The Development of S&T Statistics in Canada: An Informal Account

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The Development of S&T Statistics in Canada:
An informal account

There will be omissions and some errors in this note, for which the author apologizes. He is separated from his professional library by 13 years and several thousand kilometers, and must rely mainly on memory and three parliamentary reports[i]*. However, he should be a good source of information on the development of S&T statistics in Canada, since he directed the program for twenty-five years, from summer 1963 to summer 1988. There are three main participants in this development: the Dominion Bureau of Statistics, later Statistics Canada; the science policy unit of the Federal Government, mainly the Ministry of State for Science and Technology; and the Organization for Economic Cooperation and Development, mainly the Directorate for Science, Technology and Industry.*

Early statistics

In the summer of 1963, I joined the Dominion Bureau of Statistics(DBS) and became the first full-time statistician to work in the area of science and technology(S&T) statistics. Surveys of research and development(R&D) expenditures and personnel had been carried out for some years as part-time activities in the General Assignments Division of the DBS[ii]. These were inspired by the National Reseach Council(NRC), undoubtedly influenced by the National Science Foundation(NSF) of the U.S.A. The first "Frascati" meeting was held in June 1963 and may have influenced the decision to hire a statistician to carry out regular surveys. I believe there were three Canadian representatives at that meeting: Guy Leclerc and Don Traquair of the DBS and George McColm of the NRC.

George McColm had been the main source of R&D statistics for some time; in 1961, his estimates of of Canadian R&D expenditures from 1939 to 1959 were presented to the House of Commons Committee on Research by Dr. C.J. Mackenzie[iii]. He continued to be involved in the development of S&T statistics for several years, cooperating with the DBS and participating in the work of the OECD[iv], including the second Frascati meeting. This involvement of the National Research Council reflected its mandate, not always observed, for overall advice on science policy to the Federal Government.

The year 1963 was a crucial year for Canadian science policy and statistics. The Frascati meeting, a landmark for S&T statistics, has been noted. Even more important, for Canadian science policy, was the work of the "Glassco Commission"[v] as set out in "Scientific Research and Development," Special Areas of Administration N^{o} 23.

Effect of the Glassco Commission

The response to the report of the Glassco Commission affected S&T statistics in two ways: on the science policy mechanism of the Federal Government (market for statistics) and on the Dominion Bureau of Statistics (production of statistics).

The Commission recommended the establishment of a new ministry, the Treasury Board, responsible for overseeing general government administration. Reporting to the President of the Treasury Board was to be a "Central Scientific Bureau," under the "Scientific Secretary."

> The duties of the Central Scientific Bureau will include the assembly of data and conduct of investigations and studies required in the field of scientific policy. In addition, a general and continuing scrutiny of all government scientific programmes should be maintained and comprehensive information as to all facets of research and development conducted in Canada and elsewhere should constantly be available. ...[vi]

It also recommended the formation of a "National Scientific Advisory Council," served by the Central Scientific Bureau, with the Scientific Secretary as secretary to the Council.

> The Council should be called upon each year to review all government scientific programmes. All changes in emphasis or scope should be scrutinized and proposed expenditures as reflected in the Estimates should be considered by the Council before submission to the Treasury Board for approval. A report containing the Council's views and recommendations should be submitted to the President of the Treasury Board following each review. ...[vii]

Although not followed exactly, these recommendations were substantially implemented in the early 1960s.

The ability of the Federal Government to provide statistics was greatly enhanced as a result of the recommendations on the Commission on statistical services (Special Area of Administration N^{o} 3). This led to both an improvement in the status and authority of the Dominion Bureau of Statistics, by moving it up in the Government hierarchy, but also in the staffing levels. Thus the DBS was able to provide more resources to the collection and publication of S&T statistics.Les modes d'appropriation sociale de la science et de la technologie

Early selection of methodology

1. 1. DATA COLLECTION

In the early 1960s, there were two approaches to the collection of S&T data. One was through periodic surveys of institutional expenditures and personnel. The other was through inventories of laboratory projects and resources. The latter approach, appealing in its apparent accuracy and continuity, was a feature of the Belgian system. In 1963-64, whilst studying at the Université catholique de Louvain, I spent some time with the unit responsible for the inventory, the Unité de la Programmation Scientifique of the Conseil National de la Politique Scientifique.

The Belgian method seemed particularly desirable for coverage of the university and government sectors. The laboratory inputs of money and staff were classified by the nature of the input, i.e., type of expenditure or personnel. They were also classified, I believe, by nature of R&D and by major field of science. However, because of the greater number of laboratories existing in Canada, it was apparent that we[viii] did not have the resources to undertake a similar procedure. Consequently, S&T data were collected by periodic surveys of institutions in the business enterprise and government sectors; activities in the university sector could only be estimated indirectly.

2. DATA COLLECTED

Research-development, if not the only S&T activity surveyed (or estimated), was always the core activity. However, it was recognized from the beginning of serious data collection, that other activities should be measured. For example, there is a table in the report of the Glassco Commission[ix] in which estimates of federal expenditures "by kind of scientific research and development activity" are presented for 1951-52 to 1961-62. These are classified by operating expenditures: conduct of research and development, collection of scientific data, scientific information, and scholarships and fellowships; and by capital expenditures for buildings and works. It will be seen later that not only were these activities further developed, but that various classes of output or results of R&D were also defined.

Institutions after Glassco

The Glassco recommendations for strengthening national science were not followed exactly, nor were the new bodies as powerful as proposed. Instead of a Central Scientific Bureau under the President of the Treasury Board, a Science Secretariat was established within the Privy Council Office. It had none of the control functions recommended by the Glassco Commission but was purely advisory. It did, however, sponsor studies of four or five scientific disciplines in Canada. It was also active in keeping abreast of international developments in science policy and structures, and participated in meetings and conferences sponsored by the OECD (by the Directorate for Science, Technology and Industry - or a predecessor directorate). Contacts were frequent between us and the Science Secretariat, particularly with Dr. Sid Forman and Dr. André Desmarais. Cooperation was possible, and close, on methodological development and definitions. However, cooperation on data collection was not feasible, for two reasons. The Statistics Act prohibited sharing individual information (data) with others, so unpublishable information from our surveys could not be given to the Science Secretariat, and, as noted above, laboratory inventory surveys required greater resources than were available. It was also felt - and the proposal was made several times during my tenure - that inventories, of projects or laboratories - were not part of the mandate of the central statistical agency.[x]

As noted above, the Glassco Commission recommended the formation of a National Scientific Advisory Council, served by the Central Scientific Bureau, with the Scientific Secretary as secretary to the Council. Again, this unit had very significant information collection and control functions. A less intrusive (and less influential) body was actually created: the Science Council of Canada. It operated fairly autonomously; although the Council itself included some government employees and persons dependent on government funding; it had a relatively large and competant staff who produced a number of reports and studies during the life of the Council[xi]. There was little cooperation between the Science Council and the DBS. Because of the Statistics Act, the Science Council staff could not have privileged access to the data collected on S&T. Furthermore, the degree of aggregation necessary to preserve individual confidentiality of data, and the time needed to translate and publish statistics, were problems for studies carried out by Council staff..

The Lamontagne Committee

At the end of the 1960s the Senate Special Committee on Science Policy began hearings under its chairman, Senator Maurice Lamontagne. It recommended:

> that the Canadian government and Parliament adopt an overall plan for the Seventies for science and technology, based on longer-term projections and oveall national R&D targets, and that the procedures and organization of the planning, programming, and budgeting system be improved to provide a better assessment of the output of R&D activities and a better basis for determining annual appropriations for the financing of such activities. We also recommend that by 1980 the approach be formalized in a framework of successive five-year plans.[xii]

It also recommended:

> that the Ministry of State for Science and Technology be made responsible for keeping a national R&D inventory and be made responsible for developing a national audit of current R&D programs and projects being supported by public funds.[xiii]

The Ministry of State for Science and Technology (MOSST)[xiv]

The Ministry, established in 1971, replaced the Science Secretariat. From the beginning, the S&T statistical unit had a closer relationship with the Ministry than with the Science Secretariat. In my experience, the Secretariat had two main concerns: keeping up with trends in science internationally, including the statistical work of the OECD, and establishing the situation and future of individual major scientific disciplines in Canada. The Ministry was more focussed on the Federal Government's S&T policies and programs.

As noted above, the Lamontagne Committee recommended that MOSST keep "a national R&D inventory" and develop "a national audit of current R&D programs and projects being supported by public funds." I do not know to what extent the Ministry attempted to carry out these recommendations; I suspect that it was soon established that the national R&D inventory, if it were to be an inventory of projects, was not feasible without extensive resources and authority. I do believe that the Ministry saw a sort of <u>statistical</u> inventory as being a desirable alternative and encouraged the development of sectoral and regional R&D statistics. There was inevitably and continually a conflict, generally amiable, between the Ministry's interest in the most disaggregated data and Statistics Canada's confidentiality restrictions.

The audit of publicly funded R&D programs and projects may be associated with the first recommendation related to the control of government funding for R&D. This

involved the Ministry in the annual budgetary process. It became included, with the Treasury Board, in reviewing departmental budgetary proposals, when they included significant S&T expenditures. Besides its confidential recommendations and observations, MOSST also provided a public report on federal expenditures on S&T, the "Red Book."

However, Statistics Canada had been surveying the S&T activities of federal departments and agencies for some years. There was a potential for duplication of effort, for the respondents and the two agencies, and a potential for the release of conflicting information. Initially, the two agencies went their own ways, to the evident displeasure of the other federal departments and agencies. A cooperative arrangement was soon established, by which the statisticians became part of the budgetary process; this arrangement will be described more fully in a later section.

Two other initiatives of the Ministry affected the development of S&T statistics: national R&D targets and the "make or buy" policy. The Lamontagne Committee had recommended the establishments of national R&D targets. These targets were expressed, by MOSST, as expenditures on R&D as a percentage of Gross Domestic Product. This was a ratio used also by the OECD. The numerator in the fraction is defined as "Gross Domestic Expenditures on R&D(GERD)," or an estimate of all expenditures on R&D in Canada, including those funded by foreigners but excluding Canadian-funded R&D performed abroad. Typically Canadian GERD/GDP was about 1.2%, so targets of 1.5% or 2.0% or 2.5% within a few years did not seem unreasonable. However, once the GERD was studied in the matrix of performing and funding sectors, one asked how this growth was to be achieved? With no significant increase in government funding, for either the government sector or others, with the higher education sector dependent on government funding, the growth must come from business enterprise sector. Thus a relatively small increase in the national target implied a very great increase in the activity in one sector.

When this became apparent, measures were taken to redefine R&D and to encourage industrial R&D. The first was not an initiative of MOSST but was favoured by another department. It provided some light moments. For one government program, an official definition was made in this style: "Experimental development is defined to be experimental development plus (one of the related activities)"! However, since Statistics Canada did not change the definitions and maintained consistent time series of R&D, a divergent series could not be accepted as valid and overt attempts to broaden the definitions were not continued.

The encouragement of industrial R&D involved several federal departments besides MOSST. The Government adopted a "Make or Buy" policy for R&D and other S&T programs in 1972. In essence, departments were encouraged to contract out such programs, or components of these programs, by having to justify a decision to do the

work "in-house." It was supplemented by the "Unsolicited Proposal" program. Through the Science Centre, Supply and Services was the central department for these programs; it advertised the policies, developed the contracts, and published a newsletter which identified contracts, and contracting parties. This newsletter became an important source of information for Statistics Canada; it identified smaller industrial R&D performers which might otherwise have been omitted from the R&D surveys and provided data useful for checking completed questionnaires or estimating for companies which failed to respond to surveys.

Another measure involved increased tax incentives. These have come and gone over the years but have an uneven record. One of these early incentives, undertaken in haste to attempt to push industrial R&D towards meeting the national R&D target, became a costly lesson in program control. It also provides an example of the benefits of an independent statistical agency. A large number of companies, claiming billions of dollars for R&D, appeared in response to the new incentive. However, to the dismay of the program sponsors, we could not find a corresponding increase in R&D activity. Some claimants had no R&D facilities nor personnel; others reported that their activities were not R&D by Statistics Canada definitions. The notorious program was terminated and subsequent programs included better controls and monitoring. However, during much of the succeeding years, there was a quiet and generally friendly dispute between some managers of these incentives and ourselves. A manager would ask for advice about the eligibility of a project and, if we thought the activity not to be R&D, would argue that it was innovative. Which would lead to a discussion of the difference between innovation and R&D.

In 1988 MOSST was absorbed by the Department of Industry. The S&T unit of Statistics Canada was closely involved with the Ministry during its existence, actually being attached to it for some years. During its life, the Ministry, perhaps even more than most federal departments or agencies, seemed to be continually in movement. It seemed that every few years it would be abruptly cut, then allowed to grow again, then cut again, with no discernable rhyme or reason at the operations levels. This was a reflection not only of general federal management practice but also of its uncertainty with respect to S&T policy. I cannot help quoting:

> We trained hard but it seemed that every time we were beginning to form up into teams, we would be reorganised. I was beginning to learn in life that we tend to meet any new situation by reorganisation, and a wonderful method it can be for creating the illusion of progress, while producing confusion, inefficiency, and demoralisation.
>
> CAIUS PRETORIUS, AD 66[xv]

The Department of Industry

Relations between the S&T statistics unit and the Department of Industry were not nearly as close as those with MOSST. When the Department had a unit concerned with industrial R&D, first under John Orr and then Hugh Douglas, there were frequent contacts since the unit was a major user of our statistics and encouraged the development of industrial statistics. The unit disappeared during one of the Federal Government's financial crises and reorganizations. Strangely, there was very little contact with the branches concerned with individual industrial sectors. There seemed little interest in our R&D statistics and none in providing information to us.

The Organization for Economic Cooperation and Development

Relations with the OECD, through the Directorate for Science, Technology and Industry (DSTI) were always close and friendly. At the outset of this short section, it is appropriate to pay tribute to the leadership of Yvan Fabian, head of S&T statistics in the DSTI during most of my service. He was a friend, an innovative thinker, a good organizer and an effective international civil servant.

Personal contacts were close: I first visited the OECD in 1963/4 and soon after worked at the S&T statistics unit for three months. There were frequent meetings at the OECD in the 1960s, involving representatives of the Science Secretariat and Statistics Canada. In later years, revisions to the "Frascati Manual" involved several meetings; there were also annual meetings of national representatives for S&T statistics. This group developed a formal identity: National Experts on Science and Technology Indicators(NESTI). It has been responsible for extending international methodological standards for S&T activities beyond R&D.

Initially, the statistical work involved only R&D. However, over the years, it became evident to the statisticians - and most governments - that measurement of R&D was not sufficient to serve the needs of S&T policy, nor even to understand the full R&D activity itself. Hence the development of S&T indicators, in which the S&T unit of Statistics Canada was an enthusiastic collaborator.

Statistics Canada

1. AN ORPHAN UNIT

Statistics Canada, as the central statistical agency of the Federal Government, is responsible for providing a wide variety of statistics, including the national accounts, the census of population, and employment statistics, with the necessary supporting accounts and derived series, as well as a number of others with more limited scope, such as agriculture, education, and transportation. Strangely enough, during my service, except for one brief period in the early 1980s, S&T was not recognized as an area really falling within the Agency's mandate.

Science and technology statistics were first covered, as a part-time activity, in the General Assignments Division. Most of this division, including S&T, then became the Investment and Capital Stock Division[xvi]. Subsequently, the S&T unit was transferred to Government Finance Division (since one of our surveys was of the Federal Government). Then it was decided that, based on the analogy of UNESCO, we should be part of a new division, Education, Science and Culture, as the Science Statistics Section. Whilst institutionally part of this division, the Section moved, physically, as a "satellite" unit, to join the Ministry of State for Science and Technology as the Science Statistics Centre. When MOSST nearly disappeared in the early 1980s, the unit returned to Statistics Canada. It became, briefly, the Science and Technology Indicators Division. Its final designation, during my tenure, was as the S&T Indicators Section of the Investment and Technology Division, basically the former Investment and Capital Stock Division!

Although another Statistics Canada satellite, the Aviation Statistics Centre, had existed for some time, the relation between the S&T statistics unit and MOSST may have been unique. Data which were confidential to Statistics Canada, such as industrial R&D expenditures and employment, were processed at Statistics Canada. The Unit had its own secure facilities within MOSST to store confidential data. However, data which were not confidential to Statistics Canada, were collected with the assistance of MOSST or on the Ministry's behalf. Thus the Unit participated in the collection of budgetary information on S&T programs with the Treasury Board and MOSST, and was often provided with clerical assistance by the Ministry. Furthermore, since the Unit had very little technical support from Statistics Canada, it used the Ministry's computing facilities for non-confidential work, especially word processing. In retrospect, this arrangement, in spite of the need to maintain much of our work in Statistics Canada, worked well. S&T statistics are provided by the central statistical agency for S&T policy, and located with the central S&T policy ministry, we were always aware of this fact. There was, of course, tension between the interest of Ministry analysts in information in detail and in advance of publication and our need to maintain statistical confidentiality and impartiality. Furthermore, since our budget depended on Statistics Canada, we were seldom able to react as rapidly as the Ministry would have liked. However, the statisticians and analysts both benefitted from the cooperative arrangement. During our relationship I developed great respect for most of the analysts

with whom we worked. The analysts became more aware of the time and effort required to produce reliable statistics and the statisticians were encouraged to keep science policy needs in mind. A side benefit for the analysts was that, when there was pressure on them to provide statistics to demonstrate the success of certain programs, they could claim, quite rightly, that we were responsible for the statistics. We could, and did, make special efforts to collect data pertinent to these programs, or adjust some procedures to provide earlier estimates, but never produced statistics without "solid" data[xvii].

2. INSTITUTIONAL FACTORS

The diagram below will put the S&T statistics unit (whether designated as a section or a centre) in its institutional perspective.

Chief Statistician
|
Assistant Chief Statistican (for a Field)
|
Director-General (for a Branch)
|
Director (for a Division)
|
Chief (for a Section)

In practice, the Section designed and carried out surveys, analysed the data and published statistical reports. Directors and Directors-General were administrators; the Assistant Chief Statistician managed the Field and controlled all travel and substantial discretionary funds.

As noted earlier, S&T statistics were not considered part of the statistical agency's core program. This allowed us a great deal of intellectual freedom, since our statistics were not integrated into any other series or account[xviii]. So long as we operated within our budget, we were free to develop surveys, acquire data from other agencies in response to users' needs or methodological development, and release statistics or research papers. However, this lack of integration into the main program could be dangerous. In such cases, a high-level champion is needed to ensure that the area's needs are recognized and that it is protected in times of financial constriction. During the period 1963-1988, S&T statistics had two such champions: Walter Duffett, the Dominion Statistician in 1963, and Martin Wilk, Chief Statistician in the early 1980s. Mr Duffett's interest was

due to his membership in the Social Science Research Council; Dr Wilk had a been a senior officer of AT&T. The first authorized a small S&T statistics unit at a time when the DBS was quite a small agency; the second established S&T statistics as a divisional activity.

When there was no champion, there was a tendency for the section to be treated as an orphan. In the days when Statistics Canada was lapsing[xix] millions of dollars a year, the section was refused funds to provide a budget for electronic data processing. The only time that the unit had adequate data processing capability was when it "inherited" the MOSST computer when the Ministry was absorbed by the Department of Industry! Travel funds were also often withheld and much of the necessary liaison expenses were borne by MOSST, the OECD or UNESCO. In times of financial stringency the orphan was particularly vulnerable. From the point of view of the Agency's management, S&T statistics, outside of the core programs, must have a lower priority than other areas. This is reasonable, for Statistics Canada, but what about those who need S&T statistics?

The S&T statistics unit depended on outside support for most of the 1970s and 1980s. Since its own budget was too small to allow the unit to provide the depth of statistics some users required, various arrangements were made over the years. The most important of these was that with MOSST. As noted earlier, when the unit was attached to the Ministry, it received clerical and data processing support. When the Ministry was integrated with the Department of Industry, a number of MOSST personnel, as well as the computer, were transferred to Statistics Canada for S&T statistics. Most provincial governments were also interested in their S&T situations. Contracts were made with them under which personnel of the S&T unit would go to the provincial capitals and survey provincial government S&T activities. Each government would get a statistical report for its own use and the data would be incorporated into the national database maintained by the S&T unit. Other users provided grants to ensure their specific interests were adequately covered by our questionnaires. Special analyses were sometimes done under contract but the relatively small number of business respondents meant that the need to maintain statistical secrecy often meant an unacceptable level of aggregation. However, most users confined their financial support to the purchase of the statistical reports.

What can users do when the statistical agency proposes to eliminate or reduce services? They can provide funds to the agency, if the agency is allowed to exceed its own budget accordingly (not always permitted). They can lobby the Chief Statistician and the Minister, through such means as federal budgetary committees, federal-provincal governmental committees, and industrial and research associations, on behalf of their own interests. Such efforts preserved S&T statistics more than once.

This seems the appropriate place to discuss the location of the S&T statistical collection activity. In some countries, such as Canada, it is in the central statistical agency; in

others, it is a responsiblity of the S&T policy agency, which may contract out the actual collection of data. The advantage of the Canadian model is that a pool of statistical expertise is readily available within the organization. The best data processing facilities should also be available. But the greatest benefit is that the integrity of the statistics is assured because of the independence and traditions of the Agency. The disadvantage is indicated above: unless S&T statistics are considered part of the Agency's responsibility, they may not receive the level of support warrented and are vulnerable in times of restraint. A better arrangement might be to have the activity be carried out by members of the statistical agency but with separate funding from a Committee of users.

During these twenty-five years, there were two program reviews and an audit of our work. The program reviews were carried out by review staff of Statistics Canada, under the direction of a "wise man" from outside the Agency. The last, in the early or mid-1980s, was carried out under the direction of Dr. Rennie Whitehead. Its principal recommendation was, I believe, that the Section continue its statistical program and develop a national database of R&D projects[xx]. Although it was decided by Statistics Canada management that such a database was not appropriate for a statistical agency, and would be expensive, we were allowed to officially develop S&T indicators as an alternative enhancement to our program. This reinforced an earlier recommendation by the Auditor General: "We encourage continued efforts to develop a broad range of science activity indicators."[xxi] However, the 1981 report of the Auditor General also found that our statistical presentation was inadequate. Three problems were identified: no overall estimates of uncertainty for the GERD (total expenditures on R&D in Canada), two versions of GERD (natural sciences, and natural and social sciences), and no discussion of the nature of the Canadian economy compared to others for OECD comparisons.

3. STATISTICAL DEVELOPMENT

(1) R&D and RSA

As noted above on page 2, besides R&D some related scientific activities were covered in the earliest surveys of the federal government: collection of scientific data, scientific information, and scholarships and fellowships. I believe these reflected the classifications used by the National Science Foundation. The activity of testing and standardization was added, as well as "adminstration" of S&T grants and contracts. The latter activity ensured that the entire expenditures and staff of the granting councils were included in the S&T envelope. Related scientific activities were considered for two reasons. Some, such as information and data collection, were important in their own right and were foundations for R&D. The identification of the RSA also helped to prevent the inflation of R&D estimates with the inclusion of non-R&D activities.

The collection of R&D expenditure statistics using the classifications of basic research, applied research and experimental development was not successful and was soon given up. The problems are well-known. Subjective definitions permitted a different classification of the same activity by different respondents. Increasing reluctance over the years by performing and funding institutions to describe their activities as basic research. In practice, an institutional allocation of R&D was made when these classifications were required, depending on our appraisal of the nature of the work based on the funding and the performing institutions.

Initially, only the federal government and the business enterprise sectors were covered: S&T activities for the government and R&D for business. Subsequently, provincial research councils and non-profit research were surveyed for R&D, and cooperative survey arrangements were made with most provincial governments for S&T. As noted earlier, for some years information on federal S&T activities were collected as part of the budgetary process.

It was never practical to survey the higher education sector. The institutions did not have the necessary information since there was no reason for them to separate research from other educational activities unless it involved outside funds which passed through the university accounts. Surveys of university staff did not seem feasible. Estimates were made based on research grants and contracts reported by the universities; grants and contracts to university staff reported by funders; and estimates of staff time spent on research, by discipline. The estimates of staff time were derived from studies made in the U.S.A.

(2) Innovation

For the business enterprise sector, R&D, in itself, was not the significant activity. That was innovation and R&D was only an indicator of innovation. But how good an indicator was industrial R&D? In 1967, the U.S. Department of Commerce published *Technological Innovation: Its Environment and Management* ("Charpie report"). Dr Charpie estimated the typical cost distribution for innovation; R&D was estimated to be only a minor cost of innovation, in general (5%-15% is my recollection). If this were true, R&D would not be a very good indicator of the innovation activity. In the early 1970s, we carried out two surveys of industrial innovation in Canada to verify the U.S. estimates. The first survey covered firms' estimates of innovation costs, by activity; the second asked firms to select completed projects and estimate the relative costs, by activity. Both showed a much greater ratio of R&D to total innovation costs. This seemed reasonable, even if the U.S. estimates were correct, because of the smaller scale of Canadian innovations, with lower tooling and marketing costs. Thus R&D statistics seemed to be potentially a suitable indicator of innovation. There was little interest in these statistics and the surveys were not repeated.

(3) Patents

Most Canadian patents are granted for foreign inventions, and, if I remember correctly, more Canadian inventions are patented in the U.S.A. than in Canada. Because of the apparent low propensity to patent inventions in most industries, patent statistics did not seem good indicators of innovation. Nevertheless, Canadian patent information provided interesting insights into Canadian innovation. This was due to the PATDAT database which provided us with unique information. It was developed by the Patent Office and the Department of Consumer and Corporate Affairs. Patent examiners added a number of new classifications to the inventions being considered. These included the nature of the application of the invention (whether process or product) and up to three industries of probable manufacture and/or probable use of the invention. These data provided a rudimentary technological input-output model for Canadian industry; I believe that Louis Marc Ducharme of Statistics Canada subsequently developed this approach.

(4) Trade and technology

As a result of work by the NSF and OECD, we also developed series on trade for products and services associated with technology. From early days, our questionnaires on R&D in the business enterprise sector included questions on payments abroad, and payments from abroad, for patents, licences and technological "know-how", as well as R&D. However, only firms involved in R&D were covered. More general series were available from balance of payments surveys and, for a short time, quite detailed information was collected under the Corporations and Labour Unions Returns Act (CALURA). These service payments and receipts could be associated with individual firms and hence industries. This indicator was usually called the "Technological Balance of Payments."

Trade in commodities or products depended on statistics from External Trade Division, which were quite detailed but not linked to industries. The OECD and NSF identified products as being "high," "medium," or "low" technology by associating them with ratios of R&D/sales or R&D personnel/total employment for industries linked these products. Since the industry classifications were revised infrequently, they did not always reflect the current pattern of industrial activity; they were also far less detailed than the product classifications. Our solution was to examine the trade classifications and assign them, on the basis of our own intuition, to the three classes. We asked other departments and agencies to appraise our classifications; no substantial comments were received.

The lack of a "scientific" base for the classifications was always a potential cause for objections, especially if the statistics seemed to show a situation displeasing to the objector. However, there was no difficulty in changing the technological class of a

product so that we were always able to offer a different arrangement to anyone who felt products had been wrongly classified but I cannot recall alternative classifications ever being provided to us.

(5) Bibliometrics

Scientific publications and citations were indicators published by the NSF. The indicators provided clear rankings of institutions and individuals for various disciplines or fields, based on publication rates and relative "value" of publications, as shown by citations. They were produced, under contract, from analyses of commercial databases. The S&T unit of Statistics Canada was able to use a portion of these, those which identified Canadian institutions or had some Canadian identification. Only once, however, did we have funds to do anything in this field ourselves. Not only was there the problem of obtaining funds to pay a contractor to assemble the data, there was also considerable opposition to the publication of such indicators on theoretical grounds. Personally, I would have liked to have been able include them in our indicators.

(6) Other

I can recall three other projects that might have been of some interest. Two involved S&T personnel. One was the "HQP survey." This was a follow-up to the 1971 census of population. A large sample of persons reporting a university degree (or technical certificate?) were sent a later questionnaire seeking more information, especially on their educational qualifications and specializations. Surprisingly enough, once the data were collected and partially edited, the project was abandoned. Eventually, due to the initiative of Dr Miles Wisenthal and Mrs Eva Ryten, the tapes were recovered and the task of producing statistics from this potentially rich source was given to the S&T unit (with no additional resources or data processing assistance). We eventually produced a report but it was later and undoubtedly less analytically robust than it should have been.

The second project concerned university faculty. Dr Max von zur Muhlen provided data on the characteristics of university faculty, particularly their ages. These showed, clearly, the need for policies to compensate for the age concentration of teachers.

The third was completely speculative. During my tenure, the S&T unit began and ended in a Division which produced Capital Stock estimates. Could the product of R&D - knowledge - be treated in a similar manner? Perhaps knowledge also had a useful life before it became obsolete. The Japanese had published some estimates of this nature. It might be assumed that technological obsolescence was more rapid for some industries than for others. If R&D expenditures and payments for patents, licences and technological "know-how" could be proxy for new knowledge acquired by an industry, then such expenditures could be cumulated, to represent cumulating

knowledge, and depreciated by different rates. A simple spreadsheet operation. The value, if any, in the final estimates, might be an indication of the dangers involved in R&D slowdowns or reductions, analogous to an aging capital stock for an industry. We produced one set of estimates in a research paper.

Conclusion

I believe that the S&T unit of Statistics Canada provided reliable estimates of the S&T situation in Canada. We also participated, so far as possible, in the international development of the field. However, the rationale for these statistics, or indicators, must be their utility for S&T policy. The lack of any long-term consistency in such policy, as well as the unit's institutional perturbations, certainly affected this utility. It seems that the S&T policy needs are still not satisfied. In Chapter 9, "Overall Management of Federal Science and Technology Activities," the 1994 report of the Auditor General concludes:

> 9.5 The government needs a framework and indicators to monitor Canadian overall performance in science and technology and to determine the success of its own efforts to support science and technology ....
>
> 9.6 Parliamentarians have no basis on which to assess whether the government's expenditures on science and technology reflect Canadian needs and opportunities, and to hold the government accountable for results.

To me, it is clear that consistency, in goals and in operational application, is needed for successful government programs and S&T indicators.

Endnotes

[i] Benoît Godin has also been a great help with dates for some of our activities.
[ii] These were "occasional" surveys, perhaps biennial, which started in the mid-1950s.
[iii] *A Science Policy for Canada: Report of the Senate Special Committee on Science Policy* ("Lamontagne Committee"), Vol 1, p. 119. The earlier years were probably based on estimates published by the Department of Reconstruction and Supply after World War II.
[3] For example, he is one of the authors of an early 1960s OECD report comparing the govenment R&D expenditures and definitions of several member countries.
[v] Royal Commission on Government Organization, 1962-3.
[vi] *Ibid*., Special Area of Administration N^{o} 23, p. 223.
[vii] *Ibid*,, p. 224.
[viii] I.e., the S&T unit of the Dominion Bureau of Statistics.
[ix] Special Areas of Administration (N^{o} 23), p. 302.
[x] Although the S&T section was able, in the 1970s, to develop a sort of inventory of laboratories for the government sectors (which was non-confidential because the information was collected by us but under internal government regulations) and for industry (confidential and used to prepare estimates of regional R&D activities).
[xi] It was abolished, I believe, in the early 1980s.
[xii] *A Science Policy for Canada*: report of the Senate Special Committee on Science Policy, Vol 2, 1972 , p. 410.
[xiii] *A Science Policy for Canada*, op. cit., p. 413.
[xiv] These observations are based on my fading memories and are not intended to be a contribution to a future history of the Ministry.
[xv] This quotation is part of the signature of a genealogist who writes to one of the Internet lists to which I subscribe. I know no Latin and have not read classics but assume the quotation is correct.
[xvi] The names may not be exact, as I have no records with me.
[xvii] Although "solid" may not be an appropriate term for a field as subjective as S&T; "consistent" may be a more accurate adjective.
[xviii] I think there is a category for R&D in the National Accounts, through the Input-Output Accounts, but it would have covered only R&D activities not included elsewhere - far too restrictive to be of practical use. There may also be a service industry named R&D, which would cover only a few R&D establishments.
[xix] I.e., funds provided in the budget but not spent during the fiscal year and thus "lost."
[xx] This database of R&D projects was first proposed by the Lamontagne Committee as a responsibility for MOSST.
[xxi] *Report of the Auditor General of Canada to the House of Commons, 1981*, Section 2.149.