TECHNOLOGY DEVELOPMENT: A CANADIAN PRIORITY

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During the summer of 1984 three special reports on aspects of technology development — all addressed to the Government of Canada — were published, the first by a federal Task Force, the second by a Senate Committee, and the third by the Science Council of Canada. Of particular interest was the report of the Task Force chaired by Douglas Wright. This paper discusses the work of the Task Force, the issues it grappled with, and its recommendations. It also discusses a number of the recommendations that appeared in the other two reports. There is no Australian equivalent of the Wright report. It is more general in its mandate and recommendations than the report of the inquiry headed by Professor Ross, for example, and it does not deal with venture capital for high-technology industries as did the Espie Committee. At the time of writing (December 1984) the new Government in Ottawa has begun to make changes to the content and delivery of federal programs and to the work of the federal laboratories.

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INTRODUCTION

Early in November 1983 the then Minister of State for Science, Technology and Economic Development in Canada, the Hon. Donald Johnston, announced details of the establishment of a Task Force charged with the review of federal policies and programs for technology development, with recommending improvements to these, and with reporting back to him within six months. The Task Force's mandate was to be carried out with due regard for both industrial and social needs in the planning and implementation of these policies and programs and for the way in which they could make improved contributions to the government's objectives. In particular, the Task Force was asked to assess:

- the effectiveness of the government's industry support programs for science, technology and related activities;
- the effectiveness of government procurement of technology-intensive products;
- the effectiveness of the university-industry interface; and

- the effectiveness of the government's intramural scientific and technical activities.

Dr. Douglas T. Wright, the President of the University of Waterloo, Ontario, was named Chairman of the Task Force. He had earlier been the founding Dean of Engineering at the University and had also served for a dozen years in senior public service positions within the government of Ontario. The five other members of the Task Force were all from the private sector.

In Australian terms, the government laboratory section of the Wright Task Force mandate was broadly similar to the one given to Professor Ross for his inquiry, but the period for completion was much shorter. The Ross report also dealt with its subject in much greater detail. Under the heading of industry support programs, Dr. Wright and his colleagues shared some of the same concerns as the Academy of Technological Sciences' study headed by Sir Frank Espie, but their report did not deal with venture capital. In May 1984, the Australian Minister of Science and Technology tabled a paper describing a national technology strategy. The Canadian equivalent was tabled by Mr. Johnston in 1983, but Dr. Wright's mandate did not include a review of it.

The government laboratory section of the Task Force mandate was somewhat similar to the one given by President Reagan in the United States to a Panel under the chairmanship of Mr. David Packard. The selective approach taken by this Panel, the depth of its inquiry and the brevity of its report impressed Dr. Wright and his colleagues.[1] The Task Force's own report is brief, although it contains more explanatory and descriptive material than the one from the Packard Panel.[2] It was built around the four main sections of the mandate and the resulting recommendations. It was written with the assistance of a business journalist of proven skills and reputation.

Originally scheduled to be ready in May 1984, the Task Force report missed its tight time target by about three weeks (although it was not issued publicly in the two official languages until mid-July). However, in mid-June the governing Liberal Party chose a new leader and Prime Minister — Mr. Turner — who subsequently moved Mr. Johnston to another portfolio and had the Hon. E.C. Lumley replace him at the Ministry of State for Science and Technology (MOSST). It was to Mr. Lumley that the Task Force report was formally addressed when it was issued. Shortly after taking office, Mr. Turner called a Federal General Election for September 4. The result was that a Progressive Conservative government took office, led by Mr. Mulroney. An engineer, Dr. T.E. Siddon, became Minister of State for Science and Technology and responsible for the disposition of the Wright report.

Two other Canadian reports appeared in the weeks following the publication of the one by the Task Force — from the Senate Standing Committee on National Finance[3], and from the Science Council.[4] Both deal with the federal government's role in technology development, but from a much wider perspective. A number of the conclusions and recommendations from these reports are discussed later in this paper in the light of the views of the Task Force.

Before describing the process followed by the Task Force in its work and examining its conclusions and recommendations, it should be made clear that the subject was *technology* development. The questions of *science* and *scientific* research were, by intent and implication, peripheral. Also, the members of the Task Force had *engineering* backgrounds. In their report they said, at the very beginning:

> Technology, according to our own working definition, means tools and the capacity to create and use them. Technology is thus not just about machines; it's about the skills and knowledge and ability of people to develop and use tools which make their lives more enjoyable and productive. Technology, in other words, is know-how and know-why. As such, it's a social, cultural and educational phenomenon which cannot be considered in isolation from its human context.[5]

This human dimension and the social impact of technology were of considerable concern to the Task Force. They were reflected in its discussions, conclusions and recommendations but were not dealt with in detail. Also, the Task Force considered all kinds of technology — and not just the so-called 'high' variety — to be included in its mandate.

THE REPORT: THE GENERAL APPROACH

The report's content, language and recommendations indicate clearly that its emphasis and concern is technology policy and not science policy. Equally clearly, and not surprisingly in view of the backgrounds of its members, the Task Force has taken a business-oriented approach to both its mandate and its recommendations. Consensus views developed quickly among the members on two aspects of the Task Force's mandate — the effectiveness (or otherwise) of the industry support programs and the direction of the work of the federal laboratories — and more slowly on procurement and the university-industry interface. These views were largely reinforced after examination of submissions and briefs and, especially, after consultations and interviews. In the Preface to its report the Task Force said:

> Although our research was extensive, and although we heard from a broad cross-section of industrial, scientific and professional bodies, we found a remarkable degree of unanimity concerning the future directions in which federal technology policy should move.[6]

The Task Force challenged the conventional wisdom in the policy field. For example, it declared that, although allocation strategies could be improved, the federal government need not spend vast additional sums on technology development. In other words, the principal requirement is for improved management, not for more public funding. The Task Force said that technology development should be aimed at producing something useful. The most effective R&D is 'demand driven', and the work is undertaken in response to clearly defined need. The least effective R&D is 'supply-driven', where research institutions (and not the market) define the problem and, at their own speed, seek solutions. This, of course, is the old 'market-pull' — 'technology-push' view which the Task Force reinforced by saying that, typically, at least 90 per cent of an industrial R&D budget should be devoted to the explicit demands of manufacturing and marketing and only 10 per cent to curiosity. The report goes on to say that the federal government's involvement in technology development must be redefined to maximise the market's pull on the innovation chain. Success in global competition and in the unforgiving international economic climate will depend upon Canada's ability to develop and apply new technologies.

The Task Force also commented on Canada's relatively low place in the international 'GERD/GNP percentage' ranking — 1.3 per cent against 2.5 per cent for the U.S. and Japan, for example. But it went on to say that this does not necessarily provide grounds for concern:

> The effectiveness with which our R&D funds are deployed, in the context of our particular circumstances, is more important than how much we spend. If we doubled R&D spending tomorrow, the economic impact of that increase would be quite marginal. Spending more on R&D makes no sense unless it's spent in a culture that feels compelled to compete. Such competitive environments create a need for innovation, which generates demands for still more research. This self-reinforcing pattern is the hallmark of the vigorously growing economies.[7]

Once again, the emphasis was on management over money, but this time with the underlying assumption that unless Canadians **want** to spend more money becoming competitive they should not be encouraged to do so. The Task Force also said that if people in laboratories, in manufacturing and in selling cannot — or will not — get along, then the chances for innovative success are poor. Attitudes are therefore given their place in the equation.

The Task Force was critical of the nationalist position which has been taken in the past by a number of Canadian institutions.[8] In its report it said that, in the real world, there is surprisingly little 'pure' innovation. Most scientific advances add marginally to the existing fund of knowledge. The vast majority of industrial innovations are not so much new as novel adaptations or applications of proven technologies. The report went on to say:

> This point should be stressed because, in the course of our enquiries, we detected in some quarters a certain wistful impulse towards an 'all-Canadian' R&D effort. In our view, there is no such thing as technological sovereignty. Scientific knowledge can be drawn — and should be drawn — from many sources. No country, particularly one with a population as small as Canada's, can hope to be self-sufficient in science and technology. And from the standpoint of international competitiveness, it is far more desirable to **adapt** technology to local conditions and needs than to create it anew.[9]

The federal government, the Task Force said, is now involved at nearly every stage in the innovation chain. Although federal support for R&D will continue to be essential to Canada's status as a developed country, serious reservations should be expressed about the uneven effectiveness of this support at different parts of the chain. For example, in industrial research the aborting or abandoning of projects that are not promising is undertaken readily while, in government laboratories, it is often postponed for as long as possible — and especially if unwelcome political consequences can be expected. Public servants and their political masters are, by nature, risk-averse. The keys to success appear to be the clarity with which the mandates of the participating departments and agencies are defined and the ways in which the departments and agencies — as consumers of research output — choose projects and set priorities. The Task Force then said:

> We believe that the responsibility for actively supporting technology development should be made an explicit part of all appropriate departments' mandates and that the Chief Science Advisor (and Secretary of MOSST) should report regularly to the Prime Minister on technology development issues.[10]

In all of its work the Task Force was deeply conscious of the importance and pervasiveness of the socio-economic problems brought about by technology development. In the introduction to the report it said:

> In a six month timeframe, it was not possible for this Task Force to address fully one of the most crucial issues of all: the social impact of new

technologies. They have great potential to improve the quality of all our lives. To realize this potential will require that we marshal our wit and skill, bringing together labour and management in productive enterprise. We discussed and debated the subject in great detail, and concluded that the subject is too important and too complex to be treated merely as a side-issue of our enquiry. A Task Force or organization devoted to that subject alone, we believe, would be a more appropriate response to the urgency and magnitude of the issues involved.[11]

SUPPORT PROGRAMS

The Task Force discussions of specific federal industry support programs centred around the principal ones — the technology portion of the Industrial and Regional Development Program (IRDP) and the Defence Industry Productivity Program (DIPP), which are administered by the Department of Regional and Industrial Expansion (DRIE); and the Industrial Research Assistance Program (IRAP) and Program for Industry/Laboratory Projects (PILP), which are administered by the National Research Council (NRC). Taken together, these and others not mentioned have been providing grants, contributions and other assistance of over C$500 million annually.[12] Also discussed were the current tax-based industrial R&D incentives.[13] The Task Force did not attempt a detailed evaluation of each of these programs in its report. Instead, it listed a number of generalisations that it found to be applicable:

- most programs attempt to 'push' on the innovation chain;
- most programs are over-administered and their responsibilities frequently overlap;
- the complexity of the procedures for evaluating applications and for monitoring the resulting expenditures are based on a laudable desire to avoid squandering public funds on dubious projects; but this caution is antithetical to the spirit of successful industrial research in which risk and failure are inevitable parts of the process;
- the programs whose purpose is to share risk are administered by bureaucrats who are by nature risk-averse;
- very few programs have anything to offer start-up companies.

The Task Force said that the programs which received the highest praise in submissions and consultations were IRAP and, to a lesser extent, PILP, where the administration and management were deemed less complex and the NRC personnel involved understood risk. The least useful program was IRDP which, although new, had evolved from the (similar) Enterprise Development Program (EDP) and was perceived to be adopting the same elephantine management style. The Task Force viewed the goals of the IRDP — industrial and

regional development — as being parallel but not always complementary, with the result that neither might be adequately served. The Task Force was also concerned about the ineffectiveness of the delivery of smaller grants provided by federal programs and wanted more participation in their delivery by provincial organisations which, up to the present, have usually had minor roles to play in such activities.

With regard to tax-related industrial R&D support measures, the Task Force concluded that the Candian system is generous and that the most recent changes should greatly stimulate research in industry. It found that industry, generally, prefers tax support over grant support and said that maintaining the tax system in its present form would increasingly reduce the need for other support programs over time. The Task Force also found that the definition of R&D used by the Revenue Department in Canada to be narrower than the corresponding one in use in the United States.

The recommendations made with regard to industry support programs were:

- that there should be a thorough review of these programs carried out by a responsible ministry (such as MOSST) with a view to gradually phasing out those that have failed to win the endorsement of their intended clientele;
- that responsibility for administering the technology development portions of IRDP should be transferred from DRIE to NRC;
- that the administration of the programs should be simplified to reflect a much greater willingness on the part of the federal government to share the risks of technology development;
- that the definition of R&D used by Revenue Canada be extended and made more compatible with the one used in the U.S.; and
- that the responsibility for choosing and funding small industrial R&D projects (say less than $35,000) be delegated to provincial organisations.

PROCUREMENT

This section of the report is the only one in which the term 'high-technology' is used. The report declared that some of the most important scientific achievements in the past were made in response to military requirements. While not advocating the creation of a Canadian military-industrial complex as a means of stimulating technology development, the Task Force did advocate the creation of a peace-time equivalent which would effectively utilise the federal government's immense purchasing power to promote private sector innovation. It concluded that there is a lack of an overriding mandate to legitimise a reasonable degree of risk-taking in government

procurement, and called for one to be established. The Task Force also concluded that the lack of creative procurement policies is attributable not only to bureaucratic caution, but also to the lack of long-term planning.

The report said that a procurement-based innovation policy must recognise that Canada participates in world markets and that access to larger high-technology procurements than the domestic market can provide has to be assured. But since the federal government already participates in bilateral and multilateral agreements and projects, it can provide this assurance. There are, in fact, a number of Canadian firms with products which were first developed under government contracts. But such contracts involved risk and the possibility of failure. The report also noted United States' experience of successful technology development through procurement and was especially impressed by the activities of the Defence Advanced Research Procurement Agency (DARPA), of which there is no equivalent in Canada.

The Task Force concluded that the requirement to foster technology development through procurement should be applied by the federal government to Crown corporations (statutory authorities) such as Air Canada, PetroCanada and Atomic Energy of Canada. Also, several key government departments, such as Transport, Environment, Energy, Mines and Resources as well as National Defence, constitute important markets for high technology products and yet, with very few exceptions, these departments prefer to buy products based on proven technologies rather than develop better state-of-the-art Canadian-made alternatives through creative procurement. With regard to international procurement agreements involving offsets, the Task Force said that the 'matching dollar' approach should be replaced by one involving the qualitative assessment of industrial benefits for Canada.

The Task Force did, however, comment more favourably on recently implemented federal procurement programs administered by the Department of Supply and Services (DSS) — for example, the Unsolicited Proposal (UP) program and its provision of bridge financing to fund projects that cannot be accommodated within the current budgets of interested departments, the Source Development Fund (SDF) which assists firms to establish competence as potential government suppliers, and the policy requiring that DSS purchases of mission-oriented R&D be contracted out to private firms rather than conducted in government laboratories. However, the Task Force said that any major expansion of these DSS programs should be carefully reviewed in the context of their relationship to other industry support programs.

UNIVERSITY-INDUSTRY CO-OPERATION

Canadian universities are under provincial jurisdiction, but are heavily financed by the federal government. The Task Force identified a number of what it called 'crippling restraints' on the ability of universities to meet the industrial challenges which, increasingly, are being thrust upon them. Among the most serious are:

- shrinking revenues at a time when research demands on the universities are increasing;
- the operational inflexibility of many university departments, which makes it difficult for them to respond to new demands; and
- the constraints of federal-provincial financing arrangements — an area in which the Task Force had no mandate to give its advice.

The Task Force was persuaded that the universities now play a central and strategic role in Canada's overall research effort and that this role is a crucial link in the innovation chain. It was also persuaded that industry increasingly recognises that the universities should be involved in the longer-term aspects of technology development. It found that more generous tax allowances are available in the United States to encourage industry to contribute to the cost of university research. However, it was high in its praise for the work of the Natural Sciences and Engineering Research Council (NSERC) in Canada in providing a variety of financial vehicles for the encouragement of research and training in Canadian universities and for university people in industry. It recommended that the Medical Research Council — NSERC's counterpart in the university medical research field — should consider expanding its support to health industry technology development.

In order to improve university-industry co-operation, the Task Force recommended that the government should pay the full cost of university research — including overheads not now covered by grants or contracts from federal agencies. It argued that this would not necessarily cost more since the increases in grants could be accompanied by a reduction in the amounts payable under other federal-provincial transfer arrangements. After reviewing experience in the United States and the United Kingdom, the Task Force recommended that the government pay a flat 25 per cent bonus to the universities participating in co-operative projects with industry. It also recommended a corresponding incentive to encourage industry to farm out research to the universities. This incentive, it said, should be in the form of a 50 per cent tax credit. Going still further, it wanted non-university scientists and engineers in the private sector to be eligible to apply to NSERC for support, provided that the work could meet university standards of excellence and be carried out in appropriate facilities.

With regard to NSERC itself, the Task Force recommended that its role should be to fund long-term research, to built R&D capacity across the country, to train scientific and engineering manpower, and to act as an overall co-ordinating agency for federally-funded unversity R&D. Until 1978, the National Research Council filled the university research support role now assigned to NSERC. The Task Force felt that, in 1984 and beyond, NRC's role should be to promote the technological capabilities of private sector firms, to provide them with advice on state-of-the-art technology, and to ensure that new technologies reach the Canadian market. In order to do these things, the Council would require access to university research.

THE FEDERAL LABORATORIES

This is perhaps the most contentious section of the Task Force's report, as well as the longest. It began by stating:

> Canada's federal laboratories are justly proud of their long tradition of excellence and innovation. . . [This] tradition continues today. In scores of large and small federal laboratories, some 6,000 scientists assisted by 11,000 support personnel, are engaged in an astonishingly wide variety of pursuits.[14]

The Task Force believed that these traditions of excellence were being undermined by a growing atmosphere of irrelevance and an excessively bureaucratic management style. Both of these criticisms, the report noted, had been made by the Packard Panel with regard to U.S. federal laboratories. At the same time, the Task Force did not consider its mandate to include the issuing of 'report cards' for individual laboratories. Its conclusions and recommendations are — with certain exceptions — therefore more general than specific.

The Task Force disagreed with the argument that the quality of the work of the federal laboratories would improve if their budgets were to be increased. It was satisfied with the current levels of funding. It argued, instead, that laboratories had been suffering from a lack of constructive criticism from outside scientists.

> In our view, this 'peer review' process should be strengthened — not only for specific projects, but to monitor the overall relevance and effectiveness of specific laboratory missions. Quality must be pursued in the context of a clearly defined purpose.[15]

The report said that most federal laboratories base their claims to relevance either on serving the needs of a government agency or on support for the goals of private industry. In the view of the Task Force, these claims could be justified if — in addition to being in the national interest:

- the risks or expenditures involved are too high, or the potential payoff too small or too far down the road, to attract private industry; and
- the industry is too fragmented to undertake the necessary R&D.

These criteria, the Task Force said, should be applied rigorously, not only in the review of existing laboratory missions, but to any new research initiatives proposed by the federal government. And the 'peers' who take part in the review process should include those industries that the missions and initiatives are designed to serve.

The Task Force recognised that some federal laboratories — legitimately — have little or nothing to do directly with industry. Their principal clients are departments and agencies that must have laboratory support. This, the Task Force said, may be provided 'in-house' when required for:

- testing or monitoring;
- establishing codes, standards and regulations;
- maintaining databases;
- operating national facilities;
- addressing national or regional problems;
- carrying out national security obligations and international agreement; and
- maintaining national competence in key scientific sectors.

The Task Force said that laboratories working in these in-house fields often have greater difficulty defining their missions than do those involved in supporting industrial goals, and that inertia, irrelevance and overlapping departmental mandates and jurisdictions are "clear and present dangers". It concluded that a more formal structure for monitoring the performance and relevance of federal laboratories should be mandatory. It therefore recommended that a board of directors representing the main clientele should be established for each laboratory and that these boards be given authority to define and review missions, set priorities, and ensure that goals are reflected in budgetary allocations. It also suggested that federal scientists be permitted to apply for outside funding (from, for example, NSERC or the private sector) in cases where insufficient funding is available from these allocations.

The Task Force lent its support to the wider application of the contracting-out policy for federal R&D requirements established originally in 1970. It said, however, that due recognition should be given to scientists and administrators who support such efforts and that additional manpower resources should be allocated to them when needed. The Task Force added:

> In our view, R&D should only be done in-house when there is a need for secrecy or neutrality, or when contracting-out is not cost effective in the long run. In-house R&D can also be justified by the need to develop scientific competence in particular areas, or by the need to maintain contacts with the international scientific community. In all other cases, we believe, the government should attempt gradually to shift the bulk of its research requirements to outside contractors.[16]

The Task Force went on to say that the logical extension of the contracting-out policy would be to have private contractors operate entire laboratories on the GOCO (government-owned, contractor-operated) model in the United States and following the Canadian example of the TRIUMF nuclear research facility, which is operated by a board representing four universities in Western Canada.

The report noted that the Task Force had received "significant criticism" of recent federal initiatives establishing new laboratories and programs intended for the use and support of industry, about which industry had not been adequately consulted. It added that the NRC's proposed new Institute for Manufacturing Technology, intended for Winnipeg, Manitoba, was the "single least popular" initiative. In the light of these comments, the Task Force made two recommendations:

- that no new government-owned research facilities should be established unless it can be demonstrated through an extensive consultative process that a real need exists; and
- that an appropriate industry representative, such as the Canadian Manufacturers' Association, be asked to appoint a group of knowledgeable industrialists to define what the manufacturing technology laboratory in Winnipeg should be doing in the CAD/CAM area.

The Task Force then turned its attention to the problems of 'micro-management' and suggested that these would disappear if the federal laboratories became more responsive to market forces. It added a number of other reforms that would assist in solving these problems; for example:

- the use of rolling, multi-year budgeting;
- the use of discretionary resources to reward entrepreneurial initiatives (by laboratory personnel) and to stimulate interchanges between university, industry and government laboratories;
- the removal of the 'publish-or-perish' syndrome, and the reduction of paperwork;
- the establishment of incentives to encourage scientists to take their innovative ideas to market; and
- the establishment of mechanisms whereby laboratories and their researchers would compete for financial support.

The Task Force concluded its review of government laboratories by saying that their continued effectiveness would depend, in the first analysis, on the extent to which they could respond to market demand. A serious attempt must therefore be made to make them more business-like. It recommended that a review of all federal laboratories be carried out, with each being required to demonstrate (to a designated central agency) its relevance and usefulness.

FINALLY. . .

The Task Force was well aware of the tendency for special studies to collect dust on political and bureaucratic shelves. It was also aware of the political and ministerial uncertainty that might coincide with the release of its report. It therefore began the summary section of its report with these two paragraphs:

> We believe this report speaks for itself. Its thrust is that government policies and programs aimed at technology development are not working well, and in some cases are not working at all.
>
> We also believe that technology is at the heart of Canada's well-being and any government in Canada must include as one of its highest priorities the need to manage technological changes for the benefit of Canadians. The government's role is to set a climate that encourages the private sector to adapt and use the most up-to-date world technologies and create new technologies when they will respond to market opportunities where Canada has a comparative advantage.[17]

The Task Force said that its recommendations could form the basis for change, but only if the government acted vigorously to build upon them.

> Our first and perhaps most important recommendation, is that the government, upon receipt of this report, immediately initiate a process aimed at its implementation.[18]

THE SENATE COMMITTEE REPORT

This report was written by the Standing Committee on National Finance, chaired by the Hon. C. William Doody — a Conservative in the Liberal-dominated appointive Senate chamber. It was published in August 1984, several weeks after the Wright report appeared. The work was authorised under the Committee's mandate to examine the federal government's Main Estimates for 1982-83 and was directed to an examination of the government's role in generating economic development through technological change.

The Committee's report said that Canada's national R&D activities were low when compared on the usual GERD-GNP basis with those of other countries and identified the reasons for this:

- manufacturing industry as a whole, which accounts for most of the R&D performed in industry, is a smaller proportion of all industry in Canada than it is in other countries; also, the research intensive industries are a smaller proportion of manufacturing;
- Canada's defence R&D expenditures are, comparatively speaking, low;
- Canada lacks a large domestic market like the ones in the US or Japan;
- a relatively large percentage of Canadian manufacturing output is produced by foreign-owned companies.

The Committee therefore concluded that the quality of Canadian investments in advanced technology must be an important area of government concern, a conclusion with which the Wright Task Force would concur. The Task Force would also agree with a number of other points made by the Senate Committee; for example, that:

- a firm need not engage in R&D at all in order to be technologically innovative;
- technological innovation is not an end in itself, whether undertaken as the result of 'market-pull' or 'technology-push';
- no country can expect to excel technically in every field or generate all the technology it needs, nor can it afford to duplicate technology developed elsewhere;
- more emphasis should be given to the overall management of the innovation process, and particularly to marketing;
- firms of all sizes and in all sectors of industry must adopt technological innovations made by others that help improve productivity and competitiveness.

The Senate Committee said that a stable economic environment is essential — but not enough — to encourage technological innovation. Investment in it must also be at least as attractive as other investment opportunities. Tax incentives and government contracts, grants or contributions are also required to compensate for the higher risks and longer payback periods that are characteristic of innovation. The Task Force would agree. It would also agree with the Senators that policies and programs that try to meet too many different objectives run the serious risk of failure and waste valuable resources. The Senators' report went on to say:

> The Committee concluded that government should support research, development and technology innovation in order to promote economic development. However, government support should be confined to

> projects which offer potential benefits to the country that exceed their costs and which the government is convinced would not be undertaken by industry without such support. Other policies should not be allowed to conflict with these objectives. Research, development and other activities undertaken in pursuit of these objectives should, whenever possible, be conducted by industry where they are subject to the discipline of the marketplace.[19]

The Task Force would agree with this in principle and on the condition that the government should not try to 'pick winners'. This is the job of the marketplace.

The Senators' report noted that several witnesses favoured tax-based over grant-based support programs and that the available evidence suggested that Canada's current tax incentives for industrial R&D were more generous than those provided in other countries. However, the report went on to say that industry tends to view government support as a combination of tax and non-tax programs and, on this basis, the Canadian situation appears less favourable. The Senators were reluctant to recommend more generous tax incentives. The Committee did, however, commend the government of the day for introducing the Scientific Research Tax Credit (SRTC) — which became known as the 'quick flip' — but recommended that its effectiveness should be reviewed within two years. The Task Force would agree. It would also agree with the Senators' recommendation that consideration be given to broadening the present definition of scientific R&D used for tax purposes, and that market research undertaken in advance of an R&D project should be included.

The Senate Committee noted that the federal government's recent in-house R&D expenditures accounted for 27 per cent of Canadian GERD. Some of this was for basic research and the maintenance of a core of expertise in technologies of strategic importance in economic development, while expenditures were for R&D associated with regulations, the provision of services, or to meet the needs of industries (such as agriculture and fisheries) in which few firms were capable of conducting this kind of work. The Committee noted that federal laboratories were also doing R&D in areas (such as communications) where the work could be done in industry under the discipline of the marketplace. It noted also that making the results of federal work available to industry would not necessarily ensure its use since problems could arise in transfer and application. The Committee recommended, therefore, that the intramural R&D programs of all departments and agencies, including the National Research Council, be reviewed to exclude from them activities that could more appropriately and profitably be conducted in industry. The Task Force would agree.

The Task Force would also agree in principle with the Committee's approach to contracting-out.

> Instead of meeting its requirements by conducting R&D in its own establishments, the government may contract with industry or universities to conduct the R&D on its behalf. Large off-shore procurements of material, such as aircraft and satellites, sometimes provide opportunities for the government to negotiate industrial offsets which involve research and development and the transfer of advanced technology to Canadian industry. Where the technology can be applied to the development of new products or processes that can be commercially exploited, this contracting-out of R&D by government can be a powerful instrument for promotion of technological innovation.[20]

The Committee went on to recommend that the administration of the government's policy be examined to ensure that greater emphasis be given to contracting-out where the potential benefits are greater. Finally, with regard to technology transfer, the Senate Committee recorded its full agreement that the government should increase its efforts — in co-operation with universities and the private sector — to strengthen mechanisms for collecting information on foreign technological developments and for disseminating it within Canada. But when importing technology, the Committee said, every effort should be made to avoid impediments to its further development and to its exploitation in both domestic and export markets. Technology transfer was one element of its mandate about which the Task Force said very little and made no specific recommendations.

THE SCIENCE COUNCIL REPORT

In content, this report is closer to the one by the Senate Committee than to the one by the Wright Task Force. On the other hand, the rationale behind all three is similar. The Science Council put it this way:

> The Science Council believes that the key to Canada's ability to move with the times is to establish a climate in which technological advances, innovation, and new industrial companies can flourish. Initiatives must be directed to specific areas to stimulate and support the innovative process, provide better incentives for risk takers, heighten the commitment to research and development, increase the supply of trained technical people, and improve access to domestic and foreign markets. All levels of government can participate in helping to fulfill these goals and each should avoid legislative, regulatory or other actions that curtail their fulfillment.[21]

The Science Council is no stranger to the innovation business or to the evolution and effectiveness of government policies to support it.

But, by its own admission, this latest report puts forward no new overall approach. Instead, the Council supports the general direction of policies and programs already in place and, in consequence, appears to be less critical of the current situation than the Task Force or the Senate Committee. Nevertheless, the Council does put forward its views on how this current situation could be improved in order to enhance industrial competitiveness and encourage change.

The first part of the report reviews Canada's recent economic performance in an international context and in the light of emerging world trends towards protectionism, specialisation and high technology. It then discusses views put forward in its earlier reports.[22] In particular, it identifies three areas of special concern, all of which go beyond the mandate of the Task Force:

- governments (in Canada) must integrate long-term science and technology policies with more traditional short-term monetary and fiscal policies;
- the federal government must formulate industrial and technology policies in such a way that they strengthen the private sector's ability to identify, create and develop world market niches and to build the technological base to help raise new opportunities for traditional industries;
- governments (in Canada) must increase their efforts to foster a consensus on industrial policy.

The Science Council report then deals with the question of entrepreneurship, identifying it as an essential ingredient in the formation of new firms, the building of new industries, the stimulation of innovation and — consequently — deserving of more government support. The Task Force would be sympathetic, but it would place less emphasis than the Council has done on the direct role of the government of Canada in the encouragement of industrial enterprise. The Science Council was concerned about there being a serious gap in the capital market for high-risk, early-development money, as well as for later support. It went on to say that one approach to the risk aversion that creates such a gap would be to have society share in the risk-taking and recommended tax deductions for the start-up losses of new, small, high technology firms. It also recommnded an expansion of the Federal Business Development Bank's resources to assist during the post start-up period, but recognised that most private companies do not count government as their permanent business partner. The Task Force was primarily concerned with the problems arising from bureaucratic (rather than private) risk aversion. However, it did draw attention to the fact that current federal industrial support programs tend to favour companies with track records over new companies.

The Science Council said that, in exploiting domestic procurement, government programs should not limit their scope to manufacturing. It noted that the efforts of all three levels to co-ordinate purchasing in support of the long-term development of industrial capability were still too few. It did, however, commend the federal government for recent improvements in the encouragement and development of key sectors, including procedures to direct contracts to small businesses and increases in the Source Development Fund (SDF) of the Department of Supply and Services (DSS). The Council recommended that DSS offer incentives to the provinces to encourage the negotiation of bilateral or multilateral agreements for joint procurement, to encourage three-level co-operation designed to divert certain public sector purchases from foreign to domestic markets, and to encourage the development of a leasing market that could assist in the early diffusion of Canadian-developed machinery and equipment.

The procurement mandate of the Task Force was, of course, limited to the federal level. It would, therefore, be inappropriate to ascribe to it agreement with the Science Council's proposals involving the other levels to Canada. Nevertheless, the policy thrust of the Task Force's own recommendations could be applied at all levels.

The Science Council appears to have turned its back on one of its articles of faith of the 1970s — technological sovereignty — although its view of another one — government intervention in the private sector — has been reinforced.

> The common thread running through the economic strategies of advanced industrial countries is a commitment to exploit the new technologies to the maximum national advantage. Domestic R&D and the importation and diffusion of foreign technology lie at the heart of the process of economic development. In fact, technology transfer and R&D are complementary activities — most firms performing R&D are also heavy importers of technology. However, these two activities offer different risks and rewards to firms. A key issue is to determine the suitable balance between how much technology should come from abroad and how much should be developed at home. Should firms produce the technology with their own research in the hope of realising considerable profits if their gamble pays off? Or should they import technology that is proven but will not give them as great a competitive advantage since others share the technology?[23]

The Council said that these types of decisions are most efficiently made by "private actors in response to their markets", and to this the Task Force would agree. But the Council went on to say that individual market-induced decisions may not promote sufficiently rapid technical advances and, when this is the case, governments should become involved. The Task Force would be concerned about which rate of technical advance would be appropriate for which

degree of government intervention, yet it would agree with the Council that Canada must develop an indigenous research capability to remain or become competitive.

The Council said that, left to themselves, individual firms are unlikely to spend enough on R&D to benefit society as a whole. It also said that most Canadian R&D was process- (not product-) oriented and that the benefits of this are more likely to be reflected in reduced operating costs than in the creation of new products. The Council concluded, on the basis of the evidence cited in the report, that industrial R&D should have been about two-thirds greater in 1984 than in 1979. The actual increase, in real terms was 35 per cent between 1979 and 1982, indicating that about half the gap had been closed. The Task Force was not concerned with industrial R&D expenditure levels, but with the level of federal support and concluded that the current level need not be raised. The main change would be in allocation of this support. Finding additional funds would be industry's problem, and these would be forthcoming given the appropriate market-pull.

The Task Force decided that the most effective way for governments to increase industrial R&D would be through tax-based incentives and not through grants, and the Science Council agreed. However, the Council went on to say:

> . . .returns on additional R&D vary considerably among industries and therefore some industries would benefit more than others. Moreover, technical opportunity is not equally distributed among Canadian industries. Efficient public policies to overcome Canada's under-investment in R&D must take this into account. A general tax subsidy for R&D supplies a base level of support for innovative activities in all sectors, but these general subsidies must be supplemented by specific R&D grants that make allowances for the uneven nature of technological opportunity and benefits if all of Canada's industries are to approach a more satisfactory level of technical advancement.[24]

The Science Council discussed the contracting-out of the federal government's own R&D requirements and commented that, while there is no definite evidence of the effectiveness of this policy in encouraging firms to expand their own R&D budgets, Canada has used this approach less than most other advanced nations. The Task Force felt that this approach has been successful at times in the past, but its exploitation has not yet reached its full potential.

The Council commented on the proliferation and confusion resulting from the federal industrial and regional development program initiatives during the 1970s. It welcomed the combination of these two policy objectives in a single department — the Department of Regional and Industrial Expansion (DRIE) — in 1982 and the

introduction of the Industrial and Regional Development Program (IRDP) in 1983. The Council concluded:

> The IRDP is now the federal government's principal program of direct assistance to private sector firms. One of its potential strengths is its emphasis on the full range of the industrial innovation process — not just the initial R&D elements — and on the business plan and performance of a firm — not just the individual project being considered for funding. (However, initial evaluation of the program suggests there are some serious problems for small technology-intensive firms in obtaining a prompt response to requests.) At this time the Science Council believes that further expansion of government-assisted R&D be funded primarily by the IRDP, providing the program is audited to streamline procedures.[25]

Even with the rider that IRDP streamline its administrative procedures and be given the resources and competence to play its part well, the Task Force would **not** agree that this program should be left in its present department, DRIE.

Of the three reports discussed in this paper, the one by the Science Council contained the most extensive discussion of the social impact of the application of new (high) technology. It said, for example:

> New technologies cannot be used effectively in an environment of social suspicion and labour unrest. Resisting their adoption would be counter-productive, diminishing competitiveness and threatening wealth creation and job security rather than enhancing growth prospects and improving productivity. The management of Canadian firms must work towards progressive labour relations, particularly by encouraging labour participation in discussions about technological change.[26]

The Council went on to recommend that the federal and provincial governments adjust the legislative provisions in their labour codes by broadening the definition and interpretation of what constitutes technological change. The Senate Committee, given its political mandate and persuasive evidence of its own, might have agreed with the Council. The possibility that the Task Force would also have done so is not so clear.

COMMENTARY

This paper is principally concerned with the Wright Report because it is fast becoming a landmark in the long series of Canadian technology policy papers for its brevity, its bluntness and its preference for the private sector and the marketplace as arbiters of, and leaders in, national technology development. The other two reports are certainly useful and contain conclusions and recommendations beyond the

scope of the Wright Report. In fact, the report written by Senator Doody and his colleagues captures in many fewer pages more of the reality of a national technology policy than did the very much longer report written during the 1970s by the Special Committee chaired by the late Senator Maurice Lamontagne.

The Science Council report is also interesting because it shows a move away from the ideas surrounding the concept of technological sovereignty which dominated the Council's technology policy reports from the mid-1970s until quite recently. Of the three, the Council's report expresses most concern about the equity and social benefit of federal programs in support of technology development and about balancing the distribution of funds and opportunities. The Task Force, on the other hand, emphasises competitiveness, enterprise, initiative and the results of these — characteristics that are less gentle but more measurable than the ones the Council has emphasised.

All three reports recognise the social implications of a successful technology policy, the commercial and technical risks that innovation involves, the need to watch for success and for failure in the day-to-day application of policies and programs, and the need to point the government's own R&D activities more clearly towards the marketplace. The differences are over details — for example, the condemnation of the IRDP program by the Task Force but not by the Science Council.

According to its press — and not altogether unexpectedly — the Wright report has been very well received by the private sector. It has also received support from the new Progressive Conservative government and from its Minister of State for Science and Technology.[27] It is now clear that Dr. Siddon has "initiated a process aimed at its implementation", but the full extent of this will not be known for some time. Meanwhile, the government has begun the task of reducing the federal deficit and among the cuts made so far have been some to the budgets and programs of the science and technology departments and agencies, including the cancellation of NRC's Institute for Manufacturing Technology. Also, and in spite of having the support in principle of the Task Force, the Minister of Finance has placed a moratorium on the R&D 'quick flip' tax incentive, which has apparently overrun its original tax loss estimates significantly.

The Task Force report can, of course, be criticized on a number of grounds. One is its private sector bias. Another is the time factor. Yet another is its apparent lack of depth. It did not "go down to the benches", and it listened to the views of many who were not well informed about federal policies and programs for technology development. It did not recognise adequately the program and other controls and the review procedures that are already in place in some federal agencies to ensure the appropriateness and adequacy of their

activities. Both good and bad performers appear to have been treated without differentiation. The Task Force appears to have made its recommendations without solid intellectual underpinnings, and with insufficient regard for broad social benefit. The Task Force's recommendations are often couched in general terms, which may give the government the excuse — if it needs one — to ignore them, and especially in the face of such ministerial or bureaucratic opposition as may appear with the passage of time. There are also practical difficulties associated with the more specific recommendations of the Task Force (for example, the transfer of the IRDP program from DRIE to NRC) that may discourage change.

The report covered all of the main sections of the Task Force's mandate, but it missed several minor points. For example, it had little specific to say about the problems of technology transfer or about the interchange of personnel between the public and private sectors. It had nothing to say about the private sector acquiring equity in federal laboratory facilities, although it acknowledged the value of GOCO arrangements for operating them. There are also parts of the report that may be open to different interpretations, and the same may be said for terminology. For example, government R&D people are familiar with technical risk, are not necessarily averse to it, and can usually provide good assessments of it. They may not, however, be as familiar with commercial risk, which was the prime concern of the Task Force.

With regard to all of these points and to the contributions of Dr. Wright and his colleagues to the practice of technology development on a national scale, the view of one of Canada's most experienced technology policy commentators is of some interest. Gordon Hutchison wrote in September 1984:

> In only six months, the Task Force gathered and assimilated the national thought on technology stimulation programs. Wright produced a fine assessment of the shortcoming and value of federal programs . . . . but, more importantly, he established some fundamental guidelines for effective government participation. . . .[28]

Behind the guidelines to which Hutchison referred are three principles on which the Task Force based the ideas it put on record. They apply to both the government and industry: much more intelligent risk-taking; much more active enterprise; and much better overall management. And perhaps there should be a fourth: there is no reason why all of these things cannot happen together. The problem is to make them happen.

NOTES AND REFERENCES

1. The *Report of the Federal Laboratory Review Panel* (the Packard Committee) was published by the Office of Science and Technology Policy, Executive Office of the President, Washington, May 1983.
2. *Report of the Task Force on Federal Policies and Programs for Technology Development,* Ministry of State for Science and Technology, Ottawa, July 1984.
3. Senate Standing Committee on National Finance, *Federal Government Support for Technological Advancement: An Overview* (Chairman, the Hon. C. William Doody), Ottawa, August 1984.
4. Science Council of Canada, *Canadian Industrial Development: Some Policy Directions,* Report No. 37, Ottawa, September 1984.
5. *Report of the Task Force, op. cit.,* p. 1.
6. *ibid.,* p. 1.
7. *ibid.,* p. 3.
8. See, for example, Science Council of Canada, *Forging the Links: A Technology Policy for Canada,* Report No. 29, Ottawa, February 1979.
9. *Report of the Task Force, op. cit.,* p. 4.
10. *ibid.,* p. 5.
11. *ibid.,* p. 1.
12. These programs may be described very briefly, as follows:

    IRDP is intended to stimulate investment to enhance productivity and international competitiveness in Canadian industry. It provides support to viable projects at various stages of the innovation and business development processes and in all regions of the country. However, assistance is provided on a graduated scale of regional need and may be in the form of grants, contributions, repayable contributions, participation loans and loan guarantees.

    DIPP is designed to enhance the technological competence of the Canadian defence industry in its export activities by providing financial assistance to firms for selected projects. Assistance is given in the form of contributions and repayable loans on a negotiated shared-cost basis.

    IRAP provides support to Canadian companies in their efforts to expand through new product development, and it encourages applied research in industry with a view to increasing the calibre and scope of industrial R&D in the business environment. It has six elements: a field advisory service; a technical information service; contributions to firms employing undergraduates; contributions to laboratory investigations for small companies; contributions to small R&D projects performed by, or for, small companies; and contributions to large R&D projects by companies of all sizes.

    PILP is designed to promote the more rapid transfer of results from NRC and other federal laboratories, and from university laboratories, to industry. Funds are provided through negotiation between the parties involved.

13. The industry tax incentives in force during the mandate of the Task Force had the following elements:
    - the deduction of all current and capital expenditures for R&D in the year in which they were incurred;
    - an investment tax credit of between 20 and 35 per cent for scientific research expenditures depending on the location of the claimant firm and on the size and control of the firm;
    - the scientific research tax credit (SRTC, or 'quick flip') through which an eligible firm may renounce the tax benefit of deductions and related investment tax credits and, by so doing, allow new investors to qualify for the credits as deductions from their tax liabilities.

14. *Report of the Task Force, op. cit.*, p. 25.
15. *ibid.*, p. 25.
16. *ibid.*, p. 31.
17. *ibid.*, p. 35.
18. *ibid.*, p. 35.
19. *Federal Government Support for Technological Advancement, op. cit.*, p. 39.
20. *ibid.*, p. 44.
21. *Canadian Industrial Development, op. cit.*, p. 7.
22. See, for example, Science Council of Canada, *Innovation in a Cold Climate,* Report No. 15, Ottawa, October 1971; and *Forging the Links: A Technology Policy for Canada, op. cit.*
23. *Canadian Industrial Development, op. cit.*, p. 27.
24. *ibid.*, p. 32.
25. *ibid.*, p. 33.
26. *ibid.*, p. 47.
27. It is appropriate to note that Mr. Mulroney, the Leader of the PC Party, said in an election statement made on 28 August 1984, "It is our belief that R&D priorities in the first two years of [a PC government's] mandate must include: (i) the strengthening of the capital base of private industry; (ii) the overhaul of existing R&D programs, as per the recommendations of the recent Wright Report; (iii) better use of monies involved in R&D 'flips'."
28. Gordon D. Hutchison, 'The Wright Report — will it fly', *Canadian Research,* September 1984, P. 110.