46; OECD (1981), *Analysis of the Contribution of the Work on Science and Technology Indicators to Work on Technology and Competitiveness*, DSTI/SPR/81.21.
[161] OECD (1991), *Technology and Productivity: The Challenge for Economic Policy*, Paris.
[162] OECD (1996), *Technology, Productivity and Job Creation*, Paris; OECD (1996), *Technology and Industrial Performance*, Paris.
[163] OECD (2000), *Is There a New Economy? First Report on the OECD Growth Project*, DSTI/IND/STP/ICCP (2000) 3; OECD (2000), *A New Economy? The Changing Role of Innovation and Information Technology in Growth*, Paris; OECD (2000), *R&D and Productivity Growth: A Panel Data Analysis of 16 OECD Countries*, DSTI/EAS/STP/NESTI (2000) 40.
[164]
[165] In the 1950s, the question was discussed under what was called the residual factor, but without much interest of economists in integrating science and technology in the equation of productivity.
[166] OECD (1992), *op. cit*.
[167] OECD (1976), *Science Indicators: The Measurement of Innovation-Related Activities in the Business Enterprise Sector*, DSTI/SPR/76.44.
[168] OECD (1989), *Summary Record of the Meeting of NESTI*, SPT (89) 27, p. 2.

framework was prepared by K. Smith, from the Research Policy Group in Oslo, and would become the first draft of the manual.

The Oslo manual was an important output of the statistical unit for four reasons. Firstly, the manual was one of the first concrete examples of the alignment of EAS towards new policy priorities, that is technology and industry. Secondly, the manual extended for the first time the measurement of science and technology beyond R&D that is to related scientific activities. [169] Thirdly, the surveys conducted according to the manual posed methodological challenges: the numbers from the innovation survey and the ones in the R&D survey were different with respect to a common variable – the expenditures on R&D. [170] Lastly, the manual was one of the first steps towards increased collaboration of the OECD with other players: the second edition (1997) of the manual was developed in collaboration with the European Union - the results of the first surveys had indeed been widely used by the European Commission.

The European Union would gradually get into the field of science and technology statistics with several initiatives. Besides the development of a *Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets* (NABS) as early as 1969, it contributed, through its Enterprise Directorate, to the Oslo manual on the measurement of innovation, and the Research Directorate (DG XIII) produced, jointly with the OECD, the Canberra manual devoted to measuring human resources in science and technology. [171] The Research Directorate also produced a regional manual on R&D and innovation statistics, [172] and started publishing, jointly with Eurostat, a biennial report on science and technology inspired by the NSF's *Science and Engineering Indicators*. [173] In the meantime, Unesco, which, since the sixties, had devoted itself to extending OECD standards to Eastern Europe and developing countries, almost completely abandoned the field. [174]

[169] B. Godin (2000), Neglected Scientific Activities, *op. cit*.
[170] B. Godin (2001), Defining R&D, *op. cit*.
[171] OECD (1995), *Manual on the Measurement of Human Resources in Science and Technology*, Paris.
[172] Eurostat (1996), *The Regional Dimension of R&D and Innovation Statistics*, Brussels.
[173] European Union (1994), *European Report on S&T Indicators*, Brussels.

At the beginning of the third millennium, the OECD has succeeded in establishing a monopoly. Like Unesco in the 1960s and 1970s, the European Union would like to have a share of it, and financial pressures at the OECD are certainly helping to bring this objective nearer to fruition. The DSTI (and the DSA), under budget constraints for thirty years now, urged as early as 1972 for greater collaboration with non-OECD organizations, [175] and therefore looked for new ways of financing its work and expanding its measurements. [176] As a result, a third of the EAS Division's work is now performed using external contributions, [177] with the European Union as a major contributor. The fact remains that, in NESTI's own terms, while Unesco has experience and Eurostat achievements, the OECD has the leading role. [178]

Conclusion

The OECD had been responsible for a major output in the field of science and technology measurement, that of standardizing heterogeneous national practices. It succeeded in this task without any opposition from Member countries. This is quite different from the history of other standards and statistics. The diffusion of the French meter outside France, for example, has not been an easy task, and the meter is still not universally used today. [179] Similarly, the standardization of time units opposed for a while its English proponents against the French. [180]

[174] See: B. Godin (2000), Neglected Scientific Activities, *op. cit.*

[175] OECD (1972), *Meeting of the Ad Hoc Review Group on R&D Statistics*, DAS/SPR/72.46; OECD (1973), *Results of the Meeting of the Ad Hoc Group of Experts on R&D Statistics*, DAS/SPR/73.61.

[176] Today, the OECD prefers measuring new dimensions of science and technology by way of (any input or output) links between existing data rather than producing new data (ex.: knowledge-based economy), partly because of budget constraints – linking existing data is far less expensive than developing totally new indicators. See: OECD (1996), *Conference on New S&T Indicators for a Knowledge-Based Economy: Summary Record of the Conference Held on 19-21 June 1996*, DSTI/STP/NESTI/GSS/TIP (96) 5; OECD (1996), *New Indicators for the Knowledge-Based Economy: Proposals for Future Work*, DSTI/STP/NESTI/GSS/TIP (96) 6.

[177] OECD (1999), *A Strategic Vision for Work on S&T Indicators by NESTI*, A. Wyckoff, DSTI/EAS/STP/NESTI (99) 11.

[178] OECD (1997), *Some Basic Considerations on the Future Co-Operation Between the OECD Secretariat and Eurostat with Unesco in the Field of Science and Technology Statistics*, DSTI/EAS/STP/NESTI (97) 12, p. 2.

[179] D. Guedj (2000), *Le mètre du monde*, Paris : Seuil.

[180] E. Zerubavel (1982), The Standardization of Time: A Socio-Historical Perspective, *American Journal of Sociology*, 88 (1): 1-23.

At least three factors contributed to the easy acceptance of the Frascati manual among OECD countries. Firstly, few countries collected data on science and technology in the early sixties. The OECD offered a ready-made model for those who had not yet developed the necessary instruments. For the few countries that already collected data, mainly anglo-saxon countries, the manual reflected their own practices fairly well: it carried a community of views that was already shared by them.

Secondly, the standardization was proposed by an international organization and not by a specific country, as was the case for the meter or the time unit, for example. This was perceived as evidence of neutrality, although the United States exercised overwhelming influence.

Thirdly, the OECD introduced the manual with a *petits pas* strategy. First step: as with the first edition, the document began as an internal document only (1962). It would not be published officially before the third edition (1976). Second step: the manual was tested (1963-64) in a large number of countries. Third step: it was revised in light of the experience gained from the surveys. Regular revisions followed, the manual being in its sixth edition now.

The philosophy of the OECD was explicitly stated in 1962 in the following terms: [181]

> It would be unrealistic and unwise to expect certain Member governments to adapt completely and immediately their present system of definition and classification of research and development activity to a proposed standard system of the OECD. However, it should perhaps be possible for governments to present the results of their surveys following a proposed OECD system, in addition to following their own national systems. Furthermore, governments could take account of a proposed OECD system when they are considering changes in their own system. Finally, those government who have yet to undertake statistical surveys of R&D activity could take account of, and even adopt, a proposed OECD system.

Despite the consensus of Member countries on the Frascati manual however, there were and still are “conflicts” on certain issues, practical difficulties of implementing the suggested guidelines, and differences with other international bodies. In consequence, some recommendations of the manual are poorly followed. To take just a few examples, basic research is a concept that more and more countries are dissatisfied with and, consequently, several have stopped measuring it. [182] On another issue, certain countries (like Canada) preferred for a while to measure government funding of industrial R&D by using data from ministries, rather than those of the performer as recommended by the OECD. Lastly, there were countries (like the United States and Japan) that, until recently, never wanted to adapt their own statistics to the OECD standards - they always thought it was the organization that had to adapt to them.

All in all, the OECD manual has never been an imperative document. It suggested conventions, but each country was totally free to apply them. It was the OECD itself, in collaboration with the national experts, that had to work hard to harmonize or estimate national data. Certainly, the construction of international comparisons generally means, for a specific country, abandoning national specificities. In the case of science and technology statistics, however, standardization was facilitated by the fact that national statistics were already “international”: a select group (of anglo-saxon countries) has already defined how others would collect their data.

[181] OECD (1962), *Measurement of Scientific and Technical Activities: The Possibilities for a Standard Practice for Statistical Surveys of R&D Activity*, SR (62) 37, p. 2.
[182] B. Godin (2000), Measuring Science: Is There Basic Research Without Statistics, *op. cit*.

Annex 1.

Early experiments in the measurement of R&D

	Industry	Gov.	Univ.	Others	All
		Sectors			
United States					
National Research Council	1933				
Works Progress Administration	1940				
National Resources Committee	1941 [183]	1938 [184]			
Bush (Bowman report)					1945
Kilgore		1945			
OSRD		1947			
Steelman					1947
Bureau of Budget					
National Ass. of Manufacturers	1947				
Nat. Industrial Conference Board	1947				
Harvard	1952				
	1953				
Bureau of Labor Statistics	1953			1950 [185]	
				1951 [186]	
Am. Soc. for Engineering Education			1951		
			1956		
Department of Defense					1953
National Science Foundation	1956	1953	1953 [187]		

[183] By the NRC.
[184] Includes data on universities.
[185] On the work conditions of scientists.
[186] On the salaries of scientists.
[187] Including the non-profit sector.

		Sectors			
	Industry	Gov.	Univ.	Others	All
Canada					
National Research Council	1941				
Department of Reconstruction		1947			
Dominion Bureau of Statistics	1956	1960			
United Kingdom					
Federation of British Industries	1947				
	1961				
ACSP					1956
DSIR	1958				
Germany					
Donor' Association For German Science	1948	1964 [188]	1960 [189]		

[188] Manpower only.
[189] Manpower only. Regular suveys started in 1966 only.

Annex 2.

Repertories on Science and Technology

(First editions)

	Sectors				Personnel
	Ind.	Gov.	Univ.	Others	
United States					
National Research Council	1920		1920 [190]	1923 [191]	
				1927 [192]	
NRPB (Roster)					1940
National Science Foundation	1957 [193]				1953 [194]
Canada					
National Research Council				1927 [195]	
United Kingdom					
Association of British Workers	1936				
Royal Society					193?
OECD					

[190] Doctorates.
[191] Fellowships.
[192] Societies.
[193] Independent Commercial Laboratories.
[194] The roster is transferred to the NSF.
[195] Appeared in the US NRC repertory (1927).

Annex 3.
Statistical publications of the NSF
From 1950 to 1960 (To be completed)

Totals for the economy

1. Expenditures for R&D in the United States 1953, NSF 56-28, Washington, 1956.
2. Funds for R&D in Colleges and Universities 1953-54, Washington, 1957.
3. Funds for Research in Medical Schools 1953-54, Washington, 1957.
5. Funds for Basic Research in the United States 1953, NSF 57-22, Washington, 1957.
7. Funds for R&D in Engineering School 1953-54, Washington, 1957.
8. Funds for Research in Agricultural Experiment Stations 1953-54, Washington, 1957.
9. Scientists and Engineers in R&D 1954, NSF 58-9, Washington, 1958.

Federal Government

1. Funds for Scientific Activities in the Federal Government 1953-54, Washington, 195?
2. Scientific Manpower in the Federal Government 1954, Washington, 195?
3. Federal Funds for Science (Federal R&D Budget), Washington, 1952-59.

Industry

1. R&D by Nonprofit Research Institutes and Commercial Laboratories, Washington, 1953.
2. Research by Cooperative Organizations: A Survey of Scientific Research by Trade Associations, Professional and Technical Societies, and Other Cooperative Groups, Washington, 1953.
3. Science and Engineering in American Industry, Washington, 1956.
4. Scientific R&D in Colleges and Universities: Expenditures and Manpower 1953-54, Washington, 1959.

Nonprofit institutions

1. Scientific Research Expenditures by Large Private Foundations, Washington, 1956.
2. R&D by Nonprofit Research Institutes and Commercial Laboratories 1955, Washington, 1956.
3. Research Expenditures of Foundations and Other Nonprofit Institutions 1953-54, Washington, 1957.

Colleges and Universities

1. Scientific R&D in Colleges and Universities 1953-54, Washington, 195?

Annex 4.

NESTI seminars, workshops and conferences

(To be completed)

Workshops and conferences:

3. R&D Deflators (1977)
4. Outputs (1978, 1979, 1980)
5. Technological Balance of Payments (1981, 1987)
6. Innovation and patents (1982, 1986, 1994)
7. High Technology Trade (1983)
8. Higher Education (1985)
9. Non-member countries (1991)
10. Human S&T resources (1981, 1992, 1993)
11. High-technology industries and products (1993)
12. S&T indicators in Central and European countries (1993)
13. Application of OECD methodologies in PIT countries and the Russian Federation (1995)
14. New S&T indicators for knowledge-based economy (1996, 1998)
15. Use of S&T indicators for decision-making and priority setting (1997)
16. Biotechnology Statistics (2000)
17. Health-Related R&D (2000)

Other workshops where NESTI was involved:

18. TEP indicators conference (1990)
19. Intangible investment (1992)
20. Economics of the information society (1995-97)
21. S&T Labor Markets (1999)
22. Mobility of Highly Qualified Manpower (2001)