THE CANADIAN CONSULTING ENGINEERING INDUSTRY :

REALIZING THE POTENTIAL

The Consultative Committee on the
Canadian Consulting Engineering Industry
Chairman S. J. Cunliffe

August 6, 1982

The Honourable Herb Gray, P.C., M.P.
Minister of Industry, Trade and Commerce
and Regional Economic Expansion
OTTAWA, Ontario K1A 0A6

Dear Mr. Gray:

We are pleased to submit herewith the report of the Consultative Committee on the Canadian Consulting Engineering Industry. We are appreciative of the program that has enabled us to present our views and recommendations in this matter and we look forward to working with you and your colleagues in using the report to strengthen the Consulting Engineering sector of the Canadian economy.

The findings of the report support the view that the Canadian Consulting Engineering Industry has the potential to make a substantially larger contribution to the economy than it does at present. However, that view can be supported only if capital investment in Canada's resource, manufacturing, building, transportation and infrastructure industries is viable and encouraged. We emphasize this point because since the report was written the resources of the Consulting Engineering Industry have been sadly depleted by the present economic downturn. We, together with other sectors of the economy, including government, desperately need a revitalization of Canada's development programs, particularly in the energy field, where the long term effect of project deferrals is seen to be particularly costly. We urge, therefore, that this problem be of primary importance to the federal and provincial governments.

The recommendations in the report require the attention of all levels of government, consulting engineers, and other industrial sectors. We have not asked for subsidies from government but have identified a number of programs in which consulting engineers can and should participate. As a general statement, we advocate policies that will provide a climate in which we can maximize our contribution.

Thank you for the initiation of this report, and for the valuable assistance afforded by the Construction and Consulting Services Branch of your department in producing and printing the report. The committee also appreciates the participation of the provincial governments' representatives. You may be assured of our continued interest and co-operation following up on the recommendations made.

Yours sincerely,

S.J. Cunliffe, P.Eng.
Committee Chairman

REPORT

OF

THE CONSULTATIVE COMMITTEE ON THE CANADIAN CONSULTING ENGINEERING INDUSTRY

A report prepared for the
Department of Industry, Trade
and Commerce and Regional
Economic Expansion
August 1982

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CHAPTER I

THE COMMITTEE AND ITS TASK

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The Committee

The Consultative Committee on the Canadian Consulting Engineering Industry was convened by the Minister of Industry, Trade and Commerce in February 1981, in conformance with the Department's program of consultation with industrial sectors of the economy. The program provides an opportunity for industry to recommend to government ways and means by which a sector's performance might be improved. The inclusion of the consulting engineering industry in this program is a recognition of its reputation, the importance of its work and its potential for increasing export markets.

The Committee is comprised of 15 members selected to represent different size firms within the industry and various geographical areas across the nation. It is supported by officials from the Department of Industry, Trade and Commerce and from corresponding provincial departments who function as a secretariat and resource group. A list of the committee membership is included at the front of this report.

The Task

The task of the Committee is set out in the following excerpt from its terms of reference:

> "The purpose of the Consultative Committee is to advise the Minister of Industry, Trade and Commerce on the status of the industry, its future growth potential and how this might be advanced, its constraints and ways of overcoming them; and after consideration of these aspects, provide guidance for future actions aimed at maximizing its contribution to Canada's economy.
>
> In order to develop recommendations and a plan of action for governments and the private sector, the committee will:
>
> define the consulting engineering industry and its current structure, characteristics and economic impact

define the issues and constraints facing the industry and the potential that could be realized

propose a set of actions which could be implemented by governments and the private sector to overcome constraints and ensure maximum development of the industry."

At the start of its task, the Committee identified the following primary issues as requiring special study or attention:

definition of the industry and its scope;

supply and demand of engineering personnel;

procurement practices -- government and industry;

research and development;

export;

major project capability; and

regionalization and local preference.

Accordingly, task forces were set up within the Committee to review the issues and prepare recommendations for consideration by the Committee as a whole. The reports of the task forces form the main body of this report and are included in the subsequent appropriately titled chapters. The task force on the definition and scope of the industry dealt also with the industry's domestic potential.

Some background material that would have been helpful to the Committee was not readily available. One of the Committee's recommendations is, therefore, for a continuing accumulation of data. On the other hand, the strong liaison that has already been established between the federal government and the Association of Consulting Engineers of Canada (ACEC), as part of the Association's five-year plan and system of joint committees with federal ministries, provided a great deal of essential information. Detailed surveys were carried out in 1974 and 1978 by Statistics Canada and corresponding reports were prepared by Peter Barnard Associates in 1977 and 1980. Numerous submissions on various subjects have been made to the federal government by ACEC and have received a sympathetic response. A number of publications by other bodies have dealt either obliquely or directly with

consulting engineering concerns ranging from engineering definitions through exporting considerations to manpower studies.

The incorporation of the foregoing material into this report would provide an unwieldy document. A bibliography has therefore been included to identify work that has provided background information or detailed explanations or rationalizations of positions taken by the Committee.

After review of the task force reports on primary issues, the summary report in Chapter II was prepared to present the Committee's overall view and summarize and consolidate the findings and recommendations.

CHAPTER II

SUMMARY REPORT -- ISSUES AND RECOMMENDATIONS

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SUMMARY REPORT

The Industry

Consulting engineering has developed in Canada as a highly independent entrepreneurial service industry. A profile and analysis of the sector has been prepared and is presented in Chapter III.

Briefly stated, the industry consisted in 1980 of 1,700 active firms with 42,000 employees and drawing fees totalling $1.7 billion. It is interesting to note that 20% of that income is drawn from the international market. While the average size firm in the industry consists of 25 people with many having staffs of less than 15, some 25 major firms account for 60% of the revenues and employees. The four main categories of firms within the industry are large heavy engineering, medium-sized municipal/transportation, local engineering and specialty. The classification grouping of employees is consistant throughout the various categories: professional engineers - 30%, non-engineering professionals - 6%, technical drafting - 43%, administrative/clerical - 21%.

In 1980, 52% of consulting engineering fees were drawn from the private sector. The industry's public or government clients were 22% federal, 33% provincial, 27% municipal, and 18% foreign. The principal engineering fields in which the fees are earned are:

1. Municipal
2. Buildings
3. Petroleum and natural gas
4. Power
5. Mining and metallurgy
6. Plant process
7. Transportation
8. Forest, agriculture, fisheries
9. Dams and irrigation
10. Air and seaports
11. Telecommunications
12. Others

Of the 12 engineering fields, the first six account for 70% of all the industry's revenues.

The growth pattern over the past 20 years, while highly volatile, has averaged 6% per year. In the last three or four years, however, growth has been chiefly in the export market rather than the domestic and the percentage of fees derived from export of services has risen from 17% of total income in 1977 to 20% of total income in 1980. It is noteworthy, and pertinent to this study, that 20 major

firms enjoy most of the involvement in international projects while smaller firms enjoy little to no involvement with the exception of a small group of highly specialized practitioners. It is noteworthy also that in 1978, fees earned from foreign projects by Quebec firms represented 37% of the national total and those from Ontario firms 49%, a substantial regional concentration.

Saleable engineering services are provided also by entities other than pure consulting engineering firms. These include contractors and manufacturers, government departments and agencies and foreign firms, some of which are Canadian based and some of which are not. Government departments and agencies are taken to include departments at all levels of government, utilities, universities, research institutes, and of course crown corporations, all of whom maintain engineering staffs which do work in-house and some of which offer engineering services to others. Good data on the value of the activities of these entities are not readily available and will take some time to assemble. In view of the degree of involvement of government agencies and foreign firms in Canadian resource and energy development, it would seem that this area is one that is crucial to the health of the Canadian consulting engineering industry.

Impact on the Economy

In monetary terms the consulting engineering industry impacts significantly on the economy. It supports an annual Canadian payroll of approximately $1 billion made up of payments to trained personnel with an average salary across the industry in the order of $23,000 per year. In addition, however, it plays an important role as a repository for technological and managerial know-how in the private sector in Canada. Such a repository facilitates the transfer of research and experience from department to department, government to government, and between government and industry, and as a freely deployable pool of talent provides a manpower buffer during economic cycles in government and industry. By virtue of these functions it directly affects the quality, efficiency and economy of delivery of engineering services.

Consulting engineering has a somewhat less tangible but nevertheless real impact on the economy because of its interface with other industrial sectors. The skills it provides for rationalization, design and management of expansion and development have direct effects on the

economy and efficiency of the client sectors. At the same time, through the specifications for materials and equipment it has a direct effect on the manufacturing and supply industries. This can be particularly significant in the case of export of services where the engineering assignments can open the way for "follow-on" sales.

The industry has become a significant exporter of engineering services with sales for 1980 estimated at $340 million. In addition to contributing to the balance of payments it has enhanced Canada's image abroad by the size and quality of its contribution. Canada is the third largest member of FIDIC, a 35-country international federation of consulting engineers. The industry's international activities accomplish the transfer of technology and experience both to and from Canada and help to stabilize the industry by diversifying the market and providing additional employment. Because engineering provides the entry to projects abroad it can help to prepare the way for sales of materials, equipment and construction. The potential for these "follow-on" sales has been estimated at anywhere between 2 to 1 and 10 to 1 of engineering fees, and while a precise evaluation has not yet been achieved it is generally acknowledged that the multiplier effect is significant and could increase substantially.

Industry Potential

Substantive estimates of the growth of the consulting engineering industry have been provided by Peter Barnard in his 1981 report which is based on the detailed Statistics Canada Surveys of 1974 and 1978. He has predicted real growth to be approximately 4% domestically and 15% internationally to total revenues in excess of $2 billion by 1985. Of that amount something over half a billion dollars should be derived from the sales of services abroad. The estimates are based on historical data and do not necessarily represent the potential of the industry if constraints to its development are removed.

The volume of construction for which engineering services were required during 1980 (construction exclusive of housing) was $35 billion. It is estimated that consulting engineers were involved in approximately 40% of the volume or $14 billion, leaving 60% or $21 billion to be engineered by others. This $21 billion worth of construction could conceivably (on a proportional basis) represent approximately $2 billion in fees. If 70% of that amount were contracted out to consulting engineers the domestic practice would be doubled on construction works alone.

The Committee is satisfied that there is substantial further work available in many major studies, examples of which are project feasibility, planning, environmental concerns, and pollution control, research in such fields as resource development, energy supply and conservation, and transportation and communications, and in a largely undeveloped market in which Canadian consultants have not been competitive with foreign services in manufacturing, equipment and machinery design, and process engineering of various kinds.

Part of the reason for the consulting engineering industry's weakness in this undeveloped market is its lack of an effective research and development program. The establishment of a strong and credible research and development capability which is attractive to government and industry will strengthen the consulting engineering industry internally and enlarge its potential for opening new markets.

The realization of the potential will depend on the degree to which work can be released to the industry and the ability of the industry to develop or acquire the requisite technological and managerial skills and manpower. The contracting of more of Canada's own engineering work to the private sector consulting industry will increase its domestic growth. Provided that growth can be achieved profitably, and good profitability is a necessity for the success of any enterprise, Canadian firms will be able to compete more actively internationally. Time was not available for this study to carry out satisfactory domestic and export market analyses. Such analyses, should, however, be priority items for the industry. At present it is estimated that fees from foreign projects should be $500 million by 1985 and will probably level off at about 25% of the total billings of the industry. The size of Canada's export market for consulting engineering need not be limited to these figures and will depend on the strength and competitiveness of the industry in Canada and the aggressiveness of Canada's export policy.

ISSUES AND RECOMMENDATIONS

There are a number of issues to be addressed if the Canadian Consulting Engineering Industry is to reach its maximum potential and impact on the economy.

It is essential that the Canadian Consulting Engineering Industry be healthy and profitable if it is to continue to survive, to grow and to contribute directly to the Canadian economy. To achieve this objective it is essential that governments provide the climate and the incentive which will allow our industry to realize its full potential. Some of the key elements which must be addressed and acted upon are the following:

1. Implementation of a contracting-out policy for all federal government departments, crown corporations and agencies, and support for such a policy by provincial and municipal governments.

2. Canadian-owned engineering firms must be given first opportunity wherever possible in the execution of major projects, particularly major energy projects. Furthermore, every effort must be made to ensure that personnel from such firms have access to all managerial, professional and technical positions relative to the planning, engineering, procurement, construction and eventual operation of major projects.

3. To enhance the competitive position of Canadian firms in the export market.

   a) The Export Trade Development Board should be charged with implementing the suggestion put forward by the Hatch Committee on the establishment of a risk-sharing body made up of government and private sectors.

   b) The Canadian Project Preparation Fund (CPPF) facility of the Canadian International Development Agency's (CIDA) co-operation program be transferred from CIDA to be an instrument of external trade, thereby creating a fund to provide grants for feasibility studies. Furthermore, firms carrying out such feasibility studies should be allowed to implement the on-going project work if it is the desire of the client.

   c) Canadian citizens who are bona fide residents of a foreign country for at least ten months in any taxable year be allowed to exclude foreign-earned income from taxable income.

4. In order to build up expertise, research and development programs be contracted out to the consulting engineering industry by a procedure similar in principle to that now in place for universities.

The body of the report contains recommendations with respect to the issues which the Committee has judged to be pertinent in support of the foregoing considerations.

The Domestic Opportunity - Size of Market

The Canadian Consulting Engineering Industry is geographically and technically diverse and in a position to grow and contribute to the economy in all regions of Canada. It provides an excellent vehicle for the exchange of technology and the delivery of services between sectors and regions.

There are many organizations, other than consulting engineering firms, which provide engineering service in Canada. While it would appear that the transference of these services to consulting engineers might result in doubling the industry's activity, the true size of the total domestic market has not been accurately assessed. Planning by government and the industry will be facilitated if an achievable objective can be identified.

Recommendation 1

That a task force be set up under the direction of the joint Association of Consulting Engineers of Canada (ACEC)/Department of Regional and Industrial Expansion (DRIE) Committee with a sufficiently comprehensive membership to determine:

a) The total amount of engineering done in Canada in-house by federal, provincial and municipal governments including their various agencies, universities, utilities and crown corporations.

b) The total amount of engineering done in-house in Canada by construction, industrial and manufacturing corporations.

c) **The proportion of the engineering identified in (a) and (b) that could conceivably be done by the consulting engineering industry.**

Consulting engineering is imported to Canada in a number of ways, including:

- the use of foreign consultants by foreign investors
- the use of foreign consultants who possess special technologies not yet available in Canada
- the importation of process technology developed elsewhere
- the importation of manufacturing technology developed elsewhere.

Again, the total value of these services is not well known, nor is the value of such work that might be transferred to Canadian consultants. An assessment of these values would complete an evaluation of the total market available in Canada.

Recommendation 2

That a task force be set up by the joint ACEC/DRIE Committee to evaluate the amount of consulting engineering services that are imported to Canada, the nature of the services imported, and the countries from which they come.

The Domestic Opportunity - Relation to Exports

It is the Committee's opinion that the industry's domestic and export activities are mutually supportive. A strong domestic practice will provide the base from which to export, and a strong export practice will provide additional experience and employment that will strengthen the domestic industry. It has also been noted that theent involvem of the major firms in international projects is understandably considerably higher than that of average size or smaller firms. The domestic opportunity therefore, would seem to be the appropriate basis upon which to project the export capability.

Recommendation 3

That a task force be set up by the joint ACEC/DRIE Committee to study the relationship of domestic strength to export capability.

The Domestic Opportunity
- Engineer/Procure/Construct (EPC) Capability

The potential influence of an EPC capability on the growth of the Canadian Consulting Engineering Industry has been highlighted in chapters on the export opportunity and the major project capability. Both public and private agencies can contribute to the development of firms with an EPC capacity by providing an opportunity for gaining experience on domestic projects. The various levels of government and their agencies can initiate this development as part of their "contracting-out" policy. Because of its importance, the Committee feels that the subject is worthy of further study.

Recommendation 4

That a task force be set up by the Canadian Consulting Engineering Industry and the federal government to make recommendations to the Minister for the development and expansion of the industry's EPC role in the public sector market.

Constraints to Growth

If this potential is to be achieved, particularly in light of current worldwide economic circumstances, a financially healthy industry is essential.
The change in tax treatment of work in process proposed in the MacEachen budget will severely impede the cash flows of the industry and seriously curtail its ability to finance continued growth.

Recommendation 5

That all levels of government and industry recognize that fee schedules and price bases must allow cash flows and levels of profitability which will maintain a healthy industry.

Recommendation 6

That the proposed legislation relating to work in process be eliminated.

Procurement Policies and Practices -
Consulting Engineering and Government

The potential of the Canadian Consulting Engineering Industry will depend on the size of the market available to it and the manner in which engineering services are purchased. Because the market is so fundamentally important and can be influenced by policy, it is probably the most important single issue to be addressed.

At present, the market for engineering services is represented in almost equal proportions by private sector and government purchasers. Private sector clients on the one hand are initiators of capital works for the construction and maintenance of the means of production as well as substantial resource development. Governments on the other hand, control the development of most of the infrastructure and through utilities and crown corporations, control large expenditures for power generation, irrigation and transportation.

Services in all the foregoing areas are provided by consulting engineers. They are also provided in varying amounts by in-house staff in both government and private sector agencies and in some cases, by foreign consultants. Therefore the potential of the Consulting Engineering Industry in Canada is directly controlled by the volume of engineering services required, the degree to which those services can be contracted to the industry, and, of course, the competence of the industry and its ability to cope.

Considerable discussion, and in fact mutual agreement, on the subjects of contracting-out, selection procedures, and contracting policies have already been achieved with the federal government and to a much lesser extent with some provincial governments. In some cases, however, where a sincere effort has been made by government to contract out, the effectiveness of the policy has been undermined by selection and contracting procedures. The successful development of a substantially increased scope for the Consulting Engineering Industry will require considerable further effort on the part of the industry itself, governments at all levels, and their utilities and crown corporations, and the private sector.

The Canadian Consulting Engineering Industry must continue to work with both the government and private sectors to provide information as to its scope, aims and objectives.

Recommendation 7

That the Canadian Consulting Engineering Industry:

a) Continue its dialogue with the federal government through the Association of Consulting Engineers of Canada on the subjects of contracting-out, procurement practices, and contractual agreements.

b) Establish dialogue with the provincial and municipal governments through the member organizations of the Association of Consulting Engineers of Canada to develop policies for contracting-out, procurement practices, and equitable contractual agreements.

c) Establish dialogue with the private sector through the Association of Consulting Engineers of Canada and its member organizations, jointly with the Industry and Trade Associations such as the Canadian Construction Association (CCA) and the Canadian Manufacturers' Association (CMA) to develop mutually acceptable policies for contracting-out, procurement practices, contractual agreements and other mutual concerns.

Contracting-out has been recognized as a desirable policy by the federal government. As the effectiveness of that policy increases, the consulting industry will benefit from not only the increased activity but also the precedent that is set for the provincial and municipal governments.

Recommendation 8

That the government of Canada increase the potential of the engineering industry by taking action to:

a) Extend its contracting-out policy to all federal government crown corporations and agencies.

b) Continue to monitor its contracting-out policy to ensure that practice does conform to the policy.

c) **Continue to cooperate with the consulting engineering industry for the improvement of procurement practices and contract agreements.**

d) **Support a policy of contracting-out by provincial and municipal governments and by the private sector.**

Very large capital expenditures are undertaken by provincial governments for energy resource development, power generation, transportation and infrastructure construction. Much of the engineering work, which is carried out by government departments, crown corporations and utilities, controls the major developments and therefore the major market for engineering services in some provinces. The municipal governments in turn control most of the infrastructure and in very many cases act on cost sharing arrangements with the provincial governments. Between them provincial and municipal governments are a major factor in the provision of engineering services in many areas of the country.

Recommendation 9

That the provincial and municipal governments play a key part in the strengthening of the Canadian Consulting Engineering Industry by taking action to:

a) **Develop policies of contracting-out for consulting engineering services.**

b) **Cooperate with the Canadian Consulting Engineering Industry in the development of procurement practices and contractual agreements.**

c) **Support a policy of contracting-out for engineering services by private sector corporations.**

Procurement Policies and Practices -
Consulting Engineering and the Private Sector

The private sector, per se, is more difficult to approach on a matter of policy because of the diversity of interests and in many cases limited jurisdictions of the many entities involved. Therefore opportunities for the presentation of the case for the development of a strong privately-owned specifically-engineering industry have not been adequately made. The result is that consulting engineers have not been successful in presenting their

capabilities and quite often industrial corporations have been unaware of the services available and have experienced unnecessary difficulty in acquiring technology. It is the Committee's opinion that the Consulting Engineering Industry should address this challenge because there are decided advantages to Canadian industry in having a full scale technology base of wide experience available to it.

Recommendation 10

That private sector owners:

a) **Enter into discussions with the Canadian Consulting Engineering Industry through industrial and trade associations on the efficacy of contracting-out policies and the requirements of mutually acceptable procurement practices and contractual agreements.**

b) **Review the advantages of contracting-out to the Canadian Consulting Engineering Industry.**

c) **Develop policies for contracting-out for the guidance of senior management.**

The Export Opportunity - Proposed Initiatives

Spin-Off Sales

The degree of independence of the consulting engineering profession in Canada makes it different in character to the professions of some other countries vis-à-vis the manufacturing, utility and financial sectors. Frequently, foreign consultants have direct linkages with manufacturers and construction contractors and offer packages involving these links. Canadian consultants have tended to maintain a non-conflicting relationship with both the client and suppliers of goods and other services. The consequent role of the consultant in influencing procurement in projects is often misunderstood. The consultant/client relationship and the nature of the project, its source of financing and location of undertaking all affect the consultant's ability to influence procurement.

The federal government and ITC in particular attach great importance to further developing the link between the sale of engineering services abroad and follow-on sales of Canadian equipment and other goods, because of the

benefits this could bring to Canada. Their efforts to improve this aspect of export is hampered by the lack of interest, perceived lack of competitiveness and lack of experience on the part of some Canadian equipment manufacturers and suppliers in bidding on projects abroad.

In today's competitive international marketing environment, financing is another critical element in the export of equipment and other goods. The need also exists to enlarge the engineer-procure-construct (EPC) capacity of Canadian firms, or consortia of such firms, in order to perform effectively on large foreign projects.

Recommendation 11

It is recommended that:

a) **The Canadian Consulting Engineering Industry convene joint meetings between manufacturing, construction, government, and financial and consultant groups to discuss major projects abroad, both prior to implementation and after the awarding of a contract, to improve their knowledge about such projects and exchange information on them.**

b) **Provincial and federal governments devote further efforts and resources to improving and keeping up-to-date sourcing information on suppliers in Canada and distribute this information as widely as possible in Canada and abroad. Provincial governments can play a particularly effective role here because of their knowledge of local firms. In the same context, it is recommended that the Canadian Consulting Engineering Industry encourage engineering firms to use and subscribe to the ITC's Business Opportunities Sourcing System (BOSS).**

c) **The Canadian Consulting Engineering Industry, through its member firms, implement further studies regarding spin-off sales of Canadian goods and services in capital projects abroad so that more complete data are available on achievements to date, what the impediments to greater sales have been and what action is now required to maximize benefit to the industry from such sales.**

d) The Canadian Consulting Engineering Industry prepare a report for distribution to the public and private sectors on the factors that bear on procurement and the consultant's influence on such procurement in capital projects abroad.

e) The Canadian Consulting Engineering Industry seek new and imaginative ways to finance the export of Canadian goods and services through the use of, for example, the Arab funding organizations.

Small to Medium-Size Firms and Exports

Many of the small and medium-size firms in the industry are interested in exporting, but the problems they experience in trying to develop additional export sales are often discouraging. These problems include the cost of identifying and pursuing overseas projects, financial risk in doing so, lack of personnel and management and, often, lack of proper information on work within their capabilities. Because of the wide distribution of small and medium-size firms across Canada, their growth through exporting has important regional connotations.

Recommendation 12

It is recommended that:

a) The Canadian Consulting Engineering Industry establish, as a priority, a study to determine how small and medium-size firms can be assisted and what techniques (for example, sub-contracting) can be used to increase their participation in exports. This would also be a way of making the best use of engineering and support staff in projects, in case of shortfalls in the availability of such staff.

b) The policies of federal government departments to support joint ventures involving various size firms and giving preference on smaller contracts/projects to small to medium-size companies (for example, the policy of the Canadian International Development Agency (CIDA) in this regard) be continued and expanded.

Profitability in the Industry and Exports

Profitability is a prerequisite to successful exporting. The decreasing profitability in the industry, the lack of vigorous domestic growth, rapidly rising costs and growing competition, especially in foreign markets, are all factors which inhibit export performance.

Recommendation 13

That while encouraging firms to become increasingly selective in their pursuit of projects abroad, the Canadian Consulting Engineering Industry must make a continued and determined effort to keep member companies interested in exporting; this will help avoid any lessening of export activity and prevent a decrease in Canadian firms' interest and experience.

Canadian Banks

Canadian banks have the potential for playing an effective role in identifying projects overseas, in financing consulting services and in locating equity capital for projects, where required.

Recommendation 14

That the Canadian Consulting Engineering Industry take the initiative to encourage an even closer collaboration with Canadian banks in the marketing of exports, even to the extent of having representatives of the banks accompany the marketing staff of consultants on their overseas trips.

Domestic Development and Exports

Any export strategy for the industry, to be effective, must be related to industrial development and industrial development policies in Canada. A strong engineering base from which to export must be developed in the domestic market. Recommendations for strengthening the domestic base are included in this report under the section on Procurement Policies and Practices.

Recommendation 15

That the Canadian Consulting Engineering Industry advise the appropriate federal and provincial

government departments that it wishes to be consulted and included in any policy deliberations and discussions on the enhancement of export capability.

Front-End Costs

Canadian consultants have consistently claimed they do not receive support comparable to that of many of Canada's competitors in the key area of front-end marketing costs. The consulting engineer is usually the first Canadian to be present on a project overseas and it is the engineer who undertakes much of the project identification and marketing carried out for other countries by manufacturers. The costs of these activities are high because they represent a direct marketing effort in the foreign country and because the number of contracts obtained in comparison to projects identified and pursued is low (the industry average is probably about one in 20). The concept of CIDA's Canadian Project Preparation Fund (CPPF) facility is excellent and has been beneficial to Canadian firms in securing overseas contracts, but one underlying problem is that the mandate of CIDA is to aid, not trade.

Recommendation 16

That the CPPF facility of CIDA's Industrial Cooperation Program be transferred from CIDA to be an instrument of external trade, thereby creating a fund to provide grants for feasibility studies on projects suitable for Canadian consulting engineers' competence when there is a good chance of developing follow-on sales of engineering and equipment from Canada.

Risks

The risks in international projects are high and are likely to continue to be so as capital projects become even larger and more complicated. Canadian consultants usually have a small share of any capital project and do not have the financial resources to assume the risks for entire projects of this type. Similarly, manufacturing companies have limited ability to participate. At present, Canada has no facility or program to resolve this

problem, yet capital projects are of particular interest to the Canadian government and Canadian suppliers.

Recommendation 17

That the Export Trade Development Board be charged with reviewing the suggestion put forward by the Hatch Committee on the establishment of a risk-sharing body made up of government and the private sector. As an integral part of this review, the Board should study and update the recommendations made by the Hatch Committee in November 1979, and answer the questions we believe have not been adequately dealt with on this issue: for what specific types of projects are the risks greatest; what types of risks should be covered; can an entity of government be included, and if so, what entity.

Export Insurance and Financing -
Export Development Corporation (EDC)

Export insurance and financing are highly technical and complex matters and it is extremely difficult to make comparisons between competing systems of support by governments. The Hatch Committee correctly identified the problem of EDC when it stated that it "does not question the efficiency of EDC" but rather "its mode of operation ... its policies and practices", and then goes on to suggest a different structure for the Corporation. The consulting industry is the largest client group of the financing services of EDC and it acknowledges the tremendous support the Corporation has given in capital projects abroad. The dilemma that needs resolving is the difference in the way EDC perceives its effectiveness in providing competitive export insurance and financing and the way the private sector perceives it.

Recommendation 18

It is recommended that:

a) Consideration be given to implementing the Hatch Report proposal that the Board of Directors of EDC have a majority of its members from the private sector and a private sector chairman.

b) A study be commissioned either by ITC on its own or through the Export Trade Development Board to gather information on the export insurance and

financing programs of Canada's competitors and compare these programs with those currently available in Canada.

Tax Incentives

It is recognized that tax incentives designed to make exporting more attractive and to motivate firms to sell abroad are fundamental to expanding and diversifying Canada's exports not only of services but also of equipment and materials. Even a superficial review of the techniques used by Canada's competitors raises the question whether Canada has been either competitive or imaginative in its approach. Effective fiscal policies should be established to encourage greater interest and participation by Canadian companies without violating our international obligations. Studies to achieve this are apparently under way in Ottawa.

Recommendation 19

It is recommended that:

a) **The Canadian Consulting Engineering Industry, through its association, be invited to participate in these studies.**

b) **Preferential taxation treatment of foreign-earned income be recognized as one of the best and most affordable solutions to promoting exports and that it be implemented by both federal and provincial governments.**

Taxation of Offshore Employees

Despite the February 1981 Amendment to the Canadian Income Tax Act, current Canadian taxation of export trade employees posted overseas adversely affects the competitiveness of Canadian consulting firms already working or seeking new work abroad and discourages Canadian professional staff from accepting assignments abroad. Such tax measures in Canada are becoming increasingly unfavourable especially as Canadians are well aware of the recent tax changes that have been made in the United States and other changes by that country to make its tax system more internationally competitive in this field.

Recommendation 20

That Canadian citizens who are bona fide residents in other countries for at least ten months in any taxable year be allowed to exclude foreign-earned income from taxable income.

Other Measures

There is a growing requirement in Canada for significantly increased amounts of research and development in order to remain technologically ahead of competitors and be able to provide more advanced technology and project management services on foreign projects.

Recommendation 21

That programs for the enhancement of the Canadian Consulting Engineering Industry's capability in research and development be initiated with reference to the special needs of, and opportunities provided by, the export of engineering services.

Changes should be made in certain programs that are meant to support the export efforts of the Canadian consulting industry.

Recommendation 22

It is recommended that:

a) **The Program for Export Market Development (PEMD) be amended by increasing per diem rates to reflect current costs, and also allow the costs of draftsmen and similar technical staff to be included as eligible expenses.**

b) **The Canadian International Development Agency (CIDA) support Recommendation 16, if this program is to achieve its full potential.**

c) **The Export Development Corporation issue clear guidelines on "credit mixte" resources and the financing of feasibility studies to achieve a better understanding with the Canadian Consulting Engineering Industry.**

Major Project Capability

The large inventory of major projects that has been identified as being desirable and achievable during the next two decades represents Canada's opportunity to develop a Consulting Engineering Industry with the management skills and the special technology required for world competition. The benefits to be derived are similar to those that accrue from normal growth of the industry, such as long-term employment, enhancement of skills and technological know-how, strengthening of the industry and increased ability to export. In addition, however, there are advantages related to the scale and in some cases the special nature of the projects that provide special opportunities.

The major projects represent a unique opportunity for Canada to develop management skills, systems and know-how that are the key to the conduct of large scale undertakings. Related to the management issue is the combination of project management, and engineer/procure/construct capabilities that are a requirement for many large-scale private and foreign developments.

Significant changes have recently occurred in the investment environment. This has been particularly severe for the petroleum based industries. These changes include: high interest rates, lower oil prices, increased tax burdens, and controversial government policies such as the National Energy Program.

Recommendation 23

That governments reconsider their policies relating to industry taxation and the National Energy Program in the light of the changing economic environment in Canada and throughout the world.

Major Project Capability - Employment of Canadian Consulting Firms

The primary issue that must be addressed is that of access for Canadian firms to all aspects of the management and engineering involved. Where all the management or technology are not present in one firm, the opportunity should be there for its acquisition by joint venture or the retaining of sub-contractors. The resulting development of capability will be to the long-term benefit of the industry and Canada.

Recommendation 24

That Canadian consulting engineering firms be engaged wherever possible in the execution of major projects, particularly major energy projects.

While it is most important that Canadian firms be given the opportunity to develop, it will not be in the best interest of all concerned to have contracts awarded on the basis of preferential fee premiums. The Canadian industry must remain competitive and preference should be based on clearly perceived long-term benefits to Canada.

Recommendation 25

That the long-term benefits of employing Canadian firms to undertake major project work be a main consideration of owner/sponsors.

Recommendation 26

That Canadian-owned companies participate in major projects on a competitive basis and not on the basis of any premium.

Major Project Capability - Employment of Canadians

In some instances it is conceivable that circumstances will dictate the assignment of major projects to other than Canadian-owned firms. Canadian firms may be unable to cope because of prior commitment, insufficient size or financing, or a lack of the necessary experience or technology. In cases where management or technology are to be imported, steps should be taken to ensure that Canadians are employed in all functions where meaningful experience can be gained. This experience will be a long-term benefit in that it can become part of the Canadian industry for application to future projects.

Recommendation 27

That every reasonable effort be made to ensure that Canadians have access to all managerial, professional, technical, skilled trades, and general labour positions relevant to the planning, engineering, construction and eventual operation of major projects.

Major Project Capability - Manpower and Technology

In addition to on-the-job training, new technology can also be acquired by immigration and by research and development training. Both the immigration and research issues are dealt with in the recommendations contained in appropriate sections of this report. Any response to those recommendations should be made with full realization of the industry's requirements for participation in the major projects.

Recommendation 28

That when consideration is given to either adjustments to Canada's immigration policies and procedures or the redirection of latent engineering resources in Canada, reference be made to the particular requirements of the industry for the enhancement of its major projects capability.

Recommendation 29

That programs be initiated to enhance the capability of the Canadian Consulting Engineering Industry in research and development with full knowledge of the special needs of, and the opportunities provided by, major projects.

Major Project Capability - Regional Development

Many of the long term benefits that major projects can bring to Canada will apply equally to the various provinces or regions within the country. The same arguments with respect to regionalization that apply to other activities of the industry apply to the major projects with the added influence of the scale involved. While the consulting engineering industry does not support the regulation of the movement of goods, services, and employment within Canada, it does contend that giving consideration to the importance of the development of all regions of Canada will be in the national interest.

Recommendation 30

That the development of the regions of Canada be an important consideration when selecting engineering firms to participate in major project assignments. It is also recommended that major project owners/sponsors be encouraged to give

preference in their procurement policies, everything else being equal, to suppliers of goods and services in the following order of priority:

- **regional Canadian-owned firms**
- **other Canadian-owned firms**
- **Canadian-based (good citizen) firms**
- **others.**

Major Project Capability - Timing of Projects

The scale of the major projects together with their somewhat uncertain scheduling can result in cyclical effects that will be difficult for the Consulting Engineering Industry, at its present size, to absorb. In addition to the normal problems that face the industry when projects come to an end, or fail to start, there will undoubtedly be compression caused by the overlapping of design and construction requirements with the attendant demands on manpower and resources. While the Consulting Engineering Industry does not recommend formal regulation of project priority it is evident that the long-term interests of the industry and of Canada will be served best if undue peaking of demand can be controlled.

Recommendation 31

That major project work be packaged in ways that will maximize opportunities for Canadian firms to participate and that will avoid excessive peaking of demands.

Recommendation 32

That regulation as a means for enhancing the degree of participation by consulting engineers in major projects not be advocated. Rather, fiscal arrangements creating a climate hospitable to participation by Canadian firms is considered the appropriate route.

Recommendation 33

That maximization of industrial and regional benefits must be a leading criterion in the selection of consulting engineering firms for major project assignments.

Research and Development - Government Influence

Research and Development has been recognized as being vitally important to the achievement of national objectives and the federal government is seeking initiatives that will increase the participation of the private sector. With the removal of certain impediments the Consulting Engineering Industry can assist with those initiatives.

The Consulting Engineering Industry represents a resource of approximately 42,000 people, of whom some 12,600 are university trained engineers. The industry contains technical, organizational, and management skills which qualify many of its members for research and development projects. While the industry has been active in "own account" research involving upgrading of its own technology and systems, it has not entered the more general field because of a lack of funding, the lack of a ready market for results and the inadequacies of present programs designed to foster R&D work. The establishment of the climate and the opportunity that would encourage large scale participation in research and development would help greatly in meeting national objectives and would strengthen the Consulting Engineering Industry by developing a new high profile capability.

Recommendation 34

That a suitable interpretation of what constitutes research and development be agreed upon between government and the Canadian Consulting Engineering Industry.

Recommendation 35

That the provisions of the Income Tax Act aimed at encouraging research and development in the manufacturing sector be extended in full to the Canadian Consulting Engineering Industry for "own account" research and development.

Recommendation 36

That a research and development grant program similar to that now in place for universities be instituted to encourage research and development in the Canadian Consulting Engineering Industry.

Recommendation 37

That shared cost programs such as the Enterprise Development Program be promoted and utilized by government as a means of accelerating the research and development effort of the Canadian Consulting Engineering Industry.

Recommendation 38

That licensing regulations be simplified to reduce the cost of protecting patents and copyrights resulting from research and development activities by Canadian consulting engineers.

Research and Development - Private Sector Influence

The government is currently funding research and development in a variety of firms carrying out their own product or process development. In addition to the in-house work carried out by individual companies many contracts are let by the private sector to universities, provincial research institutes, and other specialist organizations. The Consulting Engineering Industry, being part of the private sector, is a ready-made facility for providing service to companies doing research and development in the manufacturing, resource and construction sectors.

Recommendation 39

That industry undertake, through its principal associations, educational programs aimed at developing an awareness of the advantages and scope of the research and development capability of Canadian consulting engineering firms.

Regionalization and Local Preference - Consulting Engineering Perspective

The practice of using "local preference" in awarding assignments for engineering services has begun to affect the free movement of services and therefore the development of the Consulting Engineering Industry. Some provinces and municipalities are beginning to develop policies that inhibit free competition and the free movement of services. It is, therefore, an issue to be considered. The industry is concerned that as one area moves to favour its constituents, others will be obliged to follow suit. Some aspects of regionalization are a

fact of life and provide advantages in terms of both national objectives and the Consulting Engineering Industry's development. At the same time, projects vary in requirements for both technological skills and managerial capability, and economic fortunes do vary across the country from time to time. Rigid adherence to the principle of local preference will have an adverse effect on the ability of consulting engineering firms to compete on the basis of economy and experience, and thus limit the freedom of opportunity for healthy development.

Recommendation 40

It is recommended that:

a) **Authorities developing policies dealing with regionalization or local preference consider benefits and disadvantages carefully prior to formulation. Under no circumstances should such policies be written into legislation.**

b) **Policies of local preference not be restrictive in nature.**

Regionalization and Local Preference - Client Perspective

The client/owner must be free to purchase services which in his best judgement satisfy his requirements as he sees them. In the case of governments, this will mean that in certain cases the interests of constituents and the economy of the area will be considered. Private industry may also respond to local customers or prefer to deal with a firm whose head office is nearby. These clients should also have available to them the freedom to choose whichever firm offers the most pertinent experience or is most in sympathy with the client's needs. The Consulting Engineering Industry itself, can be sensitive to these requirements for both large and small projects, and respond by combining firms with special capabilities with those with local knowledge.

Recommendation 41

It is recommended that:

a) **The Canadian consulting engineer be selected on the basis of experience and capability.**

b) **Where the local or regional firm has the technical ability to deliver the service within the time schedule and the budget required by the client, engagement of the local or regional firm be encouraged.**

c) **Joint ventures and the use of sub-consultants be encouraged where such an arrangement will satisfy the client's requirements, in particular on major projects.**

Engineering Personnel - Manpower Planning

One of the most serious constraints faced by the Consulting Engineering Industry in reaching its potential is the difficulty in providing, and keeping employed, an adequate supply of trained and experienced engineering personnel. While faced with an identified massive program of construction to be carried out over the next two decades, Canada is experiencing almost complete uncertainty with respect to national objectives for the program. Because of the scale of the major projects, and their potential influence on the future of the Consulting Engineering Industry and the Canadian economy, manpower planning is crucial to the achievement of maximum long-term benefits. Also, and again because of the scale of the potential requirement, the present degree of uncertainty makes meaningful planning almost impossible.

Recommendation 42

That the Canadian Consulting Engineering Industry give active support and assistance to the Canadian Engineering Manpower Council (CEMC) in the establishment of the Canadian Engineering Manpower Inventory (CEMI) and in carrying out its manpower planning role.

Recommendation 43

That the current Major Projects Inventory and Manpower Forecast be updated by the Department of Regional and Industrial Expansion yearly and thereafter published.

Engineering Personnel - Manpower Supply

A detailed assessment of the present supply of and demand for engineering personnel indicates that if the

Consulting Engineering Industry is to achieve its potential in Canada's domestic market, gaining the impetus from a program of major project development, and moving to exploit opportunities in export markets, the presently foreseen indigenous supply of engineering personnel will be insufficient. The short fall must be met by either increasing the output of graduates from engineering schools or technical colleges, immigration of qualified persons, on the job training, or by purchase of foreign engineering services.

The purchase of foreign engineering services is probably the least satisfactory because it does not optimize the long-term benefits to Canada. On-the-job training will be important but it does not produce graduate engineers and obviously the numbers that can be accommodated in a training mode are restricted. The two most desirable sources of supply are graduates from universities and colleges and immigration.

The option of increasing the supply of engineering personnel in the form of graduates from unversities or colleges is important because of the opportunities it provides for young Canadians. The solution, however, is a long-term one. In the case of graduate engineers, a term of four to five years is required to obtain a degree. The development of new or expanded schools will add several years on the front end and the gaining of experience will add several years following the degree. It remains, however, a desirable option particularly in view of the fact that Canada lags behind other industrialized countries in the training of engineering graduates.

Recommendation 44

That Canada's facilities for graduating engineers from universities and engineering technicians from colleges be reviewed with reference to the foreseen requirements for these personnel and steps be taken to increase capacity.

The supply of engineering personnel in the shorter or immediate term can be most readily achieved by immigration. In fact, immigration is the means by which Canada, historically has met its shortfall in technically trained personnel. Those who enter the country to apply their skills remain to enlarge the technical manpower base.

Recommendation 45

It is recommended that:

a) The Minister of Employment and Immigration be urged to adopt the recommendation of the Task Force on Labour Market Development to make adjustments "in policy, procedures and resources related to both domestic and overseas elements of the immigration system to permit prompt and accurate identification of foreign skill requirements and to recruit and process ... immigrants to meet specific labour market needs."

b) The Canadian Consulting Engineering Industry arrange liaison with the Minister of Employment and Immigration to identify the industry's requirements and the sources available.

The review of the employment of engineering personnel in Canada has revealed the fact that many qualified engineers and allied technical personnel are employed in non-engineering occupations. In view of the concern over the adequacy of Canadian manpower resources, the possibility of returning some of these personnel to engineering occupations should be considered.

Recommendation 46

That the Canadian Employment and Immigration Commission (CEIC) consider ways in which Canada might mobilize its latent engineering personnel resources as represented by qualified engineers and allied technical personnel who are employed in non-engineering occupations.

CHAPTER III

INDUSTRY PROFILE

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The Canadian consulting engineering industry is aggressive, dynamic and modern. It is competitive in both the domestic and international markets and is ranked among the most developed in the world. Three of the world's 10 largest international consulting engineering firms are Canadian. By any standard, the skills and reputation of Canadian consulting engineers are held in high regard.

As the industry is well distributed throughout the country, it contributes to the economic well-being of all regions. Industry billings for 1980 are estimated to total $1.66 billion, of which $1.32 billion was earned in the domestic market and $340 million from the export market. While the domestic market provides the major portion of fees overall, it has exhibited no real growth since 1974. The overall real growth of between 2% and 4% for the industry is attributable to growth in the export market which has moved from a 9% share of total fees in 1974 to a 20% share in 1980.

The increasing involvement of Canadian consulting engineering firms in international projects at the conceptual and design stages often creates significant spin-off opportunities for Canadian equipment manufacturing and service firms. Any increased international strength and diversity on the part of Canadian consulting engineering firms will broaden opportunities for additional sales for these suppliers.

As the Canadian economy benefits considerably from the activities of this industry it is important that it receive full support from all levels of government. A strong domestic practice must be developed to support a strong export activity and policies and program initiatives available to the industry must be as beneficial and comprehensive as those available to foreign competitors.

Definition

The Canadian Consulting Engineering Industry is composed of professional engineers in private practice whose main source of revenue is derived from the provision of engineering services, together with the appropriate management, technical, administrative and support staff.

The industry is capable of providing a wide range of services usually associated with the development and implementation of capital projects. These services include:

feasibility studies to determine the economic viability or broader impact of a project;

planning and design development which includes preparation of site development plans, preliminary layout of the facility, process studies, design standards and equipment requirements;

detailed design involving all aspects of preparing final designs and drawings together with specifications for construction;

field services during construction including the verification of construction work for general conformity to drawings and specifications for the work;

project management which involves representing the client and undertaking all or most of the administrative responsibilities of the project; in addition to the above, this can include procurement of equipment and materials, management of construction and overall coordination of the project.

In many cases, consulting engineering firms, either through corporate development, purchase or joint venture, can acquire the full range of Engineer, Procure, Construct (EPC) services. Acting on behalf of owners/sponsors, firms having this EPC capability are able to carry out and oversee the design of the project, procurement of materials, special services, construction, and commissioning of facilities.

In addition to these activities, consulting engineering firms may also provide services related to such areas as urban and regional planning, pollution control, arbitration and litigation, computer science, data processing and transmission, environmental impact studies, financial and market analyses, tender evaluation and commissioning of operations. Table 1 lists the 12 basic consulting engineering sectors, and the fields covered.

TABLE 1

The Twelve Sectors of Consulting Engineering Services*

Municipal	Water supply, sewage disposal, waste disposal roads and streets, traffic engineering, urban and regional planning.
Buildings	Acoustics, communications, electrical, elevators, escalators and moving sidewalks, heating, ventilating and air conditioning, illumination, mechanical, piping systems, refrigeration, structural.
Petroleum and natural gas	Exploration, extraction and separation, pipelines, gas process plants, oil refineries.
Power	Systems planning and operation, hydro power, thermal power, nuclear, transmission and distribution.
Mining and metallurgy	Exploration, mine planning and production, mineral beneficiation, smelting, refining.
Plant process	Aluminum fabricating, aluminum smelting, automotive plants, breweries, cement plants, chemical plants, distilleries, feed and flour mills, fertilizer plants, food processing, foundries, glass and ceramics, industrial environmental control facilities, industrial power houses, metal working, miscellaneous manufacturing plants, petro-chemical plants, steel mills, textile mills, wood working.
Transportation	Bridges, tunnels, highways and expressways, railways, public transit, transportation studies.

* These categories are taken from Statistics Canada, Consulting Engineering Services, 1978

Forestry, etc.	Agricultural engineering, fisheries, forestry, logging, sawmills, veneer and plywood, particleboard and waferboard mills, hard and soft board mills, pulp mills, paper mills.
Dams and irrigation	Dams, irrigation, flood control.
Air and seaports	Airports, harbours, docks and jetties, dredging, river and coastal works, terminals and warehouses, transportation studies, oceanography and hydrography.
Telecommunications	Microwave, broadcasting, wire line transmission, telephone systems, supervisory control and data transmission.
Miscellaneous	Air and noise pollution control, arbitration and litigation, computer science and data processing, environmental impact studies, interior design, naval architecture, remote sensing and photogrammetry, soil mechanics.

Characteristics

1. Size and Structure of the Industry

Projections, in the report by Peter Barnard and Associates (based on Statistics Canada figures and Barnard's survey; not including EPC firms which are integrated with the construction classification) estimate the Canadian consulting engineering industry to consist of approximately 1,700 firms which vary in size from one man proprietorships to corporations with staff of several thousand. The Barnard report further estimates that during 1980 the industry employed 42,000 in the categories and proportions shown in Table 2.

TABLE 2

Industry Employment by Category
1977 and 1980

Category	Percentage of Total 1977	1980
Professional engineers	29	30
Non-engineering professionals	4	6
Technician/drafting	46	43
Administrative/clerical	21	20

The 1977 figures are included to indicate that the proportion has remained fairly consistent over recent years. Because of the high ratio of professional and technically trained people, the industry provides important opportunities for careers for graduates of universities and technical institutions.

The Canadian consulting engineering industry is structured in a manner similar to that found in other industrial sectors in Canada. As can be seen from Table 3, in 1978 relatively small firms with fee incomes of less than $1 million accounted for 88% of the number of firms, but only 21% of the fee income generated. At the other end of the spectrum, the 20 largest firms with fee incomes in excess of $10 million accounted for 1.3% of the number of firms, but received 39% of the fee income generated.

TABLE 3

Distribution of Firms by
Size and Fee Income - 1978

Size by Fee Income	Number of Firms	%	Fee Income	%
Less than 99,999	401	26.3	11.5	1.0
100,000 to 999,999	936	61.5	227.0	20.4
1,000,000 to 9,999,999	166	10.9	440.9	39.5
10,000,000 and over	20	1.3	435.6	39.1
	1,523	100.0	1,115.0	100.0

Consulting engineering firms can be classified by either size or type of service offered as follows:

Large firms: Some 10-15 firms, with from 500-5,000 employees and accounting for half of the industry's total billings and employment. These provide a full range of

services primarily for major projects in the natural resources and communications fields.

Medium-size firms: Also some 10-15 firms, but with employment ranging from 200-800 per firm. The services of these firms are generally concentrated in municipal engineering and highways, roads and bridges. Although their traditional work may be concentrated in one region, these firms may operate in more than one market and several have substantial overseas operations.

Small size firms: Includes the majority of firms, which may be local or regional, in the sector and accounts for approximately one-third of all billings and employment. Market area is more concentrated than for medium and large firms with employment ranging up to 200 but averaging between 10 and 20.

Other: Primarily speciality firms which tend to offer more specific services, such as computer science and data processing, environmental impact studies, remote sensing and photogrammetry, marine facilities and soil mechanics. These firms normally operate across the entire domestic market as well as in foreign countries. It is estimated that about 10% of the consulting engineering work carried out is performed by this group of firms.

2. Ownership

The industry is predominantly Canadian owned with only 2% to 3% of the firms owned to varying degrees by foreign interests. Not unexpectedly, two-thirds of these foreign-owned firms are linked to United States interests. The total fee income of these foreign firms in 1978 was $98.9 million of which $82.9 million is represented by the proportion of foreign ownership.

Approximately 70% of the firms that are wholly Canadian owned are "employee owned" corporations and the remaining 30% are held as individual proprietorships or as partnerships.

3. Regional Distribution

The distribution of firms, together with their employment and economic impact across Canada in 1978 as shown in Table 4, reflects fairly closely the country's natural resource, industrial, and population patterns. As a result, a major consulting engineering base has developed in the Ontario-Quebec industrial heartland with firms in

TABLE 4

Billings, Fee Income and Expenses
Canada and Provinces - 1978

	Number of Firms	Total Billings $000	Fee Income $000	Total Expense $000	Number of Working Proprietors	Paid Employees	
						Number	Payroll $000
CANADA	1,523	1,283,422	1,115,051	1,025,335	363	34,072	690,187
Newfoundland	27	13,494	12,199	11,196	-	409	7,053
Prince Edward Island	3	x	x	x	-	18	x
Nova Scotia	47	17,382	15,687	14,064	5	567	8,842
New Brunswick	26	9,620	9,008	7,397	1	282	4,844
Quebec	213	338,046	301,951	281,062	215	9,616	195,299
Ontario	552	533,306	447,194	408,552	57	13,498	278,788
Manitoba	27	20,262	19,198	18,127	24	613	12,349
Saskatchewan	34	11,776	11,442	10,683	1	355	6,801
Alberta	346	169,193	151,541	139,405	33	4,477	87,248
British Columbia	247	269,611	146,156	134,274	27	4,231	88,633
Yukon	-	-	-	-	-	-	-
Northwest Territories	1	x	x	x	-	6	x

this area accounting for two-thirds of the fee income of the Canadian industry for 1978. In Quebec, more so than in any other province, the industry's development can be traced to the strong contracting-out bias of the government agencies, such as Hydro Quebec. A number of Quebec consulting firms have benefited from this policy and have developed a strong internationally recognized capability in hydro-power generation and transmission.

Recently, the increased development of natural resources in the west, and the related expansion in the industrial base has brought a considerable build-up in engineering capability within that region. A similar pattern is likely to occur in the Atlantic/Maritime region as that area's resource base is developed.

One factor now influencing the location of engineering firms is the increasing adoption by some provincial and municipal governments of policies and practices favouring local firms. This has led a number of firms, particularly the larger ones, to establish branch offices in various provinces across Canada.

4. Labour Supply

Historically, the manpower requirements of the Consulting Engineering Industry have exceeded the available supply of domestically trained engineers and technicians. At the same time, it has been relatively easy for firms in Canada to import the professional and technical expertise required to pursue opportunities particularly in the case of major capital projects in the natural resource fields, or in specialties which were not available in Canada. Today, faced with a forecasted substantial shortfall in trained personnel, the strengthening of the application of Canada's immigration regulations, and the desire to provide enhanced opportunities for young Canadians, greater emphasis must be placed on the development of Canadian training capabilities for engineering skills.

5. Wage and Salary Levels

The assets of consulting engineering firms are, essentially, its people. Professional employees in the industry are highly mobile and as a result wage and salary levels within the industry are competitive both domestically and with those of other industrialized countries. Some less developed countries, such as India and Korea, however, are benefiting increasingly from lower wage rates.

The Market

1. Domestic

The fees earned by the consulting industry in Canada, broken down by type of client, are shown in Table 5. In 1978, 53% of the fee income in Canada came from the private sector and 47% from governments. Comparison with the 1974 figures indicates that within the public sector a relative shift has occurred between the share of fees earned from municipal and regional governments and the federal government.

TABLE 5

Breakdown of Fee Income
Earned in Canada (1974 and 1978)

Sector	% of Total 1974	1978
Private	55.2	53.4
Public - Municipal	19.8	12.2
- Provincial	18.9	18.9
- Federal	6.1	15.5
Total Public	44.8	46.6
TOTAL FEE INCOME	100.0	100.0

This shift is believed to reflect some reallocation of spending rather than an actual change in the level of government served. At the same time, the share of fees earned from provincial governments remained fairly constant and of major importance.

While there are exceptions, estimates indicate that the small and large consulting engineering firms provide most of their services to the private sector. The intermediate size firm characteristically offers a wide range of services, and gains a larger share of its revenue from government contracts.

Geographically, the industry shows strength in those disciplines or sectors that predominate in particular areas. Building and municipal projects, which combine the requirements of residential, commercial, and industrial building with infrastructure are highly important in every

region. Single sectors showing strength in particular parts of the country include forestry in British Columbia, hydro-electric development in Quebec, and petroleum and natural gas in Alberta. The relative importance, on a Canada-wide basis, of the types of projects that make up the Canadian consulting engineering market for both domestic and foreign work is illustrated in Table 6.

TABLE 6

Market for Consulting Engineers by Type of Project

	1978 Fee Incomes ($ Millions)		
	Domestic	Foreign	Total
Municipal	174	7	181
Buildings	185	6	191
Petroleum and natural gas	71	7	78
Power	115	62	177
Mining and metallurgy	43	11	54
Plant process	111	37	148
Transportation	60	2	62
Forestry, etc.	55	16	71
Dams and irrigation	17	11	28
Airports and seaports	21	6	27
Telecommunications	9	5	14
Miscellaneous	77	7	84
Total	$938	$177	$1,115

2. International

Over the last two decades, the export of consulting services has grown from less than 5% of total billings to become an important part of the industry's work. Export billings for 1980 were estimated to be nearly 20% of total fee income for the industry. The average annual rate of growth for export work has in fact, been responsible for the overall growth of the industry.

Firms that have been able to develop sufficient expertise and economic strength on the domestic scene or that have matured and expanded to the limits of the domestic market, traditionally look for opportunities and challenges in other countries. The consequent expansion of markets provides opportunity for the continued development of personnel, and as a hedge against economic slowdown or encroachment of in-house forces on traditional areas of

activities. Services exported are primarily those in which Canada is a technological leader and are based on strong domestic capabilities in energy and natural resources, buildings, roads and infrastructure. Having developed this expertise on the domestic front, and thus a proven track record, Canadian consulting firms have shown flexibility in applying it to the requirements of the export market.

The regional distribution and the principal specialties involved in export work, as deduced from the 1978 Statistics Canada survey, are shown in Table 7.

TABLE 7

Field of Endeavour for Consulting Engineers (1978)

Geographic Area	Percentage of Total Billings	Major Sector of Work
United States	14%	Mining and metallurgy, petroleum and natural gas; buildings; plant process design
Europe	9%	Petroleum and natural gas; mining and metallurgy; power generation, transmission and distribution
Latin America	16%	Power generation transmission and distribution; forestry, plant process design
Caribbean	7%	Transportation; power generation, transmission and distribution; municipal services
Africa	23%	Power generation, transmission and distribution; municipal services, plant process design
Far East	19%	Power generation, transmission and distribution; water

TABLE 7 (cont'd)

Field of Endeavour for Consulting Engineers (1978)

Geographic Area	Percentage of Total Billings	Major Sector of Work
		resources; plant process design
Middle East	10%	Power generation, transmission and distribution; transportation; municipal services
Australasia	2%	Mining and metallurgy

By far the largest single-country market for Canadian consulting firms is the United States, which accounted for about 14% of all international billings in 1978. In contrast to other major export regions, a major share (about 60%) of the work carried out in the U.S. is in the private sector. It is expected that the U.S. will continue to be Canada's largest single-country export market.

Apart from the U.S., there are four broad regions that use Canadian professional services: Latin America/Caribbean, Africa, the Far East and the Middle East. The emergence of the Middle East as a major export market has occurred only in the last three to five years. There now appears to be a trend towards a more evenly spread market share amongst these four regions. The dominant region in export billings might, of course, vary from year to year due to the particular significance and timing of one or two major projects.

Economic Spinoffs

Recently, considerable attention has been focussed on the economic impact of follow-on sales related to consulting contracts abroad. While discussions to date have demonstrated the complexity of this issue, there is wide agreement that securing of an overseas contract by Canadian consulting engineers can lead to substantial opportunities for follow-on sales of machinery, equipment and other services. However, tracing the exact ratio of follow-on sales to the original consulting contract is

difficult, largely due to timing and type of effect. Since the export sales are seldom realized in the year that the consulting activity actually takes place, it is difficult to relate sales in one year to the consulting fees of another. Also, especially with a lapse of time, it sometimes becomes difficult to determine whether a particular export sale can be directly or indirectly attributed to a particular consulting project.

It is estimated that the ratio of follow-on sales to the original contract will generally range in the order of 2:1 to 10:1. Principal factors affecting this relationship include:

Source of funding: For international work, the source of project financing is often a main factor in the selection of the consulting firm. Very often the availability of tied aid, or subsidized or commercial financing from the country of the firm can be the overriding factor in the selection process. Similarly, the source of financing can influence the opportunity for follow-on sales of equipment and material.

Project location: The level of economic development in the particular location will influence the degree of competition in the supply of both manufactured goods and services provided by local firms. Also, local content requirements can severely limit the export of Canadian goods as will the relative distance of the project from Canada, historic trading patterns and political relationships.

Canadian capability: To manufacture and supply competitively the equipment and materials required or to provide necessary installation and maintenance will also be a strong influence in any client decision to select Canadian manufacturing firms for their requirements.

CHAPTER IV

THE DOMESTIC OPPORTUNITY

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There is an excellent opportunity in Canada for the development of a much stronger and more competitive consulting engineering industry than presently exists. The program for resource and energy development currently underway and projected for the year 2000 will impose a heavy surcharge of capital expenditure in the construction and development industries and will provide a greater opportunity for the involvement of Canadian consultants in large projects. The potential for growth and economic strength of the industry will be constrained only by the size of the market available to it and its ability to service that market competitively.

The size of the market available is the total value of engineering done in Canada, less that carried out in-house by government and industry or imported. Therefore, the potential for the private sector consulting industry is greatly affected by government and corporate policy on "contracting-out". In fact, the consulting engineering industry is unique in that the principal competitors faced by its members are its hoped-for clients and those clients control the programs and the budgets. The case for "contracting-out" by the federal government has been made over the years by the Glasgow Commission, the Senate Special Committee on Science Policy and others, in addition to the Association of Consulting Engineers of Canada through its joint committees with government departments and its submissions to cabinet. The government has responded favourably with a policy of "buy" rather than "make" but full implementation through departments has been slow and little or no effect has been discernible with crown corporations or utilities.

While the federal government has responded favourably, neither the provincial nor the major municipal governments have adopted similar policies. The provincial governments between them have annual expenditures equal to those of the federal government and in addition control very large crown corporations and utilities which in turn control some of the major resource related capital expenditures in Canada. Collectively the municipal governments also control large capital expenditures for municipal and public works construction and while they are already substantial clients of consulting engineers there is an

increasing amount of in-house work being done particularly by the larger municipalities.

The amount of in-house work being done by private industry corporations which could be done by consultants is more difficult to identify. Many resource related and other industrial corporations maintain substantial engineering staffs for on-going works programs because of perceived procedural and economic advantages. In these cases the opportunity for consultants would seem to lie in developing an understanding of the market and an ability to demonstrate special expertise and economy of delivery. In addition to expansion and development aspects, there are markets in private industry for process engineering and manufacturing, equipment, and machinery design which have not been seriously developed by consulting engineers. The potential of these markets will take time to assess but such an assessment should be undertaken. The development of such markets will undoubtedly be related to the success of programs initiated to develop the research and development capability of Canadian consulting engineers.

There are no comprehensive statistics on the total value of all engineering carried out in Canada, either in-house, by private consulting engineers, or by foreign firms. However, statistics are available for the construction industry and indicate that the total value of capital expenditures for construction work in Canada with an engineering involvement, was $35 billion in 1980 dollars. This figure includes approximately $22 billion in engineering or heavy construction and approximately $13 billion in building construction. An additional $13 billion spent on housing is not included in these figures. Assuming engineering fees of 12.75% for engineering construction and 3% for building construction, the theoretical total fee value for 1980 may be calculated as follows:

engineering construction	- $22 B @ 12.75%	= $2.81 B
building construction	- $13 B @ 3%	= $ .39 B
- Total		$3.2 B

During the same year, Canadian consulting engineering firms in private practice, engaged on Canadian projects, earned approximately $1.3 billion in fees or 40% of the theoretical total. "Other organizations" carrying out work similar to that done by consulting engineering firms,

are responsible for the other 60% or $1.9 billion worth of engineering work. The "other organizations" are the three levels of government related to public works, municipal works, the environment and transportation, crown corporations, public and privately owned utilities, and the construction, manufacturing, mining, agricultural, forest, shipbuilding, and other industries, or foreign consultants working in Canada. The following explanatory notes will clarify the foregoing assumptions.

Explanatory Notes for Comparison Calculation

1. The ratio of the work volume (measured as fees) of consulting engineers in private practice to the theoretical work potential is, for the purpose of this calculation, assumed to be equal to the ratio of the construction cost of work that is the responsibility of consulting engineers in private practice to the cost of construction in Canada.

2. Lead time of engineering to construction and the consequent cost distortion of inflation is ignored.

3. No construction value has been included for the value of machinery, ships, aircraft, etc., that may have resulted from consulting engineering beyond the amount included in the Canadian Construction Association figures. Special services, long range studies, abandoned projects and R&D have also been ignored. The effect of these would tend to reduce the proportion of the theoretical total work carried out by consulting engineers in private practice.

4. The engineering fee percentage of engineering construction value was derived as a weighted average using the relative construction values of the various sectors and the "cost of services as a percentage of total capital cost" material derived by the sub-committee on Major Project Capability as contained in Appendix I of that sub-committee's report, and other experience history as appropriate. This resulted in a fee of 12.75% of cost.

5. The engineering fee percentage for the building construction sector was estimated at 3% and was applied to the building construction sector value after the residential component of that sector had been reduced by 90% to eliminate single and smaller multiple dwellings. (cf - CCA "The Construction Outlook for Summer 1981", page 14, Appendix 1-2.)

Approximately 12,600 professional engineers are employed in private practice. Based on the foregoing calculation that these engineers accounted for 40% of the total value of engineering carried out, it can be assumed that an additional 18,000 were employed in the $1.9 billion worth of engineering carried out by "other organizations". As the total number of professional engineers in Canada is estimated at between 75,000 and 100,000, it is estimated that 45,000 to 70,000 engineers are in non-construction oriented work. Many of these are engaged in engineering related activities in management, operations and maintenance, sales, national defence, research and development, teaching and government, and some are engaged in totally non-engineering occupations. From this analysis it is clear that if a large portion, or indeed all, of the in-house and foreign assigned engineering work carried out in Canada were to be shifted to Canadian firms in private practice, the industry would employ only about 30% of all the professional engineers in Canada.

Engineer/Procure/Construct (EPC) Capability

In view of the nature of the development foreseen in Canada, a fortuitous opportunity exists for developing the Canadian capability in EPC contracting. EPC contractors operate in a highly competitive environment throughout the world providing design and management services, materials, equipment, labour and supervision for major projects. The values of projects that can be handled in this manner vary over a wide range and as EPC firms mature, gain experience and add technology and services they will develop the capability to handle the major or mega projects. They are often required to guarantee workmanship, plant operating conditions, equipment performance, utility demand and product quality, and must be able to demonstrate to clients that they have the resources to meet these responsibilities.

While not all consulting firms will choose to develop in this manner, those that do will substantially enhance Canada's resource development and export capacities. Several chapters in this report refer to subjects which, if reviewed in this context, illustrate the means by which the public and private sectors of Canada's economy can assist the Canadian Consulting Engineering Industry to measurably enlarge its EPC capability.

a) Chapter IV - The Domestic Opportunity - refers to the large volume of in-house engineering done by federal, provincial and municipal governments,

including their various agencies, utilities, and crown corporations and by the private sector.

b) Chapter V - Procurement Policies and Practices - refers to the case for contracting-out, by both the public and private sectors of Canada's economy.

c) Chapter VI - The Export Opportunity - refers to the need to enlarge the EPC capacity of Canadian firms or consortia in foreign competition.

d) Chapter VII - Major Project Capability - refers to the need to develop Canadian Engineer/Procure/Construct capability for involvement in major projects.

There are, however, a number of policy preferences that will have to be resolved if compatibility between the various authorities and agencies is to be achieved. The EPC contractor prefers to retain full responsibility for his work to ensure control of quality, costs, and overall project performance. This enables him to discharge his obligations to the owner and therefore protect his reputation.

At the risk of increasing costs because of a greater number of management interfaces, certain agencies and industries have encouraged EPC contractors to "contract-out" thereby utilizing a broader spectrum of local, regional and national capability and resources. Indeed, in recent times, this has been the thrust of the activities of the Office for Industrial and Regional Benefits.

At the same time, certain government agencies, utilities and crown corporations, for reasons similar to those put forward by EPC contractors, prefer to retain responsiblity for their major projects. The federal, provincial and municipal governments have a public trust that they must carefully guard when contracting public works. This responsibility has resulted in the retention of large professional staffs to supervise the provision of services, administer procurement policies and in many instances, to perform the actual design procurement and construction work.

The Canadian Consulting Engineering Industry has the capacity and ability to provide these organizations with the full range of service, and because of the breadth of

its markets, can absorb the peak demands placed on the government agencies, utilities and crown corporations. Contracting-out from these organizations, therefore, would measurably improve the overall productivity of the manpower resource in Canada's consulting engineering community.

The consulting engineering industry recognizes that by enlarging its EPC capability it can improve its ability to expand Canada's exports. The dilemma confronting the industry is its lack of sufficient opportunity to develop a domestic base of viable EPC capability that can gain sufficient international recognition.

Canada's public sector more than any other element in Canada's economy, provides a market where the consulting engineering industry, and indeed the construction industry, can develop a strong domestic EPC base. The precepts of the Office for Industrial and Regional Benefits applied in the public sector would assist in the evolution of a strong Canadian EPC capacity and continue to protect the public trust that government, utility, and crown agencies must guard in our overall interest.

The ability of consulting engineers to develop both new and existing markets will be enhanced if more is known about the magnitude and nature of these markets. The recent report of the Major Projects Task Force and publication by the federal government of an inventory and detail on all major projects expected to be undertaken in Canada over the next decade have significantly improved this knowledge base. However, more is required with respect to information on other capital expenditures particularly in-house activity. Ideally, once the total value of engineering performed in Canada can be assessed, and an estimate made of that portion of the total that can be performed by consultants, a relationship might be established between domestic strength of the industry and its export capability.

RECOMMENDATIONS

Recommendation 1

That a task force be set up under the direction of the joint Association of Consulting Engineers of Canada (ACEC)/Department of Regional and Industrial Expansion (DRIE) Committee with a sufficiently comprehensive membership to determine:

a) The total amount of engineering done in Canada in-house by federal, provincial and municipal governments including their various agencies, universities, utilities and crown corporations.

b) The total amount of engineering done in-house in Canada by construction, industrial and manufacturing corporations.

c) The proportion of the engineering identified in (a) and (b) that could conceivably be done by the consulting engineering industry.

Recommendation 2

That a task force be set up by the joint ACEC/DRIE Committee to evaluate the amount of consulting engineering services that are imported to Canada, the nature of the services imported, and the countries from which they come.

Recommendation 3

That a task force be set up by the joint ACEC/DRIE Committee to study the relationship of domestic strength to export capability.

Recommendation 4

That a task force be set up by the Canadian Consulting Engineering Industry and the federal government to make recommendations to the Minister for the development and expansion of the industry's EPC role in the public sector market.

Constraints to Growth

If this potential is to be achieved, particularly in light of current world wide economic circumstances, a financially healthy industry is essential. The change in tax treatment of work in process proposed in the MacEachen budget will severely impede the cash flows of the industry and seriously curtail its ability to finance continued growth.

Recommendation 5

That all levels of government and industry recognize that fee schedules and price bases must allow cash

flows and levels of profitability which will maintain a healthy industry.

Recommendation 6

That the proposed legislation relating to work in process be eliminated.

CHAPTER V

PROCUREMENT POLICIES AND PRACTICES

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PROCUREMENT POLICIES AND PRACTICES

A strong and urgent case exists for the establishment and implementation of aggressive contracting-out policies and practices by government and client industries with respect to in-house engineering. Such policies and practices will contribute to the future rapid growth and development of engineering expertise in the private sector, increase R&D expenditures, and enhance export capability, thereby improving the prospect for increased follow-on sales of manufactured goods and other services.

Support for such policies and practices depends upon the acceptance, in whole or in part, of three basic assumptions. First, an organization requiring engineering services but whose principal business is other than engineering can be served best by a healthy and expanding private sector consulting engineering industry. Second, governments can contribute to their stated objective of a strengthened economy by avoiding competing in or duplicating the provision of service best provided by the private sector. Third, the amount of work available to the consulting engineering industry has a direct impact on its efficiency and therefore on the overall performance of the economy.

The Case for Contracting-Out

The ability of the Canadian consulting engineering industry to compete in the foreseen expanding domestic and export market will depend on its ability to continually keep pace with advancing technologies, develop managerial skills required for major projects, and attract required professional and technical manpower.

Expansion of any enterprise, particularly into new fields of endeavour, requires investment. Consulting engineering is no exception. New technologies and processes must be acquired by R&D expenditures or be purchased, the proper calibre of manpower must be acquired and/or trained, and the cost of new and larger ventures must be carried for months, even years, before returns are forthcoming. Because the funding for these undertakings must come from the earnings of individual consulting engineering firms, it must be recognized that their willingness to commit the required funds for growth and development will be much greater if visible contracting-out policies are being

applied to ensure the availability of a continued market for competitive firms.

Canada's ability to compete internationally for consulting engineering contracts is tied to the competitive strength and expertise of its private sector consulting engineering firms. A close linkage exists between the contracting-out of engineering assignments to private sector consulting firms and their export capability. In certain instances, the contracting-out practices by governments, public utilities and resource development and manufacturing firms have enabled Canada's consulting engineers to achieve international recognition in sectors such as hydro power generation, power transmission, mine development, forestry and communications.

Perhaps the most noteworthy example involves the development and growth of several of the world's major consulting engineering firms in the Montreal area. This development can be traced directly to the contracting-out policies of Quebec Hydro. In other instances and areas where contracting-out practices have not been pursued, development of the consulting engineering industry has not proceeded as rapidly or as effectively as might have been the case as the expertise developed in-house has been "locked-in" and hence unavailable to the industry. Historically, federal and provincial departments and agencies which have developed in-house expertise do not compete for export work.

Achieving Optimum Development

It is the view of the Committee that if the Canadian consulting engineering industry is to attain its full potential, the following actions must be taken.

a) Strengthen government's and crown corporation's practices for contracting-out engineering services to private consulting engineering firms.

b) Encourage private corporations to establish policies and practices for the contracting-out of engineering services to private consulting engineering firms.

c) Accept (1) a selection procedure that permits freedom of access, is visible and understandable and that recognizes ability, experience and

regional familiarity and, (2) the fallacy of tendering for professional services by price.

d) Adopt equitable contractual agreements that define the responsibilities of all parties, provide for participation of the engineer in planning the scope of his work and ensure fair remuneration for services rendered.

Each of these is discussed below.

a) Increased Government Contracting-Out

Contracting-out has been the subject of extensive debate and has been strongly supported by a number of enquiries. In 1962, the Glassco Royal Commission on Government Organization found that the true costs of providing goods and services in-house by government were understated by 50% or more. More recently, the Senate Finance Committee recommended that the Department of Public Works reduce further the share of construction design work carried out in-house.

Policies for the selection of and contracting with consulting engineers have been the subject of cooperative effort between members of the industry and the federal government over the last decade. The views of consulting engineers have been adequately documented in numerous committee meetings as well as in the following publications:

1. Procurement of Consulting Engineering Services -- Submission to Treasury Board on Procurement of Consulting Engineering Services, ACEC, 1974

2. Contracting Policy for Consulting Engineering Services -- Submission to the Treasury Board on Contracting Policy for Consulting Engineering Services, ACEC, 1977

3. Guide to the Use of Independent Consultants for Engineering Services, Federation Internationale des Ingenieurs Conseils (FIDIC), 1967

4. A White Paper on the Implications of Competitive Bidding for Professional Engineering Services, Task Force on Competitive Bidding Implications National Society of Professional Engineers, U.S.A., 1973

In 1977, the federal government accepted the principle of contracting-out as beneficial to the entire country and published its "Policy and Guidelines on Contracting-Out: The Government's Requirements in Science and Technology". While this initiative represented a major step forward, it is the industry's experience that the actual implementation of this policy has been less than satisfactory and well below the industry's expectations.

To a certain extent, some cooperation and understanding has developed between the private consulting engineering industry and provincial and municipal governments. In general, however, unanimity respecting contracting-out has not been achieved.

It is recognized by the industry that regional and local circumstances will affect procurement in some instances and on-going relationships and sole sourcing will apply to many minor projects and to some specific types of services. In many instances, selection procedures have represented an unnecessarily high cost to the industry where agencies require elaborate proposals from a large number of firms, or on small projects where the cost of the proposals outweighs the fees. As a general rule, however, the most efficient production of engineering services will result from the acceptance of the principle of contracting-out, free access to major projects for Canadian firms, fair procurement procedures, and equitable fee and contract agreements.

b) Corporate Contracting-Out Policies

The private sector clients, as a group, present a much different perspective to the consulting engineer than does government. Comprised as it is of a large number of diverse entities, the private sector lacks the central authority that government possesses for discussion and negotiation. Also its components respond to different stimuli and each will have some specific responsibilities. Where government responds to the tax-paying public in all its forms, the private sector entity must have special concerns for its shareholders, its market or customers, and in some cases union agreements. It is recognized that these special concerns may have an influence on procurement practices, but the ultimate development of the consulting engineering industry will require a policy

decision by private owners to contract out for engineering services wherever possible.

As has been the case with the provincial and municipal governments, the consulting engineering industry has not established a substantial liaison with the private sector enterprises to demonstrate the advantages to the economy and to the individual entities of strengthened and diversified domestic industry with an expanding export capability. While the private sector does not exhibit the centrality of government it does organize in trade and industry associations where policy proposals can be presented and debated. Individual firms will have to be convinced of the economic and practical feasibility of selecting engineering services from the broad range available. While government can support this policy by example and by expressing the importance of a strong domestic industry, consulting engineers themselves must identify and secure the specific market available.

The mega or major projects are a special case because of the size of individual undertakings, the inclusion of management, design, procurement, and construction in one contract, and the combination of foreign financing and technology required. Governments have recognized the importance of these projects as opportunities for the development of Canadian know-how and the Office of Industrial and Regional Benefits is playing an important part in ensuring Canadian consulting engineering participation. Procurement of engineering services for major projects will typically involve the selection of a project manager or prime contractor by the owner, followed by the selection of design firms for portions of the project as required. The owner, through the contract manager, will ensure that Canadian content is acquired and, as with other projects, the procurement practices followed should provide opportunity for all members of the industry. Again, it is recognized that the fee and contractual arrangements may vary to suit the particular associations entered into, but the same general principles apply as with other projects.

c) ACEC Recommended Selection Procedure

Where sole sourcing does not apply, the procedure recommended by ACEC for the normal selection of consultants for engineering services encompasses the following steps:

- Client agency advertises the requirement with a request for "expressions of interest" (not an elaborate proposal).

or

- Client agency prepares a long list from its own sourcing files and requests "expressions of interest" (not an elaborate proposal).

- Client agency selects short list and requests proposals to include:

  ° details of organization and qualification of staff
  ° approach and methodology proposed
  ° staff to be assigned and experience record
  ° project experience
  ° statement of ability to complete as required

- Client agency ranks, interviews and selects.

- Client agency and consultant meet to reach agreement on final terms of reference, procedures and remuneration.

- If no agreement client agency proceeds to second ranking consultant.

This procedure recognizes that the consulting engineer, as a technical expert and practitioner on the project, should be included in the detailing of technical requirements, procedures, and terms of reference all of which affect the cost of engineering which also must be agreed for project budgeting. It should be recognized that the "cost" of engineering services can be quite different from the "value" which depends on knowledge, experience, ingenuity and competence. If engineering services represent approximately 12% of project costs, variations in cost of delivery of those services have a much smaller impact on the cost of the project than do variations in value. Yet the "cost of delivery" must be met before the "full value" can be realized.

Provincial fee guidelines are recommended for normal design projects in recognition of provincial jurisdictions and conditions. Where there is a need for more flexibility, ACEC has recommended the "time-plus-percentage" or "time-plus-lump sum" bases which provide the following advantages:

- encourage innovation and total preliminary planning and effect economies related to construction costs without regard to fee.

- create an atmosphere for client participation, use of specialists, changes in scope without complicating accounting procedures.

- eliminate the problems associated with pre-establishment of the scope and complexity of the work and seasonal and regional construction cost variations.

- generate a productivity incentive.

d) Equitable Contractual Agreements

Despite the federal government's agreement on the contracting-out policy and the preparation of the Treasury Board guidelines, many anomalies are still present in existing contract agreements. Individual departments and agencies often use different contract agreements some of which contain clauses that are unfair, expose the consultant to risks for which he should not be held liable, or impinge on other operations of his practice. Examples of the foregoing inclusions are:

- "Master-servant" relationship which does not recognize the responsibilities of both parties.

- Requirements for guarantees beyond the consultant's responsibilities.

  ° adequacy of government's preconceived estimates before designs and checking have been carried out

  ° certification of quality of construction work in a manner that renders the engineer liable for performance of the construction contractor's work.

- Ownership of design, plans, and drawings for reuse.

- Arbitrary fee schedules, disclosure clauses, and salary limitations.

- Holdbacks on consulting engineering fees.

In summary, the realization of the full potential of the consulting engineering industry will require a greater access by the industry to the engineering work being done in-house by government and its agencies and by industrial

and manufacturing corporations. It will require also a correction of the decreasing profitability being experienced by the industry and which is due, at least in part, to the procurement practices and contractual arrangements that prevail.

RECOMMENDATIONS

Recommendation 7

That the Canadian Consulting Engineering Industry:

a) Continue its dialogue with the federal government through the Association of Consulting Engineers of Canada on the subjects of contracting-out, procurement practices, and contractual agreements.

b) Establish dialogue with the provincial and municipal governments through the member organizations of the Association of Consulting Engineers of Canada to develop policies for contracting-out, procurement practices, and equitable contractual agreements.

c) Establish dialogue with the private sector through the Association of Consulting Engineers of Canada and its member organizations jointly with the industry and trade associations such as the Canadian Construction Association (CCA) and the Canadian Manufacturers' Association (CMA) to develop mutually acceptable policies for contracting-out, procurement practices, contractual agreements and other mutual concerns.

Recommendation 8

That the government of Canada increase the potential of the engineering industry by taking action to:

a) Extend its contracting-out policy to all federal government crown corporations and agencies.

b) Continue to monitor its contracting-out policy to ensure that practice does conform to the policy.

c) Continue to cooperate with the consulting engineering industry for the improvement of procurement practices and contract agreements.

d) Support a policy of contracting-out by provincial and municipal governments and by the private sector.

Recommendation 9

That the provincial and municipal governments play a key part in the strengthening of the Canadian Consulting Engineering Industry by taking action to:

a) Develop policies of contracting-out for consulting engineering services.

b) Cooperate with the Canadian Consulting Engineering Industry in the development of procurement practices and contractual agreements.

c) Support a policy of contracting-out for engineering services by private sector corporations.

Recommendation 10

That private sector owners:

a) Enter into discussions with the Canadian Consulting Engineering Industry through industrial and trade associations on the efficacy of contracting-out policies and the requirements of mutually acceptable procurement practices and contractual agreements.

b) Review the advantages of contracting-out to the Canadian Consulting Engineering Industry.

c) Develop policies for contracting-out for the guidance of senior management.

CHAPTER VI

THE EXPORT OPPORTUNITY

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THE EXPORT OPPORTUNITY

During the period from the early fifties to the early seventies, economic expansion in Canada continued at signficantly higher than historical rates. Such high rates of almost uninterrupted growth have not since been matched. Furthermore, current indicators strongly suggest that economic development in the medium term, even when allowance is made for the positive impact of the large number of planned major projects, will not approach in buoyancy the fifties to early seventies period. Because of this prevailing economic condition, the Committee believes that Canada must continue to place the highest practical priority on the export of capital goods and services as a means toward sustaining the domestic economy.

In Canada's overall export effort, the exports of engineering services may in many respects be considered unique because such exports can contribute to a realization of government objectives in several ways. For example, exports of engineering services, while having a positive effect on Canada's balance of payments account, can also be effective in opening markets for Canadian goods and follow-on services. Moreover, through the transfer of knowledge to the export marketplace in the conduct of engineering assignments, the image of Canada as a modern industrial state is enhanced. This enhancement is complemented by the fact that exports of engineering services serve to increase the number of satisfying jobs for Canadians domestically, especially in the highly trained and professional categories.

Although engineering firms engaged in assignments abroad tend to be concentrated in Ontario, Quebec, British Columbia and Alberta, exports of engineering services originate across Canada and hence are important from a regional development point of view. This means that, through successful export business, individual engineering firms are enabled to expand beyond the confines of their local markets, permitting, in turn, the development of new skills at the level of the firm. It means also an escape route from disruptions arising from instability in local demand, thereby creating the opportunity to enhance the reputation of the firm and providing greater challenges for professional staff.

Canadian Trade in Engineering Services

Exports have become an important activity for consulting engineers. From a small base in the 1960s, work in export markets has increased by nearly 20% annually and now accounts for about 20% of the industry's billings. In 1980 exports accounted for about $340 million, compared to $290 million in 1979, $220 million in 1978 and $200 million in 1977. It is estimated that exports will continue to grow at about 10% to 15% over the next five years to reach a figure of over $500 million by 1985, and should level off at a range of 25% of total billings for the industry.

Traditionally, the most important export market for Canadian engineering services has been the United States. While this market continues to account for about 15% of the total, export opportunities in other regions of the world are indicative of a more evenly spread market with the Middle and Far East increasing significantly in importance.

Statistics relating to imports in the past two to three years are not available. It is estimated, however, that approximately 10% of the domestic market is supplied by foreign consultants. Imports of consulting engineering services are mainly in the industrial sub-sectors and occur principally in major oil and gas projects. Such imports originate almost totally from U.S. sources. Balance of trade figures for the industry are available only to 1977. Nevertheless, comparison of the years 1973 and 1977 shows an interesting trend. In 1977, imports accounted for $130 million compared to $89 million in 1973. Exports in 1977 accounted for $186 million compared to $41 million in 1973. Thus, in a period of five years a deficit was turned into a surplus. Trade in engineering services with the United States during this period shows that the gap with that country also is closing from a ratio of imports/exports of about 3:1 to one of about 2:1. Imports from the U.S. in 1977 were $105 million compared to $81 million in 1973. Exports to the U.S. in 1977 were $48 million, a rise from $24.5 million in 1973.

Industry Export Potential

The potential exists for a great deal of growth in the export sale of Canadian consulting engineering services. No formal assessment of the export market has been attempted but there is evidence to suggest that the propensity to export is enhanced where the industry has

achieved strength and diversification in the domestic market. Diversification of exports will allow more firms to take part in exporting services, open up new markets and allow the number of Canadian firms engaged in exporting to grow. As Canadian consulting engineering firms become more knowledgeable in exporting, imports may be further reduced.

Increases in the capacity of the industry to participate and lead in EPC projects abroad should be encouraged. As this develops, it may be possible to improve even further the spin-off sales of Canadian goods and services in projects abroad where Canadian consultants are involved.

Changes taking place in international markets will affect the Canadian consulting engineering industry's efforts to expand exports. Shifts in market concentration are frequent as political and economic conditions change. Canadian firms must be flexible to adjust to these changes and have the resources that will allow them to look for new markets. There are risks to selling and carrying out projects abroad, particularly in the developing parts of the world, but unless the industry is prepared to face up to these risks, opportunities will be missed. Because of local legislation and policies in foreign markets, and the natural development of their own economies, engineering firms abroad are increasing in number and skill. This has many ramifications for competition and the types of services for which there will be sales opportunities for Canadian firms.

One noticeable trend is that larger Canadian-owned consulting engineering firms are establishing subsidiary operations abroad. The reason for this includes increased competition in the foreign marketplace, government policies directing purchases of engineering services to local firms and the desire, particularly of developing countries, to gain access to new technologies. For the Canadian export market, there are both advantages and disadvantages to such developments. It can be expected that portions of contracts may be transferred to the overseas subsidiary. On the other hand, there are many examples where such subsidiaries, through their knowledge of local conditions, their range of contacts, and access to other sources of financing, have brought projects or portions of projects to the parent organization and locale. There also appears to be a trend in the industry in Canada, as far as exporting is concerned, towards two basic types of firms: the large, almost multinational organization and the very specialized firm. There is a

discernible shift in demand abroad from infrastructure to industrial sector projects.

Current Industry Initiatives

Canadian consultants are increasing their already substantial expertise in working abroad by undertaking projects in new markets and by the sale of new types of services (for example, acting as the client's representatives in EPC projects, procurement services, etc.).

The industry has achieved pre-eminence, on a world scale, in engineering in specific sectors -- in pulp and paper, for example, and in mining and hydro developments. It is now working to extend this capability to other sectors through the purchase of technology and corporate joint ventures with international organizations.

The industry recognizes the need to encourage and assist more of the smaller and medium-size firms to become active in exporting. It also accepts the need to work with local engineering firms in foreign countries and provide services complementary to those of the foreign organizations.

It is also paying attention to the need for research and development in both management methods and technology such as computer-aided design and computer methods for procurement, and the increased use of government and industry knowledge in securing and carrying out export contracts by such means as joint ventures between crown corporations, federal and provincial governments and private firms.

Current Government Initiatives

The federal government maintains a number of policies that are helpful in exporting consulting engineering services. The policy that maintains the exchange rate of the Canadian dollar is a substantial basic assistance. Industry, Trade and Commerce, the Export Development Corporation and the Canadian International Development Agency all have effective programs and provide excellent support to the efforts of the industry in selling abroad. In particular, ITC's program for Export Market Development (PEMD) and CIDA's Canadian Project Preparatory Fund (CPPF) and Industrial Cooperation Program lend specialized aid to firms seeking to improve their export performance. The facilities offered by EDC for financing feasibility

studies and overseas capital projects and its performance-related insurance scheme help firms finance their export ventures. Other services provided by government to industry include the consulting services, geographical bureaus and line branches of the aforementioned departments.

Canadian embassies abroad offer important assistance to Canadian business firms attempting to enlarge their export business. The Trade Commissioner Service of ITC aids in identifying forthcoming projects and supports the efforts of Canadian consultants to win foreign contracts in the field.

The Task Force on Major Projects in Canada has made recommendations designed to further develop Canadian manufacturing and service capacities (especially EPC) and supports the principle of preference in procurement for major domestic projects to Canadian-owned and Canadian-based firms. The chapter on Major Project Capability comments on the report of the Major Projects Task Force and upon its potential impact on the export effort of the consulting engineering industry.

A further aid to exports, because its efforts will strengthen the domestic base of the industry, is the newly established Regional and Industrial Benefits Office of ITC. The persistency of the Minister of State for Trade on behalf of the industry has also been effective in making sure that industry concerns are fully met. The recent reorganization of Industry, Trade and Commerce and External Affairs reflects the federal government's concern with developing regional and exporting capabilities.

On the provincial level, export promotion programs for the use of consultants also help expand export performance.

Proposed Initiatives

Spin-Off Sales

The degree of independence of the consulting engineering profession in Canada makes it different in character from the professions of some other countries vis-à-vis the manufacturing, utility and financial sectors. Frequently, foreign consultants have direct linkages with manufacturers and construction contractors and offer packages involving these links. Canadian consultants have tended to maintain a non-conflicting relationship with both the client and suppliers of goods and other services.

The consequent role of the consultant in influencing procurement in projects is often misunderstood. The consultant/client relationship and the nature of the project, its source of financing and location of undertaking all affect the consultant's ability to influence procurement.

The federal government and ITC in particular attach great importance to further developing the link between the sale of engineering services abroad and follow-on sales of Canadian equipment and other goods because of the benefits this could bring to Canada. Their efforts to improve this aspect of export are hampered by the lack of interest, perceived lack of competitiveness and lack of experience on the part of some Canadian equipment manufacturers and suppliers in bidding on projects abroad.

In today's competitive international marketing environment financing is another critical element in the export of equipment and other goods. The need also exists to enlarge the engineer-procure-construct (EPC) capacity of Canadian firms, or consortia of such firms, in order to perform effectively on large foreign projects.

Recommendation 11

It is recommended that:

a) **The Canadian Consulting Engineering Industry convene joint meetings between manufacturing, construction, government, and financial and consultant groups to discuss major projects abroad, both prior to implementation and after the awarding of a contract, to improve their knowledge about such projects and exchange information on them.**

b) **Provincial and federal governments devote further efforts and resources to improving and keeping up-to-date sourcing information on suppliers in Canada and distribute this information as widely as possible in Canada and abroad. Provincial governments can play a particularly effective role here because of their knowledge of local firms. In the same context, it is recommended that the Canadian Consulting Engineering Industry encourage engineering firms to use and subscribe to ITC's Business Opportunities Sourcing System (BOSS).**

c) The Canadian Consulting Engineering Industry, through its member firms, implement further studies regarding spin-off sales of Canadian goods and services in capital projects abroad so that more complete data are available on achievements to date, what the impediments to greater sales have been and what action is now required to maximize benefit to the industry from such sales.

d) The Canadian Consulting Engineering Industry prepare a report for distribution to the public and private sectors on the factors that bear on procurement and the consultant's influence on such procurement in capital projects abroad.

e) The Canadian Consulting Engineering Industry seek new and imaginative ways to finance the export of Canadian goods and services through the use of, for example, the Arab funding organizations.

Small to Medium-Size Firms and Exports

Many of the small and medium-size firms in the industry are interested in exporting, but the problems they experience in trying to develop additional export sales are often discouraging. These problems include the cost of identifying and pursuing overseas projects, financial risk in doing so, lack of personnel and management and, often, lack of proper information on work within their capabilities. Because of the wide distribution of small and medium-size firms across Canada, their growth through exporting has important regional connotations.

Recommendation 12

It is recommended that:

a) The Canadian Consulting Engineering Industry establish, as a priority, a study to determine how small and medium-size firms can be assisted and what techniques (for example, sub-contracting) can be used to increase their participation in exports. This would also be a way of making the best use of engineering and support staff in projects, in case of shortfalls in the availability of such staff.

b) The policies of federal government departments to support joint ventures involving various size

firms and giving preference on smaller contracts/projects to small to medium-size companies (for example, the policy of the Canadian International Development Agency (CIDA) in this regard) be continued and expanded.

Profitability in the Industry and Exports

Profitability is a prerequisite to successful exporting. The decreasing profitability in the industry, the lack of vigorous domestic growth, rapidly rising costs and growing competition, especially in foreign markets, are all major factors which inhibit export performance.

Recommendation 13

That while encouraging firms to become increasingly selective in their pursuit of projects abroad, the Canadian Consulting Engineering Industry must make a continued and determined effort to keep member companies interested in exporting; this will help avoid any lessening of export activity and prevent a decrease in Canadian firms' interest and experience.

Canadian Banks

Canadian banks have the potential for playing an effective role in identifying projects overseas, in financing consulting services and in locating equity capital for projects, where required.

Recommendation 14

That the Canadian Consulting Engineering Industry take the initiative to encourage an even closer collaboration with Canadian banks in the marketing of exports, even to the extent of having representatives of the banks accompany the marketing staff of consultants on their overseas trips.

Domestic Development and Exports

Any export strategy for the industry, to be effective, must be related to industrial development and industrial development policies in Canada. A strong engineering base from which to export must be developed in the domestic market. Recommendations for strengthening the domestic base are included in this report under the section on Procurement Policies and Practices.

Recommendation 15

That the Canadian Consulting Engineering Industry advise the appropriate federal and provincial government departments that it wishes to be consulted and included in any policy deliberations and discussions on the enhancement of export capability.

Front-End Costs

Canadian consultants have consistently claimed they do not receive support comparable to that of many of Canada's competitors in the key area of front-end marketing costs. The consulting engineer is usually the first Canadian to be present on a project overseas and it is the engineer who undertakes much of the project identification and marketing carried out in other countries by manufacturers. The costs of these activities are high because they represent a direct marketing effort in the foreign country and because the number of contracts obtained in comparison to projects identified and pursued is low (the industry average is probably about one in 20). The concept of CIDA's CPPF facility is excellent and has been beneficial to Canadian firms in securing overseas contracts, but one underlying problem is that the mandate of CIDA is to aid, not trade.

Recommendation 16

That the CPPF facility of CIDA's Industrial Cooperation Program be transferred from CIDA to be an instrument of external trade thereby creating a fund to provide grants for feasibility studies on projects suitable for Canadian consulting engineers' competence when there is a good chance of developing follow-on sales of engineering and equipment from Canada.

Risks

The risks in international projects are high and are likely to continue to be so as capital projects become even larger and more complex. Canadian consultants usually have a small share of any capital project and do not have the financial resources to assume the risks for entire projects of this type. Similarly, manufacturing companies have limited ability to participate. At present, Canada has no facility or program to resolve this

problem, yet capital projects are of particular interest to the Canadian Government and Canadian suppliers.

Recommendation 17

That the Export Trade Development Board be charged with reviewing the suggestion put forward by the Hatch Committee on the establishment of a risk-sharing body made up of government and the private sector. As an integral part of this review, the Board should study and update the recommendations made by the Hatch Committee in November 1979, and answer the questions we believe have not been adequately dealt with on this issue: for what specific types of projects are the risks greatest; what types of risks should be covered; can an entity of government be included, and if so, what entity.

Export Insurance and Financing - Export Development Corporation (EDC)

Export insurance and financing are highly technical and complex matters and it is extremely difficult to make comparisons between competing systems of support by governments. The Hatch Committee correctly identified the problem of EDC when it stated that it "does not question the efficiency of EDC" but rather "its mode of operation ... its policies and practices", and then goes on to suggest a different structure for the corporation. The consulting industry is the largest client group of the financing services of EDC and it acknowledges the tremendous support the corporation has given in capital projects abroad. The dilemma that needs resolving is the difference in the way EDC perceives its effectiveness in providing competitive export insurance and financing and the way the private sector perceives it.

Recommendation 18

It is recommended that:

a) **Consideration be given to implementing the Hatch Report proposal that the Board of Directors of EDC have a majority of its members from the private sector and a private sector chairman.**

b) **A study be commissioned either by ITC on its own or through the Export Trade Development Board to gather information on the export insurance and financing programs of Canada's competitors and**

compare these programs with those currently available in Canada.

Tax Incentives

It is recognized that tax incentives designed to make exporting more attractive and to motivate firms to sell abroad are fundamental to expanding and diversifying Canada's exports not only of services but also of equipment and materials. Even a superficial review of the techniques used by Canada's competitors raises the question whether Canada has been competitive and imaginative in its approach. Effective fiscal policies must be established to encourage greater interest and participation by Canadian companies without violating our international obligations. Studies to achieve this are apparently under way in Ottawa.

Recommendation 19

It is recommended that:

a) The Canadian Consulting Engineering Industry, through its association, be invited to participate in these studies.

b) Preferential taxation treatment of foreign-earned income be recognized as one of the best and most affordable solutions to promoting exports and that it be implemented by both federal and provincial governments.

Taxation of Offshore Employees

Despite the February 1981 Amendment to the Canadian Income Tax Act, current Canadian taxation of export trade employees posted overseas adversely affects the competitiveness of Canadian consulting firms already working or seeking new work abroad and discourages Canadian professional staff from accepting assignments abroad. Such tax measures in Canada are becoming increasingly unfavourable especially as Canadians are well aware of the recent tax changes that have been made in the United States and other changes by that country to make its tax system more internationally competitive in this field.

Recommendation 20

That Canadian citizens who are bona fide residents in other countries for at least ten months in any

taxable year be allowed to exclude foreign-earned income from taxable income.

Other Measures

There is a growing requirement in Canada to conduct significantly increased amounts of research and development in order to remain technologically ahead of competitors and be able to provide more advanced technology and senior management services on foreign projects.

Recommendation 21

That programs for the enhancement of the Canadian Consulting Engineering Industry's capability in research and development be initiated with reference to the special needs of, and opportunities provided by, the export of engineering services.

Changes should be made in certain programs that are meant to support the export efforts of the Canadian consulting industry.

Recommendation 22

It is recommended that:

a) **The Program for Export Market Development (PEMD) be amended by increasing per diem rates to reflect current costs, and also allow the costs of draftsmen and similar technical staff to be included as eligible expenses.**

b) **The Canadian International Development Agency (CIDA) support Recommendation 16, if this program is to achieve its full potential.**

c) **The Export Development Corporation issue clear guidelines on "credit mixte" resources and the financing of feasibility studies to achieve a better understanding with the Canadian Consulting Engineering Industry.**

CHAPTER VII

MAJOR PROJECT CAPABILITY

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PREFACE

Since the drafting of this chapter, significant changes have occurred in the investment environment. This has been particularly severe for the petroleum based industries. These changes include: high interest rates, lower oil prices, increased tax burdens, and controversial government policies such as the National Energy Program.

As a result, many of the opportunities identified in the Blair-Carr Major Projects Task Force Report are no longer realistic, and lead to the following recommendation:

Recommendation 23

That governments reconsider their policies relating to industry taxation and the National Energy Program in the light of the changing economic environment in Canada and throughout the world.

The following text, prepared prior to many of these major changes in investment climate, should be read with this qualification in mind.

Introduction

Industrial development in Canada in the remaining years of the 1980s and in the decade of the 1990s will be accelerated by the realization of many projects of extraordinary scale and complexity. These projects, appropriately referred to as "major" in every respect will give rise to outstanding opportunities for the consulting engineering industry as well as for other sectors.

An inventory compiled by the Blair-Carr Major Projects Task Force (MPTF) indicates that as much as $440 billion will be invested in major projects in the period to the year 2000. Despite the fact that such inventories are inherently unstable due to alterations in investment intentions, cost of money and other factors, further estimates by the Department of Industry, Trade and Commerce and by firms in the private sector serve to confirm the magnitude of capital investment programs that will be accounted for by these major projects. The inevitability of delay rather than acceleration of these programs must, however, be recognized.

Opportunities arising from major projects will benefit Canadian consulting engineers only to the extent that certain serious constraining factors can be overcome. Among such constraints are those related to demand for qualified manpower, contracting-out procedures of owners/sponsors of major projects, cyclical effects of major projects, employment of Canadian-owned firms, long-term considerations, national and regional considerations and the implementation of Major Projects Task Force recommendations involving government policies.

All of these constraining factors are treated in considerable detail in this chapter. Information thus generated and conclusions consequently reached in the process have also been taken into account in other related chapters. This means that, for example, data contained and conclusions reached in the chapters, "Engineering Personnel -- Supply and Demand" and "Research and Development" are consistent with the "Manpower Demand" and "Research and Development" sections respectively in this chapter.

Manpower Demand Forecast

It is recognized that not all projects listed in the MPTF inventory will produce a manpower demand on the Canadian consulting engineering industry since several owners/sponsors such as B.C. Hydro, Ontario Hydro and AECL carry out engineering on an in-house basis. Utilities also frequently undertake full management of their respective projects. However, manpower demands on the consulting engineering industry and on utilities will combine in creating the overall Canadian demand. Therefore, it was decided to produce two forecasts, the first including the manpower demand from B.C. Hydro, Ontario Hydro and AECL projects and the second excluding the manpower demand from projects which would or could be designed in-house.

To assess the manpower demand from these various projects, it was decided to adopt some simple basic cost criteria for the engineering, management and field supervisory services that would be typical in each of the industrial sectors. Typical durations of work were also assigned. These assumptions are set forth in tabulated form in Table 1. The whole inventory, comprising some 300 major and mega projects, was computerized so that future changes to the inventory and to the input assumptions can be easily made.

Within the computer program, there is provision to vary the distribution of manpower across the years of duration of each type of service and this can be further varied between projects. It was assumed that the distribution of manpower for the durations established in Table 1 would be on the basis that the peak annual demand would be 1.65 times the average demand for the period of duration.

The national manpower forecasts based upon the updated MPTF inventory* of major and mega projects are shown in Tables 2 and 3. Table 2 includes the demand from B.C. Hydro, Ontario Hydro and AECL projects, and Table 3 excludes these on the assumption that all the work of these agencies will be done in-house. The difference between the totals of the two estimates is of the order of 5,000 manyears per year. Both forecasts indicate that the impact of major projects on the consulting engineering industry will be greatest in the years 1983 to 1985 and that the buildup of engineering personnel in early years could present problems.

The forecasts were rerun to show the demand on a sector/regional basis and these are shown in Tables 4 and 5. As before, the differences between the forecasts represent B.C. Hydro, Ontario Hydro and AECL work done on an in-house basis.

Conclusions from the Manpower Forecast

Assessment of demand for manpower arising from major projects must be properly interpreted in relation to all other employment opportunities available to the industry. Such assessments, moreover, are completely conditional upon the implementation of the program forecast in the Blair Carr Report.** However, certain conclusions may be drawn from the major project manpower forecast by itself.

The first conclusion is that the demand for engineering will increase very rapidly through the mid-eighties by an average of about 4,000 to 5,000 consulting engineering staff per year. Thereafter, the demand decreases at a

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*See Bibliography

**Note: At the date of writing this report of the Consultative Committee on Consulting Engineering, the Blair-Carr program forecasts have fallen far behind schedule. This means that the high levels of demand for engineering personnel may not be realized in the time frames indicated.

TABLE 1

Cost of Services as a Percentage of Total Capital Cost and Durations	Engineering Technical		Management and Support Services		Field Non-Manual		Total	
	%	Duration (years)	%	Duration (years)	%	Duration (years)	%	Duration (years)
Mining Primary Metals Forest Products Transportation Manufacturing	6.0	2	2.5	2	3.5	2	12.0	3
Hydro Power	3.5	4	3.0	5	3.5	5	10.0	8
Thermal Power	5.0	4	3.5	5	4.5	4	13.0	7
Nuclear Power	7.0	5	4.5	6	7.0	6	18.5	8
Heavy Oil Development	5.5	3	2.0	4	4.5	4	12.0	6
Pipelines	6.0	1.5	4.0	1.5	3.0	mile/day	13.0	mile/day
Petrochemicals	9.5	2.5	3.5	3	5.5	2.5	18.5	4
Exploration and Development	2.0	5	1.0	5	1.5	6	4.5	10
Cost of Services per Manyear in 1981 dollars	$80,000		$80,000		$75,000			
Effective Manhours per year	1,850		1,850		2,500			

TABLE 2

Manpower Demand from Major Projects Including B.C. Hydro, Ontario Hydro and AECL Projects

Year	Engineering	Management	Field	Total
1981	12,882	4,610	5,034	22,526
1982	16,433	6,532	6,962	29,927
1983	18,319	8,468	9,791	36,578
1984	17,412	9,504	11,912	38,828
1985	17,087	9,294	12,750	39,131
1986	15,359	8,923	12,814	37,096
1987	12,710	8,445	12,478	33,633
1988	11,033	7,548	12,140	30,721
1989	8,590	6,109	11,280	25,979
1990	5,233	4,702	9,845	19,780

TABLE 3

Manpower Demand from Major Projects Excluding B.C. Hyrdro, Ontario Hydro and AECL Projects

Year	Engineering	Management	Field	Total
1981	11,179	3,531	3,555	18,265
1982	15,579	5,369	5,318	26,266
1983	16,956	7,306	7,964	32,226
1984	14,787	8,119	10,087	32,993
1985	13,328	7,729	10,599	31,656
1986	11,714	7,105	10,572	29,391
1987	10,435	6,458	10,138	27,031
1988	10,073	5,533	9,795	25,401
1989	8,168	4,267	8,764	21,199
1990	5,063	3,259	7,322	15,644

TABLE 4 - MANPOWER DEMAND FROM MAJOR PROJECTS ON THE CONSULTING ENGINEER INDUSTRY - BY REGION AND INDUSTRIAL SECTOR
INCLUDING B.C. HYDRO, ONTARIO AND AECL PROJECTS (Based on ITC Inventory dated October 1981)

	*** ALBERTA ****			*** ATLANTIC ***			***** B.C. *****			*** MANITOBA ***			*NORTHWEST TER.*			*** ONTARIO ****			*** QUEBEC ****			*SASKATCHEWAN*			* UNDETERMINED *			*** YUKON ****			*SECTOR TOTALS *		
	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.
EXP & DEVEL																																	
1981	178			144	24	35							649	200	60																793	224	95
1982				104	38	38							927	425	319										75	37					1106	500	357
1983				348	204	45							1180	549	680										175	87	28				1703	840	753
1984				717	416	313							1340	657	883										175	87	72				2232	1160	1268
1985				717	403	650							1327	761	1055										75	37	100				2119	1201	1805
1986				317	175	648							1155	665	1218												100				1472	840	1966
FOR PROD																																	
1981	219	45	24	60	25	18	131	62	120								98	114		41	125										410	271	401
1982	109	58	68		12	37		28	86								54	109			62										109	152	362
1983		45	87			18		18	55								21	60														84	220
1984		16	68					13	43								21	29														50	140
1985			24					9	23								15	25														24	72
1986								3	10								11	20														14	30
HEAVY OIL																																	
1981	137		16																174			111									422		16
1982	1123	207	189																406	63		303	24	27							1832	294	216
1983	2714	702	593																406	148	152	334	64	101							3454	914	846
1984	3353	1087	1056																174	148	354	286	88	182							3813	1323	1592
1985	3820	1489	1606																	63	354	223	105	214							4043	1657	2174
1986	5086	1851	2258																		152	80	94	226							5166	1945	2636
HYDRO																																	
1981				150	51	45	269	175	135	80	23					78	33	17	618	529	608	41	25					22	19	11	1258	855	816
1982	77	40		290	58	56	261	220	216	188	60	28				74	64	41	505	522	660	15	61	32					9	23	1410	1034	1056
1983	180	40	50	264	55	81	530	249	266	188	93	74				43	64	80	784	499	649	6	64	76						11	1995	1064	1287
1984	180	40	50	105	81	90	1661	352	300	80	108	116				25	31	80	1583	612	622		31	80							3634	1255	1338
1985	77	40	50		124	87	2958	705	532	26	93	135				170	11	39	2065	973	763		3	39							5296	1949	1645
1986		40	50		150	134	2990	1330	1096	61	70	116				415	123	14	1592	1345	1211			4							5058	3058	2625
MANUF																																	
1981																61															61		
1982																61	25	38													61	25	38
1983																37	25	38													37	25	38
1984																37	15	23													37	15	23
1985																	15	23														15	23
1986																																	
MINING																																	
1981	680	127	41	37			480	136	114				41	62		168	45	67				573	229	194				11	68	1938	589	546
1982	373	164	218	37	2	3	614	215	191	122	25			30		131	43	51				364	248	308				15	17	1641	712	818
1983	39	109	272		7	8	600	263	304	122	51	38				94	67	79				139	178	270				11	17	994	686	988
1984		85	164		9	11	532	214	392		25	76					52	87					155	216				4	12	532	544	958
1985	65	72	100		7	11	278	124	354			38					22	63					87	197					4	343	312	767
1986	65	43	85	39	18	8	42	102	208								4	29					34	117						146	201	447

TABLE 4 (Cont'd) - MANPOWER DEMAND FROM MAJOR PROJECTS ON THE CONSULTING ENGINEER INDUSTRY - BY REGION AND INDUSTRIAL SECTOR
INCLUDING B.C. HYDRO, ONTARIO AND AECL PROJECTS (Based on ITC Inventory dated October 1981)

		*** ALBERTA ****			*** ATLANTIC ***			***** B.C. *****			*** MANITOBA ***			*NORTHWEST TER.*			*** ONTARIO ****			*** QUEBEC ****			*SASKATCHEWAN*			* UNDETERMINED *			*** YUKON ****			*SECTOR TOTALS *		
		ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.
NUCLEAR																																	
	1981				559	36	60										875	836	1228		32	78									1434	904	1366
	1982				644	90												841	1388		12	40									644	943	1428
	1983				503	232	150										472	705	1396			15									975	937	1561
	1984				181	323	386										1312	773	1169												1493	1096	1555
	1985				-	323	536										1680	635	1284	74											1754	958	1820
	1986					232	536										1312	520	1053	205	28										1517	780	1589
PIPELINE																																	
	1981													122			269	134		857	285									1248	419	
	1982							328						122	24	19	269	179	107	857	571	228							1568	376		3144	1150	354
	1983							384	256	87					57	45		44	143		285	457							3137	1045	301	3521	1687	1033
	1984							56	256	205					57	45			35			228							2032	1449	836	2088	1762	1349
	1985									117					24	19													928	1354	1159	928	1378	1295
	1986																												464	772	1083	464	772	1083
PR & PET																																	
	1981	1661	514	717				1006	10	33							315	83	144	268	61	82									3250	668	976
	1982	1007	468	915				2988	277	137							305	104	191	179	51	103									4479	900	1346
	1983	585	348	855				3112	755	683							297	129	177	57	45	86									4051	1277	1801
	1984	375	231	601	74			1770	948	1329							148	98	166		35	76									2367	1312	2172
	1985	113	96	253	148	27	45	1261	717	1447								32	128		12	59									1522	884	1932
	1986			70	222	54	91	593	504	1082									55			21									815	558	1319
PR METALS																																	
	1981																74	112	167		39	116									74	151	283
	1982							87			122	25					74	71	168			58									283	96	226
	1983							243	20		122	51	38				75	47	125												440	118	163
	1984							312	52	30		25	76				75	25	51												387	102	157
	1985							243	82	78			38					15	19												243	97	135
	1986							87	95	122								15	18												87	110	140
THERMAL																																	
	1981	407	145	140	131	23					55	13	6					101	148					11	32						593	293	326
	1982	318	191	208	131	65	32				70	20	18					78	112						25						519	354	395
	1983	167	225	283	56	84	90	140			55	24	27					62	85				22		9						440	395	494
	1984	52	201	309		65	115	328	59		19	28	33					54	85	165	54		52	9							616	470	542
	1985		130	251		23	90	328	164	81		24	38					42	74	386	138	74	77	26	12						791	547	620
	1986		43	160			32	140	209	225		20	33					27	58	386	193	190	81	43	36						607	535	734
TRANSP																																	
	1981	441	114	143				718	64	66							139	58		103											1401	236	209
	1982	477	92	112				415	209	160							149	59	86	164	12	8									1205	372	366
	1983	96	130	151				510	272	324							25	3	87	78	36	45									709	441	607
	1984		113	182				150	245	561							25	4	5	38	53	70									213	415	818
	1985		55	147					175	255							10	6	6	38	36	54									48	272	462
	1986		14	70					78	136								6	9	27	12	30									27	110	245
TOTAL																																	
	1981	3545	945	1081	1081	159	158	2604	447	468	135	36	6	771	241	122	1979	1500	1885	2020	987	1009	725	265	226				22	30	79	12882	4610	5034
	1982	3484	1220	1710	1206	265	166	4693	949	790	502	130	46	1049	449	368	1063	1518	2291	2111	1231	1159	682	333	392	75	37		1568	400	40	16433	6532	6962
	1983	3781	1599	2291	1171	582	392	5519	1833	1719	487	219	177	1180	606	725	1043	1167	2270	1325	1013	1404	501	306	456	175	87	28	3137	1056	329	18319	8468	9791
	1984	3960	1773	2430	1077	894	915	4809	2139	2860	99	186	301	1340	714	928	1622	1073	1730	1960	902	1350	338	283	478	175	87	72	2032	1453	848	17412	9504	11912
	1985	4075	1882	2431	865	907	1419	5068	1976	2887	26	117	249	1327	785	1074	1860	793	1661	2563	1222	1304	300	221	462	75	37	100	928	1354	1163	17087	9294	12750
	1986	5151	1991	2693	578	629	1449	3852	2321	2879	61	90	149	1155	665	1218	1727	706	1256	2210	1578	1604	161	171	383			100	464	772	1083	15359	8923	12814

TABLE 5 - MANPOWER DEMAND FROM MAJOR PROJECTS ON THE CONSULTING ENGINEER INDUSTRY - BY REGION AND INDUSTRIAL SECTOR
EXCLUDING B.C. HYDRO, ONTARIO HYDRO AND AECL PROJECTS (Based on ITC Inventory dated October 1981)

	*** ALBERTA ****			*** ATLANTIC ***			***** B.C. *****			*** MANITOBA ***			*NORTHWEST TER.*			*** ONTARIO ****			*** QUEBEC ****			*SASKATCHEWAN*			* UNDETERMINED *			*** YUKON ****			*SECTOR TOTALS *		
	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.
EXP & DEVEL																																
1981	178			144	24	35							649	200	60																793	224	95
1982				104	38	38							927	425	319										75	37					1106	500	357
1983				348	204	45							1180	549	680										175	87	28				1703	840	753
1984				717	416	313							1340	657	883										175	87	72				2232	1160	1268
1985				717	403	650							1327	761	1055										75	37	100				2119	1201	1805
1986				317	175	648							1155	665	1218												100				1472	840	1966
FOR PROD																																
1981	219	45	24	60	25	18	131	62	120								98	114		41	125										410	271	401
1982	109	58	68		12	37		28	86								54	109			62										109	152	362
1983		45	87			18		18	55								21	60														84	220
1984		16	68					13	43								21	29														50	140
1985			24					9	23								15	25														24	72
1986								3	10								11	20														14	30
HEAVY OIL																																
1981	137		16																174			111									422		16
1982	1123	207	189																406	63		303	24	27							1832	294	216
1983	2714	702	593																406	148	152	334	64	101							3454	914	846
1984	3353	1087	1056																174	148	354	286	88	182							3813	1323	1592
1985	3820	1489	1606																	63	354	223	105	214							4043	1657	2174
986	5086	1851	2258																		152	80	94	226							5166	1945	2636
HYDRO																																
1981				150	51	45				80	23					78	33	17	618	529	608	41	25					22	19	11	989	680	681
1982	77	40		290	58	56	51			188	60	28				74	64	41	505	522	660	15	61	32					9	23	1200	814	840
1983	180	40	50	264	55	81	142	24		188	93	74				43	64	80	784	499	649	6	64	76						11	1607	839	1021
1984	180	40	50	105	81	90	529	63	30	80	108	116				25	31	80	1583	612	622		31	80							2502	966	1068
1985	77	40	50		124	87	953	98	201	26	93	135				170	11	39	2065	973	763		3	39							3291	1342	1314
1986		40	50		150	134	862	292	443	61	70	116				415	123	14	1592	1345	1211			4							2930	2020	1972
MANUF																																
1981																61															61		
1982																61	25	38													61	25	38
1983																37	25	38													37	25	38
1984																37	15	23													37	15	23
1985																	15	23														15	23
1986																																
MINING																																
1981	680	127	41	37			480	136	114				41	62		168	45	67				573	229	194				11	68	1938	589	546
1982	373	164	218	37	2	3	614	215	191	122	25			30		131	43	51				364	248	308				15	17	1641	712	818
1983	39	109	272		7	8	600	263	304	122	51	38				94	67	79				139	178	270				11	17	994	686	988
1984		85	164		9	11	532	214	392		25	76					52	87					155	216				4	12	532	544	958
1985	65	72	100		7	11	278	124	354			38					22	63					87	197					4	343	312	767
1986	65	43	85	39	18	8	42	102	208								4	29					34	117						146	201	447

TABLE 5 (cont'd) - MANPOWER DEMAND FROM MAJOR PROJECTS ON THE CONSULTING ENGINEER INDUSTRY - BY REGION AND INDUSTRIAL SECTOR
EXCLUDING B.C. HYDRO, ONTARIO HYDRO AND AECL PROJECTS (Based on ITC Inventory dated October 1981)

	*** ALBERTA ****			*** ATLANTIC ***			***** B.C. *****			*** MANITOBA ***			*NORTHWEST TER.*			*** ONTARIO ****			*** QUEBEC ****			*SASKATCHEWAN*			* UNDETERMINED *			*** YUKON ****			*SECTOR TOTALS *		
	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLD.	ENG.	MNG.	FLO.
NUCLEAR																																	
1981																					22												22
1982																																	
1983																																	
1984																																	
1985																																	
1986																																	
PIPELINE																																	
1981													122			269	134		857	285											1248	419	
1982							328						122	24	19	269	179	107	857	571	228							1568	376		3144	1150	354
1983							384	256	87					57	45		44	143		285	457							3137	1045	301	3521	1687	1033
1984							56	256	205					57	45			35			228							2032	1449	836	2088	1762	1349
1985									117					24	19													928	1354	1159	928	1378	1295
1986																												464	772	1083	464	772	1083
PR & PET																																	
1981	1661	514	717				1006	10	33							315	83	144	268	61	82										3250	668	976
1982	1007	468	915				2988	277	137							305	104	191	179	51	103										4479	900	1346
1983	585	348	855				3112	755	683							297	129	177	57	45	86										4051	1277	1801
1984	375	231	601	74			1770	948	1329							148	98	166		35	76										2367	1312	2172
1985	113	96	253	148	27	45	1261	717	1447								32	128		12	59										1522	884	1932
1986			70	222	54	91	593	504	1082									55			21										815	558	1319
PR METALS																																	
1981																74	112	167		39	116										74	151	283
1982							87			122	25					74	71	168			58										283	96	226
1983							243	20		122	51	38				75	47	125													440	118	163
1984							312	52	30		25	76				75	25	51													387	102	157
1985							243	82	78			38					15	19													243	97	135
1986							87	95	122								15	18													87	110	140
THERMAL																																	
1981	407	145	140	131	23					55	13	6					101	148					11	32							593	293	326
1982	318	191	208	131	65	32				70	20	18					78	112						25							519	354	395
1983	167	225	283	56	84	90	140			55	24	27					62	85				22		9							440	395	494
1984	52	201	309		65	115	328	59		19	28	33					54	85	165	54		52	9								616	470	542
1985		130	251		23	90	328	164	81		24	38					42	74	386	138	74	77	26	12							791	547	620
1986		43	160			32	140	209	225		20	33					27	58	386	193	190	81	43	36							607	535	734
TRANSP																																	
1981	441	114	143				718	64	66							139	58		103												1401	236	209
1982	477	92	112				415	209	160							149	59	86	164	12	8										1205	372	366
1983	96	130	151				510	272	324							25	3	87	78	36	45										709	441	607
1984		113	182				150	245	561							25	4	5	38	53	70										213	415	818
1985		55	147					175	255							10	6	6	38	36	54										48	272	462
1986		14	70					78	136								6	9	27	12	30										27	110	245
TOTAL																																	
1981	3545	945	1081	522	123	98	2335	272	333	135	36	6	771	241	122	1104	664	657	2020	955	953	725	265	226				22	30	79	11179	3531	3555
1982	3484	1220	1710	562	175	166	4483	729	574	502	130	46	1049	449	368	1063	677	903	2111	1219	1119	682	333	392	75	37		1568	400	40	15579	5369	5318
1983	3781	1599	2291	668	350	242	5131	1608	1453	487	219	177	1180	606	725	571	462	874	1325	1013	1389	501	306	456	175	87	28	3137	1056	329	16956	7306	7964
1984	3960	1773	2430	896	571	529	3677	1850	2590	99	186	301	1340	714	928	310	300	561	1960	902	1350	338	283	478	175	87	72	2032	1453	848	14787	8119	10087
1985	4075	1882	2431	865	584	883	3063	1369	2556	26	117	249	1327	785	1074	180	158	377	2489	1222	1304	300	221	462	75	37	100	928	1354	1163	13328	7729	10599
1986	5151	1991	2693	578	397	913	1724	1283	2226	61	90	149	1155	665	1218	415	186	203	2005	1550	1604	161	171	383			100	464	772	1083	11714	7105	10572

similar average annual rate. The demand will be very sensitive, however, to actual commitment to design on major projects. The demand could only be met by transfer of staff from other sectors of engineering or by immigration whether on a temporary or permanent basis.

The increase in demand for management staff is indicated to be of the order of 2,000 per year in the mid-eighties, after which the demand, although sustained, begins to level off. The order of demand, while presenting a magnificent opportunity to Canadian engineers to be involved in management of major projects, may prove to require special immigration policies. It is possible that some of the required skills may be repatriated from present overseas projects, but this would seem to run counter to our national objectives.

The demand for field supervisory services is in some ways the most significant, requiring an average annual increase of some 2,000 people per year through the mid-eighties, and the demand would appear to remain level for some years thereafter. The significance of the demand lies mostly in the fact that it could treble over a 1981 base load of 4,000 in a four-year period.

General indications are that the manpower demand is spread across virtually all regions of the country. Taking 1984 as an example, the overall demand from major projects on a national basis is apportioned to the various regions as follows:

Province	Percentage
Alberta	23
Atlantic	14
British Columbia	17
Manitoba	2
Ontario	4
Quebec	11
Saskatchewan	3
Multiprovince	18
Yukon	8

The strongest sectoral demand is in Electrical and Transmission with a percentage demand of 34%, if work in B.C. Hydro, Ontario Hydro and AECL is included and 24% if such work is done in-house. The next three strongest sectors are Heavy Oil, Process and Petrochemical, and Pipelining which are each of the order of 15% of the total manpower demand during the peak demand period.

The overall forecast for engineering, management and field personnel indicates an increase from a current participation at the end of 1981 of 25,000 to a peak of 45,000 if utility projects are included and an increase from 20,000 to 39,000 if utility work is to be done on an in-house basis.

To set the forecast manpower demand in perspective, the following makeup of the consulting engineering industry, excluding Engineer/Procure/Construct (EPC) companies, was established in 1980 by Barnard and Statistics Canada:

Professional engineers	- 12,700	(30%)
Specialists	- 2,600	(6%)
Technicians and draftsmen	- 18,200	(43%)
Administrative staff	- 8,500	(20%)
	42,000	(100%)

Statistics for EPC companies and EPC components of consulting firms are not readily available, but it is estimated that some additional 5,000 professionals and about 10,000 nonprofessionals are engaged in activities similar to those involving the Canadian consulting engineering firms. The total Canadian resource would, therefore, appear to be 20,000 professionals and 36,000 to 37,000 nonprofessionals, making a total available work force of about 56,000. The current manpower forecast, excluding utility projects deemed to be engineered and managed on an in-house basis, runs from a 1981 base of 20,000 to a 1984 peak of 39,000. Anticipating that schedule slippages and cancellations or postponements will occur, the manpower demand from major projects will be of the order of one-half of the total available Canadian consulting engineering resource.

Cyclical Effects of Major Projects

The present manpower forecast indicates very clearly that there is a strong near-term impact and that, after a peak in the early years of build-up, there is a reduction in engineering demand. On the other hand, the requirement for management staff remains virtually constant throughout this decade. The demand for field nonmanual supervisory staff grows rapidly to peak in the middle of the decade and remains quite high through to the end of the decade. The implications of these trends could well be significant, particularly in engineering. For example, if work shortages in the latter part of the decade are to be avoided it may be that joint venture arrangements with foreign companies are desirable for the

first half of the decade and provisions should be made for international marketing for the second part of the decade and thereafter. The management sector remains strong, and every effort should be made by Canadian companies to participate to the maximum possible degree in that sector. The field non-manual supervisory category will require special consideration. It is possible that a large proportion of the manpower required for that sector will not or need not come from the Canadian consulting engineering industry. There may be a particular opportunity in this sector to train young people to participate in and learn from field operations.

Cyclical compressions or the overlapping of design and construction of major projects will lead unquestionably to a demand for technical manpower that is not available in Canada. The effects could be:

- An increase in immigration of professionals as Canadian firms strive to participate to a maximum extent in major project work.

- An increase in joint ventures with foreign firms, particularly those having a special expertise in such areas as heavy oil or tar sands.

- Strong incentives to attract specialists with process experience to Canada.

- Inflated salaries and allowances and escalating project costs unless utilization of manpower in Canada is optimized, with due regard to minimizing relocation.

While it is not realistic to assume that engineering and construction schedules can be idealized in view of the importance of the projects themselves, owners/sponsors, governments, labor organizations and the consulting engineering bodies should act in consort to the greatest degree possible to minimize cyclical effects.

Potential Benefits Deriving From Major Projects

Most of the benefits have been well described in the MPTF report. The particular elements of benefits that apply to the Canadian consulting engineering industry may be summarized as follows:

- Increases in relatively long-term employment and enhancement of skills.

- Opportunities to develop Canadian technological capability and strengthening of R&D involvement.

- Improvements in industrial capability including development and broadening of project management, engineering, procurement and construction supervisory skills with the added prospect of greater participation in foreign markets.

- Development of expertise and credibility, including technology, products and financing, which will contribute to the potential for future exports.

- Strengthening of the Canadian image in the international community.

- Development and demonstration of the capability of mobilizing funding for major projects including the provision of investment vehicles for Canadian savings.

- Opportunities to improve regional equity by conscious planning to achieve regional distribution of spin-off benefits.

- Development both in design and construction methods to reduce impact on the environment.

To take maximum advantage of the opportunities presented by major projects, the Canadian consulting engineering industry should strive to achieve improvement and development in the following fields:

- Management capability and experience.

- Process design and construction capability.

- Engineering, procurement and construction (EPC) capability.

- Establishment of a broader based technical work force.

Capability

The manpower forecast indicates that the present numerical resources of the Canadian consulting engineering industry, including firms with EPC capability, would not be able to meet the forecast peak demands from major projects, particularly if there is compression of

construction periods for the early projects in the inventory. Barnard, in his update report of March 1981 on the consulting engineering industry in Canada, observes that the majority of the 1,700 firms within the industry are small and that about half of the total manpower resources of the industry belong to a relatively small number of large firms. The impact of major projects will mostly affect these larger firms, since they already have, in addition to their broad technical skills, the significant management skills that major project sponsors will seek. However, the resources of these few larger firms are located in particular places and are not wholly or immediately mobile. To some degree, particularly on a regional basis, it will be possible for joint venture and subcontract arrangements to be made between large and smaller firms. This could be mutually beneficial and could reduce the real impact of manpower demand on the few larger firms.

It should be further noted that reserves of technically trained prople are to be found in many government-controlled organizations, and it would be advantageous to the industry as a whole if these reserves could be encouraged to transfer to industry.

In the work undertaken by the Major Projects Task Force, it was apparent that the Canadian consulting engineering industry at large already had developed skills in management systems, procurement organizations and practices and far-ranging technical skills. However, these skills are not necessarily available in the quantities required to cover the needs of the inventory of major projects. The particular skills that are least available in Canada in relation to the demands of major projects are those relating to process design. Improvement in this area presents one of the greatest challenges to the industry if it is to avail itself of the great opportunities provided by the inventory of process-dependent projects. The requirements for technology in dealing with the tar sands could provide a long-term opportunity to Canadian engineers.

Constraints on the Use of Canadian-Owned Firms

In general, Canadian-owned firms have difficulty in competing effectively on major projects where, compared with foreign competition, they lack:

- well-established reputation in particular fields,

- required technology,

- corporate size to handle a large project,

- a "track record" on similar projects,

- construction and construction-related skills.

Table 6 makes a preliminary identification of those projects on which competition to Canadian engineering is likely to be greatest. Since these cover the hydrocarbon, heavy oil, pipeline, processing and petrochemical areas, they account for some 40% of the total listed value of the major projects identified in the Major Projects Task Force report.

This analysis identifies clearly the concern felt by a concensus of the Canadian Consulting Engineering Industry and leads to consideration of what might be appropriate government strategy with respect to the participation of the industry on such major projects. To maximize participation, the roles of small and medium-size firms should not be overlooked.

Long-Term Considerations

The following suggestions are based on the concept that Canadian resources should be directed at technologies which have long-term applicability in Canada, and ultimately good export potential.

This implies that:

- Canada should not necessarily expect to build a competitive resource in the world marketplace on every class and kind of major project. A successful export market should be based on and developed from a strong home market.

- Canada should not "re-invent the wheel". Canada and Canadian firms should be prepared to acquire technology if it is already in existence, and build upon it.

- Research and development should be selectively applied to those new technologies required to develop a home market and which have good long-term competitive export potential.

TABLE 6

Summary of Inventory of Major Projects

to the Year 2000

(millions of dollars)

Sector	% of Total Expen.	Total	Competition to Canadian Engineering					
			Heavy		Moderate		Light	
				%		%		%
Conventional hydro-carbon exploration and development	17.8	78,150	78,150	17.8				
Heavy oil development	9.7	42,735	42,735	9.7				
Pipelines	7.2	31,640	31,640	7.2				
Processing and petrochemicals	6.5	28,505	28,505	6.5				
Electrical gen. and trans.	45.3	198,855					198,855	45.3
Forest products	1.8	7,710					7,710	1.8
Mining	4.5	19,935			19,935	4.5		
Primary metals prod.	1.4	6,235			6,235	1.4		
Transportation	1.4	6,355			6,355	1.4		
Manufacturing	3.1	13,380	13,380	3.1				
Defence	1.2	5,105	5,105	1.2				
TOTAL		438,605	199,515		32,525		206,565	
% OF TOTAL EXPENDITURES				45.5		7.3		47.1

Source: Major Projects Task Force Report, Table 4-1

In many areas of activity, this "home-grown" capability has already developed. Canadian capability is recognized by world standards in a number of areas. Those specifically related to major projects include:

- Mining and metallurgy.
- Forest products.
- Electric power generation (hydro, coal and nuclear).
- Bulk transportation over long distances.
- Cold climate technologies.
- Communications.

There are clear advantages to Canada for building on and expanding from this base. Activities which should merit priority consideration in accordance with the criteria expressed above may be summarized as follows:

- To develop an indigenous technological resource with respect to the exploitation of oil sands and heavy oils.
- To develop an indigenous capability with respect to the exploitation of petroleum resources.
- To develop capabilities with respect to Canada's coal resources.
- To build on Canada's present capability in long distance transportation.
- To build on Canada's growing capability to exploit the ocean and its resources.
- To acknowledge that of all resources trained technical manpower is the key one. It is, and will continue to be, in short supply in Canada. Therefore, priority should be given to automation techniques such as computer applications, word processing, computer graphics, etc.
- To recognize that Canada's engineering industry is more fragmented than that of other developed countries for historic and geographic reasons. Priority should be given to developing management

methods which will facilitate effective mobilization of these scattered and "balkanized" resources and will allow building on existing capabilities.

Research and Development

Canadian research and development should be given appropriate priority. Opportunities arising from the conduct of major projects and through which the consulting engineering industry can contribute to the achievement of national R&D objectives are numerous. Table 7 contains a list which, although by no means exhaustive, provides a good indication of areas of opportunity for research and development activity for pursuit by consulting engineers.

TABLE 7

Some Areas for Canadian Research and Development Priorities

Oil Sands Technology

In-situ techniques
Mining
Dry-process separation
Waste water processing
Waste disposal
Sulphur control technology

Coal Utilization Technologies

Liquification
Gasification
Hydro carbon chemical feed stocks

Heavy Oil Technology

In-situ techniques
Upgrading
Environmental impacts
Waste disposal technology

Cold Climate Technology

Permafrost construction
Habitations and infrastructure
Environmental aspects
Ice breakers and bulk carriers
Pipelines and pumping
Energy conservation techniques

Electronic

Computer applications
Word processing
Computer graphics
Automation
Communication

National and Regional Factors

National Factors

The Major Projects Task Force makes the recommendation that preference should be given to suppliers of goods

and services (including project management, engineering, procurement and construction services) in the following order of priority:

- Canadian-owned firms.
- Canadian-based firms.
- Others.

In making this recommendation, the Major Projects Task Force recognizes that there is an opportunity for Canadian-owned firms to access the substantial markets for Management/Engineer/Procure/Construct (MEPC) and EPC services. Canada will represent one of the world's largest markets for such skills. Should Canadian-owned and Canadian-based firms develop their capability to world scale, they will not only improve Canada's balance of payments, but will also develop a more effective export capability. This in turn will provide significant employment opportunities for Canadians directly, and indirectly, through procurement-generated spin-offs to Canadian manufacturers and other suppliers.

However, the Task Force also recognizes the constraints Canadian firms face:

- Canadian-owned MEPC firms have in the past been limited generally to the electric power, pulp and paper, transportation, and mining sectors.
- In hydrocarbon based projects, they have tended to be small and narrowly focused.
- Canadian firms are not perceived to have the "state of the art" technology in the hydrocarbon field.
- Owners/sponsors are often foreign-owned and the parent organizations frequently have established ties with foreign-based EPC organizations.

Recognition of the contrary arguments in favor of free trade in MEPC services at the international level is implied if not detailed.

Canada, as a nation, is highly dependent on its foreign trade. Restrictive steps which might be contrary to the spirit of the GATT Agreement could arouse antagonism in our trading partners and perhaps even retaliatory intervention.

Foreign multinational corporations have been encouraged to build up Canadian-based organizations and to follow a "good citizen" policy. Some of the leading international EPC firms have made every effort to comply.

For example:

- They have developed competent technical and management groups in Canada.
- They have provided opportunities for the Canadian operation to participate in a lead role in Canadian projects.
- They have encouraged their procurement groups to "buy Canadian".
- They have involved the Canadian operation in export projects.

It would be clearly unfair and a disincentive for such "good citizens" in future if severe discrimination is practised against them.

To determine where the trade-off should be between these conflicting points of view will be a difficult decision.

The Committee endorses, in concept, the recommendation that increased Canadian ownership and control is to be encouraged. However, the Committee does not endorse the policy of applying a flat rate cost premium of, say, 3%. A more flexible approach which takes into account the preceding considerations would be more appropriate. This should lead to the definition of:

- areas where Canadian ownership should be strongly encouraged,
- areas where Canadian-based "good citizens" merit equally serious consideration,
- areas where foreign input should be carefully evaluated.

The section on Long-Term Considerations outlines areas where, in the majority opinion of the Committee, Canadian ownership should be strongly encouraged.

Table 8 identifies some areas which lend themselves to use of foreign technologies. Such inputs should, where

possible, be accessed through "Canadian-based" firms which have proven themselves to be "good citizens" of this country. In general, they cover areas where combinations of the following factors justify the choice:

- It is not foreseen that Canada has a long-term requirement for such developments.
- The technology is well developed overseas and Canada's share is comparatively minor.
- There is little opportunity over the long-term for continued local exploitation.
- There is little opportunity over the long-term for substantial export activities.
- In the more immediate future, non-Canadian sourcing will reduce the problems caused by an overload to the Canadian engineering industry.

TABLE 8

Major Project Sectors Amenable to Foreign Input

Conventional Practice (MEPC)	Process (EPC)
LNG and NGL	Petrochemical plants, including benzine, hydrogen and methanol plants
Slurry technology, including coal, etc.	Ammonia plants
Special vessels, tankers, rigs, etc.	Heavy/residual oil installations
Fighter aircraft	Coal liquefaction

Regional Factors

The Major Projects Task Force makes three recommendations all related to a policy of support to "less advantaged regions" of the country. The Committee endorses these recommendations.

In doing so, however, the Committee believes it is appropriate to recognize that within the mosaic that is Canada regional interests will, and should have considerable weight.

It is recognized that most of the arguments advanced with respect to Canada's participating as an active trading

partner in the world are also applicable at a regional level. Each regional government, whether it be municipal or provincial, has a duty and obligation to consider the long-term interests of its constituents. This is part of our democratic process and cannot be ignored.

Regional sourcing preferences are and will continue to be a fact of life in Canada, and are not necessarily inappropriate.

For example:

- Many of the smaller regional firms in the consulting industry are legitimately fearful of concentration of power on major projects in the hands of a few giant organizations. Past experience has led them to believe that they will find it virtually impossible to compete for staff and for work with these large firms.

- Regional governments are concerned that nonregional firms involved in major projects in their area will withdraw their key staff and know-how when a project is finished.

- All levels of governments wish to ensure that in the long term their constituents will participate in long-term growth and potential exports. Regional governments would like to see regional firms with a strong management role wherever possible.

It is the view of the Committee that these concerns can be dealt with by recognizing:

- Legitimate regional aspirations.

- That nonregional firms must accept and welcome participation of regional firms and vice versa.

- That where a long-term continuing resource-based activity is likely to develop, regional firms should be given every encouragement to become the cornerstone of such developments.

- That, conversely, for "one-off" projects or for those where the technology is already well developed elsewhere in Canada, no reluctance should be shown to assigning such work outside the regional area after use is made of available regional technology.

- That regional preferences should be considered as long as there is a gross imbalance between that region and the rest of the country, that is, the region is and continues to be a net importer of engineering services.

In summary, recognizing legitimate national and regional aspirations within Canada, major project participants should be encouraged to give preference in their procurement policies, everything else being equal, to suppliers of goods and services (including project management, engineering, procurement and construction services) in the order of priority:

- Regional Canadian-owned firms.
- Other Canadian-owned firms.
- Canadian-based (good citizen) firms.
- Others.

Comments On Major Projects Task Force Recommendations Involving Government Policies

The Major Projects Task Force outlines a series of recommendations with respect to the policy environment required for the maximization of industrial and regional benefits from the major projects.

These recommendations are grouped under the headings:

- Canadian Participation, Ownership and Control
- Regional Equity
- Legislative Administrative Practices
- Timing of Major Projects

The following are comments on these recommendations making particular reference to the perceived needs and requirements of the consulting industry and taking into account the long-term considerations outlined above.

Canadian Participation, Ownership and Control

The Major Projects Task Force makes the following recommendations:

1. "Every reasonable effort should be made to ensure that Canadians have access to all managerial, professional, technical, skilled trades and general labor positions relevant to the planning, engineering, construction and eventual operation of major projects."

The Committee fully endorses this recommendation.

2. "Recognizing that potential participants in major projects have to be assessed on a firm-by-firm basis in order to determine the contribution they will make to the maximization of Canadian industrial and regional benefits, Canadian-owned firms or, as a second priority, other Canadian-based firms, should be selected to play key actor roles (including owners/sponsors, MEPC firms, and suppliers and sub-suppliers of goods and services) in future major Canadian projects. In cases where no Canadian-owned or other Canadian-based firm is deemed to be capable of undertaking the work associated with a particular key actor role in a major project, work should be packaged in ways that allow participation by these types of firms in accordance with the contribution they will make to the maximization of Canadian industrial and regional benefits."

As indicated elsewhere, these recommendations should be implemented selectively and with proper regard to impacts on cost and schedule. Recognition should be given to long-term goals. For projects which have high priority in terms of these goals, efforts should be made to ensure that Canadian-owned and Canadian-based firms, which are committed to developing the technology as a Canadian resource for sale at home and abroad, develop by participation the know-how and capability required to undertake such projects. Conversely, for those projects which do not rank highly in terms of long-term Canadian goals, participation by foreign firms may be considered.

3. "Project financiers should not, when offering financial terms, discriminate against projects with a high degree of participation by Canadian-owned firms in key actor roles".

The Committee is concerned that this recommendation borders on wishful thinking. Project financiers have responsibilities to their shareholders and will only discriminate against a high degree of participation by

Canadian-owned firms in key actor roles if they see it as contrary to their shareholders' interest. Positive action by this government is recommended to ensure that the risk climate for the financier is no worse than would otherwise be the case.

4. "With respect to improving Canada's balance of payments position, major project participants (including owners/sponsors, MEPC firms, and suppliers and sub-suppliers of goods and services) should afford Canadians the maximum opportunity to participate in the equity ownership of the projects themselves and of their firms."

While the Committee endorses the intentions demonstrated by this recommendation, they believe major project participants will require some inducement to afford Canadians such opportunities to participate. The Committee does not endorse regulation; a more appropriate vehicle would be taxation provisions which would allow Canadian individuals and companies to provide their capital competitively.

Regional Equity

The Major Projects Task Force makes three recommendations all related to a policy of support to "less advantaged regions" of the country. The Committee endorses these recommendations.

In doing so, however, it is appropriate to recognize other regional interests and the Committee has suggested guidelines elsewhere.

Legislative Administrative Practices

The Major Projects Task Force makes two recommendations aimed at correcting the atmosphere of uncertainty concerning the "rules of the game".

The Committee endorses that part of the recommendations agreed to by the business members of the Task Force, but disagrees with the labor members of the Task Force who believe that "government should ensure conformance with these guidelines through the use of legislative, regulatory and financial powers".

The Committee further believes that the "clear set of guidelines" to be developed by government should recognize

the long-term considerations relating to the consulting industry outlined in this report.

Timing of Major Projects

The following Task Force recommendations were aimed at smoothing out the levels of demands for inputs to major projects.

> "Business, labour and government should cooperate to solve potential problem areas including those related to unacceptable peaking of major project demands..."

The Committee endorses this recommendation but not the use of regulatory and legislative powers to bring it into effect. While endorsing this recommendation, the Committee recommends that any cooperation between business, labour and government to smooth out the level of demand must recognize the demands of the marketplace.

It is noted that one of the most critical areas, if not the most critical, where peaking will be disadvantageous to the long-term interests of Canada is with respect to the provision of services from the consulting engineering industry. Smoothing such peaks will, in the view of the Committee, be important.

RECOMMENDATIONS

It is recommended most strongly that both government and industry be made aware of and recognize the potential, provided by the major projects, for a great increase during the next ten years in the strength of the Canadian Consulting Engineering Industry. There are two prime requirements leading to the realization of that potential, the willingness of the industry to increase its capability and the creating of the industrial climate in Canada that will provide the opportunity.

Recommendations for the enhancement of the Consulting Engineering Industry's capability through research and development programs, manpower development, and better interaction between consulting firms are included with the appropriate chapters. The following recommendations are made for the achievement of the desired climate.

Recommendation 24

That Canadian consulting engineering firms be engaged wherever possible in the execution of major projects, particularly major energy projects.

Recommendation 25

That the long-term benefits of employing Canadian firms to undertake major project work be a main consideration of owner/sponsors.

Recommendation 26

That Canadian-owned companies participate in major projects on a competitive basis and not on the basis of any premium.

Recommendation 27

That every reasonable effort be made to ensure that Canadians have access to all managerial, professional, technical, skilled trades and general labour positions relevant to the planning, engineering, construction and eventual operation of major projects.

Recommendation 28

That when consideration is given to either adjustments to Canada's immigration policies and procedures or the redirection of latent engineering resources in Canada, reference be made to the particular requirements of the industry for the enhancement of its major projects capability.

Recommendation 29

That programs be initiated to enhance the capability of the Canadian Consulting Engineering Industry in research and development with full knowledge of the special needs of, and the opportunities provided by, major projects.

Recommendation 30

That the development of the regions of Canada be an important consideration when selecting engineering firms to participate in major project assignments. It is also recommended that major project owners/

/sponsors be encouraged to give preference in their procurement policies, everything else being equal, to suppliers of goods and services in the following order of priority:

- regional Canadian-owned firms
- other Canadian-owned firms
- Canadian-based (good citizen) firms
- others

Recommendation 31

That major project work be packaged in ways that will maximize opportunities for Canadian firms to participate and that will avoid excessive peaking of demands.

Recommendation 32

That regulation as a means for enhancing the degree of participation by consulting engineers in major projects not be advocated. Rather, fiscal arrangements creating a climate hospitable to participation by Canadian firms is considered the appropriate route.

Recommendation 33

That maximization of industrial and regional benefits must be a leading criterion in the selection of consulting engineering firms for major project assignments.

CHAPTER VIII

RESEARCH AND DEVELOPMENT

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The Canadian Consulting Engineering Industry is not achieving its potential in research and development at a time when Canada is seeking initiatives that will increase participation by the private sector. The future of both Canada and its Consulting Engineering Industry are vitally dependent on the exploitation of science and technology for the enhancement of life style, production of goods and services, and the improvement of our position in competitive world trade. The whole field of scientific activity in which the Canadian Consulting Engineers have a vital interest is defined in the Canada Year Book 1980-81 as follows:

> "Science and technology (S & T) is a term used to encompass activities which involve the generation, dissemination, and initial application of new scientific knowledge and technology. Research and development (R&D) is creative work undertaken on a systematic basis to increase the stock of scientific knowledge and technology."

Canadian consultants have a well established interest in the conduct of research and development and have long sought an effective means of entering the field. The industry, through the Association of Consulting Engineers of Canada, has fostered and expressed this interest over many years through the activities of a continuing committee on the subject, briefs to governments and seminars. The latest seminar was held on October 6, 1981, and was addressed by senior officials of industry and government attracting an important audience from the consulting engineering community.

Because of their interest and concern, consulting engineers have noted with enthusiasm the ambitious goal of the federal government, articulated at the October 6 seminar and elsewhere, calling for reseach and development expenditures amounting to 1.5% of Canada's Gross National Product by 1985. The Consulting Engineering Industry, with its vast reservoir of scientific and technological skills and its potential for effectively executing R&D programs is ideally suited to making a major contribution toward achievement of the government's goal. The exploitation of that potential and the achievement of the contribution requires that practical and economically viable policies be adopted that will generate the

industries long-term investment in R&D. These policies would include the application to the consulting engineering firms of the full range of government incentives and tax measures which are now available to the manufacturing sector for the encouragment of R&D, and more practical federal government policy for contracting with engineering firms for R&D work.

The Committee believes that the future competitiveness and prosperity of the consulting engineering industry is closely linked to its conduct of R&D on a much increased scale. In this way, the scientific and technological capability of the industry would be not only utilized but enhanced with a consequent overall improvement of performance by the sector and its client industries. There are three principal ways in which the consulting engineering industry can participate in R&D:

- through sponsorship of government
- through paid studies commissioned by private industry
- through the commitment of individual firms "own account" to R&D programs.

In all likelihood, a healthy on-going research and development department in a firm would be sustained in all three ways. The immediate requirement is to stimulate the establishment of such departments.

Government Supported Research and Development

Spending by government on science and technology is substantial when all aspects are considered. Data on the federal expenditures are given in Tables 1 and 2. The data shows total expenditures to be $2,094 million in 1980-81, of which $1,646.8 million was spent on the natural sciences. Of this amount, $1,242 million was spent on R&D and $405 million was spent on related scientific activities (RS). The major portion of the money was spent either in-house by government or through grants to universities or industry.

Table 1 shows that of the $1,646.8 million spent on the natural sciences, $975 million or almost 60% was spent in-house by government. In the fiscal year 1977-78 an estimated 23,300 employees were engaged in natural science activities with over 15,000 in R&D work.

TABLE 1
Federal Expenditures on Natural Sciences R&D and RSA
by Performer, 1978 - 1981
(thousand dollars)

PERFORMER	1978-79		1979-80		1980-81	
	$	%	$	%	$	%
R&D						
Intramural	583,406	57.7	592,566	54.5	658,496	53.0
Industry	181,804	18.8	214,730	19.7	238,117	19.2
Universities	190,298	18.8	203,258	18.7	252,672	20.3
Non-profit Institutions	8,276	0.8	8,050	0.7	8,684	0.7
Provincial and Municipal	13,781	1.4	32,568	3.0	44,123	3.6
Foreign	29,293	2.9	31,486	2.9	34,674	2.8
Other Canadian	4,341	0.4	4,782	0.4	5,275	0.4
TOTAL	1,011,199	100.0	1,087,440	100.0	1,242,041	100.0
RSA						
Intermural	296,085	76.6	293,968	77.1	316,566	78.2
Industry	57,970	15.0	50,014	13.1	49,809	12.3
Universities	13,747	3.6	14,210	3.7	21,049	5.2
Non-profit Institutions	2,500	0.6	2,609	0.7	2,798	0.7
Provincial and Municipal	7,503	1.9	9,286	2.4	6,591	1.6
Foreign	2,424	0.6	2,627	0.7	3,265	0.8
Other Canadian	6,329	1.6	8,347	2.2	4,688	1.2
TOTAL	386,558	100.0	381,061	100.0	404,766	100.0

Source: Statistics Canada 1980-81 Year Book, Table 14.1.

TABLE 2
Federal Expenditures on Natural Sciences and Human Sciences
by Major Funding Department or Agency

Department or Agency	Natural Sciences			Human Sciences		
	1978-79	1979-80	1980-81	1978-79	1979-80	1980-81
	(million dollars)					
Agriculture	124.1	138.7	151.9	3.1	3.3	3.8
Communications	55.9	58.8	60.8	6.0	6.3	5.5
Energy Mines and Resources	116.1	133.6	156.8	8.5	10.1	11.0
Atomic Energy of Canada Ltd.	92.0	91.3	96.5	-	-	-
Environment	193.9	201.7	215.2	12.5	13.7	14.6
External Affairs						
Canadian Interntl. Dev. Agency	30.5	32.5	34.0	5.1	5.3	4.7
Interntl. Dev. Research Centre	19.4	18.6	20.2	17.4	17.2	19.8
Fisheries and Oceans	119.4	109.0	112.9	3.1	3.4	3.5
Industry, Trade and Commerce	59.8	72.8	101.8	1.6	2.0	3.0
National Defence	81.6	91.7	102.1	1.7	1.7	1.8
Natural Health and Welfare	36.8	32.4	36.0	21.3	16.0	18.0
Medical Research Council	64.2	70.1	80.0	-	-	-
Science and Technology						
National Research Council	197.2	211.2	227.7	-	-	-
National Sciences and Engineering Research Council	111.9	121.1	163.0	-	-	-
Secretary of State						
National Library	-	-	-	13.1	14.7	17.2
National Museums of Canada	19.1	18.4	18.9	36.0	32.9	33.6
Social Sciences and Humanities Research Council	-	-	-	34.6	36.6	42.6
Statistics Canada	-	-	-	133.3	127.7	139.9
Transport Canada	41.3	26.8	25.5	0.7	0.3	0.1
Sub-total	1,363.2	1,428.7	1,603.3	298.0	291.2	319.1
Others	34.6	39.8	43.5	113.3	124.1	128.0
TOTAL	1,397.8	1,468.5	1,646.8	411.3	415.3	447.1

Source: Statistics Canada 1980-81 Year Book, Table 14.2.

When assessing R&D activity at universities it is worth noting that for the year 1980-81 expenditures on education in Canada were $22,570 million with $4,286 million going to universities. Assuming that approximately one-half the university budget goes to faculty salaries and that approximately half of faculty time is devoted to research or scholarly work, this would mean that another $1 billion is effectively directed to that purpose in addition to research allocations shown in the attached tables. A review of the Directory of Federally Supported Research in Universities, published by Statistics Canada for 1980-81, indicates that research grants to engineering faculties were in the order of $30 million for the year. The total number of faculty members involved in the 30 or so engineering schools is estimated to be approximately 2,000 with only a portion of those receiving the grants. In actual fact some individuals may command grants totalling several hundred thousand dollars at a given time.

The purpose in reviewing the foregoing figures is to indicate that the government support of R&D by direct expenditure is significant, particularly in view of the number of players involved. In the mid-1970s Canada ranked eighth out of the top 12 industrialized countries in terms of the percentage of gross domestic product spent nationally by industry, government and others, on R&D, but was second in terms of the percentage of total expenditure provided by government. Since one of the most pressing needs for improvement of the overall Canadian effort in R&D is an increase in activity in the private sector, it would appear that the consulting engineering industry, given its reservoir of scientific and technological skills, can participate effectively. The university model provides an indication of how this might be done.

As previously noted, in addition to the salaries paid to academics for research, some $30 million in funds for R&D was granted to the 30 engineering schools during 1980-81. Some of the faculty members involved attracted additional contracts from industrial concerns. By comparison the consulting engineering industry with 1,700 firms of various sizes and specialties have staff totalling some 42,000 of whom over 12,600 are university-trained professional engineers, many with many years of practical experience. Individual firms, because of the trend to specialization, have their particular spheres of experience and interest just as departments of engineering schools do. By the nature of their activities they are forced to be organized and managed for the production of results. They operate in the private sector and

constitute a ready-made facility for interaction with the manufacturing, resource and construction sectors. An R&D program could hence be mounted through the consulting engineering industry similar to that being carried out with universities and such a program should have an equal or greater impact. As is the case with the university program, a consulting engineering program might be slightly less "manufacturing" oriented and broadened to include technique and process and other aspects of technological development. In a recent speech David Golden, Chairman of Telestat Canada, made the observation that:

> "...experience might also show that although grants and support for specific programs will always be required, the pendulum has swung too far toward trying to identify a winner, rather than trying to develop a climate in which winners are likely to occur."

This thought would appear to be worth consideration, since many of the most useful discoveries have been made during a search for something else.

A successful government sponsored R&D program would bring substantial advantages to the consulting engineering industry and these advantages would appear to be consistent with Canadian objectives. Engineering firms could carry out R&D projects by contract as for any other project with the same resulting gains in workload, earnings and experience. As results and findings become known either through application in practice or by publication, the firm would gain in reputation and prestige. Such activities would likely require some addition of research personnel, probably at the doctorial level, to work under senior engineers thus providing stimulus to the training and employment of post graduate students. The research capability of engineering firms, once established, would be saleable to private industry in domestic and export markets where the research capability and the enhanced technical dimension of the firms involved would render them more competitive.

The potential for increased employment of engineering personnel is worthy of additional comment because Canada lags behind many other industrial countries in this regard. In 1976 for instance, Japan granted 68,126 bachelor degrees in engineering. The figures for the United States and Canada were 49,284 and 4,853 respectively. Japan with approximately five times

Canada's population had 14 times the graduate engineer output. Twenty per cent of the student population in Japan is in engineering, compared with approximately 7% in Canada. This accent on the training and employment of technical people parallels the great upsurge that has taken place in Japan in the development of high technology based industry. It is also interesting to note that of the students studying for doctorates in engineering in Canadian universities, 40% are foreign students and recently announced policies may reduce these substantially. It appears, by implication, that additional stimuli are required if Canada is to become a leader in S&T activities.

The establishment and operation of a stimulating program would require the cooperation of the government and the consulting engineering industry. This could be achieved through the recently established Joint Committee of NRC and ACEC. Recommendation for funding under such a program should probably be made by an advisory committee separate from that handling the university program because the perception, evaluation, and even the approach may often be different.

To be avoided in the formulation and implementation of any such program are the present shortcomings in government contracting with engineering for R&D assignments. Such government contracts are on a much too limited scale and generally involve amounts of under $50,000. Maximum profit permitted to the contractor is about 10% of the value of the contract. Against this, the cost of preparing and presenting a proposal amounts to approximately $6,000. Therefore, a company committed to an ongoing R&D effort must succeed in having about 60% of its proposals accepted in order to break even. Furthermore, such small contracts ($50,000 and less) do not provide the continuity of work to attract senior, well-qualified researchers. This discontinuity presents almost insurmountable barriers to sustaining the effort.

A much superior way for R&D contracting by government would be for assignments having a specific aim and involving a time frame of one to two or more years to be open for proposal. This procedure, while calling for the value of contracts to be less limited and larger, would permit a time frame of practical dimension and work of greater sophistication. In addition, such an approach would have the following advantages:

- administration costs would be lower;

- the R&D program could be redirected from time to time as it progressed to take advantage of promising new avenues for exploration;

- the research team could be kept together during the longer life of the project;

- performance evaluation and monitoring of the project would be facilitated.

Private Industry Supported Research and Development

The government is currently funding R&D in a variety of firms carrying out their own product or process development. As indicated in the previously mentioned tables, the 1980-81 total of grants to industry was $288 million or approximately 17½% of the total government budget of $1,646.8 million for natural science. In addition, substantial expenditures are made by many of the firms themselves. A recent Financial Post survey during 1981 indicated that 83 private sector firms spent $915 million and the 11 crown corporations spent $355 million for a total of $1,270 million. If this figure does, in fact, represent 70% of the total, it means a total Canadian industry expenditure of $1,800 million in addition to the $288 million granted by government. Much of this is performed in-house by the individual companies but contracts are let to universities, provincial research institutes and other specialist organizations. Expenditures of these dimensions represent an important potential market for consulting engineers as contractors to the industries receiving and expending funds for the conduct of research and development. Consulting firms should apply themselves to servicing this market as researchers, managers and coordinators of R&D programs and as advisors in the exploitation of results.

"Own Account" Research and Development by Consulting Engineers

The extent of performance of "own account" research and development by consulting engineering firms is not well documented. The Committee estimates, however, that as with the other principal ways in which the consulting engineering industry can participate in research and development, the industry falls far short of its potential in "own account" activity. Yet, given an hospitable climate, this is perhaps the most important means by which

consulting engineers can, through improving their scientific and technological knowledge base, remain competitive in domestic and export markets and contribute to achieving national R&D objectives at the same time.

"Own account" R&D activity by the consulting engineering community can encompass myriad subject areas. Amongst these are developments in computer assisted design, project management systems, management methods internal to the individual firm especially in the R&D area, development of empirical formulae for a variety of purposes, energy conservation and life cycle costing for buildings, and development of manufacturing and production processes.

There are many constraints which inhibit or prevent the consulting engineering industry from realizing its potential in "own-account" R&D activity. If a climate is to be created that is conducive to rapid improvement of the industry's performance, government and industry must take measures to eliminate these constraints.

In this regard, it would seem appropriate for the income tax provisions designed to encourage the manufacturing sector in the conduct of R&D to be extended to the consulting engineering industry. This would encourage investments which are of the magnitude necessary for the conduct of "own account" R&D, but which previously have been beyond the reach of most firms. Also an improvement is required in licensing regulations to help protect firms, especially smaller ones, against infringements of patents, copyrights, etc., developed from their R&D.

The industry itself can assist through the formation of consortia to conduct R&D programs where, for example, a single firm might not have the required financial or technological strength to carry the program or exploit its results.

Conclusions

In general, the consulting engineering industry should be recognized by both the government and private sectors as possessing a vast reservoir of scientifically trained personnel capable of contributing significantly to the government's stated R&D objectives. Recognition should take the form of programs designed to make possible, and indeed encourage, the development of the capability to its full potential. Therefore, the full range of government programs for encouraging R&D in manufacturing and in the

universities should be open to consulting engineers. At the same time, the private sector should be solicited and made aware of the capability available.

For purposes of accelerating the industry's effort, a broad interpretation of what constitutes R&D needs to be agreed upon. Such an interpretation might include but in no way be limited to:

- Both scientifically and empirically based R&D activity to arrive at a significant advance in technology development and application;

- Research aimed at encouraging higher productivity through improved management technology and industrial processes and procedures whether for manufacturing or service industries;

- R&D aimed at the industrial application of computers (CAD/CAM) and the development of computer software.

RECOMMENDATIONS

In the case of government it is recommended:

Recommendation 34

That a suitable interpretation of what constitutes research and development be agreed upon between government and the Canadian Consulting Engineering Industry.

Recommendation 35

That the provisions of the Income Tax Act aimed at encouraging research and development in the manufacturing sector be extended in full to the Canadian Consulting Engineering Industry for "own account" research and development.

Recommendation 36

That a research and development grant program similar to that now in place for universities be instituted to encourage research and development in the Canadian Consulting Engineering Industry.

Recommendation 37

That shared cost programs such as the Enterprise Development Program be promoted and utilized by government as a means of accelerating the research and development effort of the Canadian Consulting Engineering Industry.

Recommendation 38

That licensing regulations be simplified to reduce the cost of protecting patents and copyrights resulting from research and development activities by Canadian consulting engineers.

In the case of industry or the private sector:

Recommendation 39

That industry undertake, through its principal associations, educational programs aimed at developing an awareness of the advantages and scope of the research and development capability of Canadian consulting engineering firms.

CHAPTER IX

REGIONALIZATION AND LOCAL PREFERENCE

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REGIONALIZATION AND LOCAL PREFERENCE

Each level of government--federal, provincial, regional and local--is committed to the growth and diversification of its industrial and service supply base for the purpose of developing a balanced economic structure. Each has a duty and obligation to consider the long-term interests of its constituents. Such policies lead to procurement practices that have a significant effect on the strength and growth of the consulting engineering industry.

Governments have made public policy statements pertaining to major projects and, while no formal policies exist for engaging consulting engineering services, informal policies of regional or local preferences are practiced throughout Canada. The private sector which provides 52% of the fees earned by the consulting engineering industry also practices regional or local preference with the encouragement of government and internal policies due to the location of the project or the location of the owner. The intent of regional and local preference policies are clearly understood to be for the benefits of the jurisdiction. Yet there are potentially many disadvantages to regional preference if the policies are applied arbitrarily in all projects.

Clients or customers have the right to purchase goods and services as they see fit; local preference policies should, therefore, be carefully studied for their effects on these persons before they are formulated.

The Consulting Engineering Industry is comprised of privately-owned firms that are very competitive in the wide-ranging services they offer. They range in size from the very large, employing some 5,000 people, to the very small one and two-man firms. Ability and the quality of service should be the basis on which consulting engineers are chosen. When these qualities are available in local firms, then regional preference policies will naturally be followed because of the benefits that will accrue to the region.

"Policies" on Preference

Regional preference policies affect not only the domestic market. They affect the export market to the extent that they influence the concentration of technical know-how and manpower.

The Federal Government and Regional Preference

In his news release dated August 27, 1981, on industrial benefits initiatives, the Honourable Herb Gray, Minister of Industry, Trade and Commerce, announced as part of the measures "the creation of an office of industrial and regional benefits within the Department of Industry, Trade and Commerce" and "the formation of a Committee on Industrial and Regional Benefits (CIRB)." The measures announced are intended to increase the federal government's ability to identify and stimulate industrial benefits, particularly those associated with the development of Canada's natural resources.

Two of the objectives of the industrial and regional benefits are:

> to diversify and strengthen the industrial base of Canada's regions;
>
> to create new industrial opportunities in slower growing regions.

There are no other formal policies of the federal government dealing with local preference.

Provincial Governments and Regional Preference

Certain provincial governments have recently issued procurement policy statements, dealing primarily with major project developments within their jurisdiction.

In British Columbia, the Ministry of Small Business Development has issued a procurement policy for major project developments.* The policy states that the Government of British Columbia is committed to growth and diversification of the province's industrial and service-sector supply base and to enhancing the free flow of goods and services in the Canadian market. Further, it intends to seek the active support of the private and public sector in encouraging competitive sourcing from British Columbia and other Canadian suppliers. Guidelines for the implementation of the policy have also been provided.

When he was Minister of Mines and Energy of Newfoundland, the Honourable A. Brian Peckford issued guidelines and

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* See Bibliography

procedures under certain sections of the Newfoundland and Labrador Petroleum Regulations 1977*. These guidelines state among other things that "the companies and their contractors must give preference to local competitive goods and services where competitive in price, quality and delivery" and "first preference to supply and service companies 51% owned by the residents of the province, and second preference to companies which, while not owned in the province, are managed from the province and have at least 50% of their labour force resident in the province". Further, the Government of Newfoundland announced that as of August 1, 1980, a new local preference policy would be in effect for all future government procurement efforts including consulting engineering services. The new policy utilizes a "local value added" approach to evaluate all tenders for construction and for the supply of specified goods and services to government departments, agencies, institutions, crown corporations and all groups receiving government funding.

The Public Purchasing Act of 1973 of the Province of New Brunswick limits provincial procurement to in-province suppliers where this is in the best interests of the province. An occasional price preference is awarded where provincial value added justifies the preference. There is no formula for preference and in most cases it is small (less than 5%).

The Nova Scotia Government Purchases Act of 1967 provides that preference in government purchasing be given to in-province goods and suppliers where practicable, i.e., when it is consistent with good business practices and in the public interest. Up to a 10% provincial preference is given on an "informal and ad hoc basis" to ensure continued economic viability and job maintenance in particular local industries.

With respect to provincial procurement, the province of Prince Edward Island advertises contracts for projects in excess of $1,000,000 in central as well as eastern Canada while smaller contracts are advertised only in the Atlantic Region. Projects under $5,000 are advertised only in Prince Edward Island. In addition, the province has agreed along with New Brunswick and Nova Scotia to a Maritime Purchasing Policy recommended by the Council of Maritime Premiers. Under this new policy, tenders from provincial and Maritime suppliers would not only be rated

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* See Bibliography

on cost but also on value added within the province or region.

Several years ago, the Government of Alberta issued a statement of policy on Alberta engineering services, the objective of which "is to increase the Alberta and Canadian content of major construction projects and to strengthen the capabilities of Alberta and Canadian engineers, contractors, manufacturers, and suppliers".*

Other provinces do not appear to have official policies dealing with the procurement of consulting engineering services.

Municipal and Local Governments and Regional Preference

Most municipalities have no formal policies on the procurement of consulting engineering services. There are, however, many informal policies in most major cities dealing with preference to firms. Preference is given, first, to head offices located within their boundaries, second, to branch offices, third, to offices located elsewhere in the province and last to other Canadian and foreign firms. In some instances the place of residence of shareholders or principals is requested.

Private Industry and Regional Preference

Private industry provides some 52% of fees earned by consulting engineers, but its policy on procurement has never been stated. Uniform procurement policies of the kind that exist at government levels are non-existent in the private sector. Generally, firms in the industry engage consulting engineers because of their ability and the specialized services they offer. There are, of course, occasions when the client will prefer to engage a firm in his own area or in the area of the project or some combination of the two.

Implementation of Policies

Procurement preference policies are understandable, attempting as they do to meet the aspirations of the various levels of government, their constituents and industry. At times, however, problems occur with the implementation of the policies, particularly when they are used arbitrarily for all engineering services. Policies

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* Note in Bibliography

may be necessary to sustain local firms within a particular region. Similarly, many national firms with branch offices in various regions may also depend on such policies. Procurement policies lead to difficulties only when they become the overriding factor in the selection process. When the consulting engineer is technically competent and is able to provide services within the client's schedule, the practice of local preference is generally satisfactory to both the client and the consulting engineering industry.

The Benefits of Regional Objectives

The policies on regionalization referred to above are based on the concept of sharing and cooperation on which Canada was built. The advantaged regions of Canada have grown more quickly than the less advantaged and have always aided these other regions. The fostering of greater equity among Canada's regions is a long-standing goal of federal and provincial governments. And, of course, there are several advantages to regional or local governments in fostering the use of local resources. Among these are:

the development of a balanced economy;

the development of an integrated body of industries with appropriate strong interrelationships;

the development of a healthy tax base;

the provision of employment opportunities to skilled personnel and the level of personal income compatible with these opportunities;

stimulation of long-term growth for constituents.

Regional sourcing preferences, therefore, are and will continue to be a way of life in Canada and this should not necessarily be seen as inappropriate. Local and regional firms in the consulting industry, because of their dependence on local and regional projects to provide income and opportunity for themselves and their staff, often foster local preference. Many local firms are legitimately fearful of the concentration of power within the hands of a few large organizations. Recognition of the benefits that accrue from regional sourcing preferences should not, however, be allowed to become a barrier to the broad flow of manpower, goods and services within the country.

Disadvantages of Regional Objectives

If regional preference policies are or appear to be restrictive in one region or sector of the economy, similar retaliatory policies may be instituted elsewhere. In Canada, the peaks and valleys of the economic cycle occur in various regions at different times. Restrictive policies to protect the economic base at one time may meet similar discrimination elsewhere at another time. This may impose the economic hardship that the policies were specifically intended to prevent. One example of this is the present unusual situation of high unemployment nationally and in certain regions and, at the same time, labour shortages in other parts of the country. Such an occurrence cannot be considered economically healthy.

Firms Affected: Routine or Ongoing Projects

Regional or local firms account for approximately one-third of the fees earned by the consulting engineering industry. Further, the principal services offered by these firms are in the building, municipal and transportation fields. These services apply to the more routine and continuing activities of the public and private sectors. To a lesser degree they are offered as part of major projects. These fields are long established and the firms within them are capable of providing efficient and reliable service. The selection of local firms for these tasks is almost automatic.

Given that it has the ability to deliver the services, the local firm can offer other advantages. It is more familiar with local codes and practices, and can offer the convenience of close communication without the associated communication costs. Local preference is certainly justifiable in such cases.

On the other hand, if the client is most interested in economy and broad experience, the firm that has gained a broader experience elsewhere may be more appealing.

Firms Affected: Major Projects

Most local and regional firms do not possess the resources to undertake major projects. Firms can, however, undertake any number of sub-projects within the major projects and should be given the opportunity to do so. Large firms and government policies within regions should recognize these legitimate regional aspirations. The participation of regional firms must be accepted and

welcomed. To this end, a recommendation from the Major Projects Task Force* states that: "Federal and provincial governments should jointly establish criteria for judging cases where regional sourcing preferences relative to manpower, goods and services are likely to be supportive of broader regional equity objectives in a long-term sense". This Committee supports this recommendation.

Professional Licensing

Professional engineers form about 30% of consulting engineering firms' staff. All professional engineers are licensed to practice by their professional association in the province in which they practice. Membership requirements are similar from one province to another and it is not difficult for engineers to become licensed in provinces other than their own. The transfer of licences from one province to another has also been made reasonably easy through the cooperation of the provincial associations and the Canadian Council of Professional Engineers.

Recently, the Association of Professional Engineers in Ontario and Saskatchewan have set up more stringent bylaws on standards for practice as a consulting engineer within their jurisdiction. As all consulting engineers in a province, resident and non-resident alike, must qualify under these bylaws in order to practice, they do not pose a barrier to transfer in themselves, neither do they encourage local preference practice.

RECOMMENDATIONS

Recommendation 40

It is recommended that:

a) Authorities developing policies dealing with regionalization or local preference consider benefits and disadvantages carefully prior to formulation. Under no circumstances should such policies be written into legislation.

b) Policies of local preference not be restrictive in nature.

* **See Bibliography**

Recommendation 41

It is recommended that:

a) The Canadian consulting engineer be selected on the basis of experience and capability.

b) Where the local or regional firm has the technical ability to deliver the service within the time schedule and the budget required by the client, engagement of the local or regional firm be encouraged.

c) Joint ventures and the use of sub-consultants be encouraged, where such an arrangement will satisfy the clients requirements, in particular on major projects.

CHAPTER X

ENGINEERING PERSONNEL--SUPPLY AND DEMAND

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ENGINEERING PERSONNEL--SUPPLY AND DEMAND

This chapter examines the existing and projected supply/demand situation for engineering personnel in Canada, reports on the capability of the consulting engineering industry in relation to the supply and demand, identifies constraints which may prevent the industry from meeting the demand, and identifies ways in which the consulting engineering industry can assist in the necessary manpower planning effort. In its preparation the conclusions contained in the chapters on Major Project Capability and Exports are taken into account.

Currently available data are utilized. However the engineering manpower planning field is evolving very quickly. New and innovative manpower forecasting methods have been and are being developed and new data is becoming available each month. Furthermore there is a continuing amount of analytical and editorial comment being published in the public and trade press which bears on the real or imagined shortages of personnel in various regions and industrial sectors. No doubt the conclusions reached from the examination of current data will have to be revised as newer and better information becomes available.

The reader should not place too much significance on the apparent precise nature of the numbers presented but should consider them in terms of the underlying general trends and relative magnitudes which are implied. In particular the magnitude and timing of demand occasioned by the planned major projects are affected by the constantly shifting imperatives of political and economic conditions. Such demand projections given in this chapter should be viewed in the context of the best information available at the time.

Scope

The chapter contains historical data on the supplies and stocks of engineering personnel during the decade of the seventies. Forecasts are provided for the supply of engineering personnel from 1980-85 and the total Canadian demand for engineering personnel during this same period.

NOTE: The source papers and reports referred to in this chapter are listed in detail in the Bibliography at the end of this report.

General conclusions based on these forecasts are presented.

Methodology

For the purpose of this chapter, "Engineering Personnel" are defined as all of those persons who fall within the "Engineering" aggregate occupational category as defined in the Statistics Canada Occupational Classification Manual (OCM) prepared for the 1971 Census. Specifically the occupations falling within that category are:

OCM No.	Occupation
2141	Architecture
2142	Chemical Engineering
2143	Civil Engineering
2144	Electrical Engineering
2145	Industrial Engineering
2147	Mechanical Engineering
2151	Metallurgical Engineering
2153	Mining Engineering
2154	Petroleum Engineering
2157	Nuclear Engineering
2159	Architects and Engineers, n.e.s.
2160	Supervisors, Other Engineering and Architecture
2161	Surveyors
2163	Draftsmen
2165	Architectural and Engineering Technologists and Technicians
2169	Other Occupations in Architecture and Engineering

This occupational category does not include other occupations (university teaching, administration, etc.) which may be filled by persons with engineering qualifications.

The above definition is considered to be appropriate since it:

- lends itself to an analysis of supply data and the prediction of available stocks;
- is representative of the resources demanded by the market place wherein the consulting engineering industry operates; and

- is analogous to the standard definition used in the industry.

The Canadian Consulting Engineering Industry provides one convenient and useful model for describing the breakdown of the occupational classes which constitute "Engineering Personnel". The Stats Can surveys of 1974[a] and 1978[b] provide the following data:

	1974		1978	
	No.	%	No.	%
Professional engineers	10,480	28.5	10,086	30.0
Other professionals	1,217	3.3	2,129	6.3
Technicians and draftsmen	17,217	46.9	14,582	43.3
Administrative and non-technical	7,804	21.3	6,877	20.4
Totals	36,718	100.0	33,674	100.0

The distribution of personnel indicated by this data is consistent with accepted norms in the industry. While the distribution of "Other Professionals" and "Technicians and Draftsmen" has varied, the combined total for these non-engineer technical personnel has remained consistent.

The first three categories above are equal to approximately 79 per cent of the staff of consulting engineering firms and are analogous to the "Engineering Personnel" described earlier. A reasonably accurate model of the makeup of "Engineering Personnel" therefore is:

Engineers	37%
Allied professionals	8%
Engineering Technicians and Draftsmen	55%

It would be possible to test this model against the census data for the OCM occupational classifications described above. This analysis would demonstrate the relative applicability of the consulting engineering industry's experience to the entire stock of engineering personnel.

(a) Consulting Engineering Services, 1974, Statistics Canada
(b) Engineering and Scientific Services, 1978, Statistics Canada

Relatively good data are available on the supply of engineers, while there is a paucity of information on the supply of other occupations making up engineering personnel. For this reason the adopted method of analysis deals first with the supply/demand situation for engineers. Once this has been determined, analogous data is imputed where possible for the other occupational groupings.

A supply/demand model has been prepared for engineers to show the various sources of supply and the manner in which they are applied to satisfy demand. Each element of the supply side is examined to determine whether existing research efforts have quantified the historical and projected supply.

Existing Canadian engineer stocks are similarly examined and the available research data is reviewed.

The total Canadian demand for engineers is examined to determine which of its elements have thus far been established and which elements are yet to be defined.

Finally, comments are made on the capacity of the Canadian Consulting Engineering Industry and its ability to help fulfill part of the overall demand.

Supply/Demand Model

A suggested Supply/Demand model for Persons in Engineering Occupations is given in flow-chart form in Figure 1.

The central portion of the chart is devoted to those elements which influence the level of indigenous engineering resources which are a relatively stable and permanent part of the Canadian manpower resource. The right hand side of the chart illustrates elements of the residual Canadian labour force. The left hand side of the chart includes elements of imported resources which are transient in nature.

Supply of Engineering Graduates

There are four main inputs which determine the available supply of engineering graduates (all degree levels), i.e.-

- Domestic Supply of New Graduates

- Returning Canadian Graduates of Foreign Institutions

- Immigrant Graduates

- Repatriated Canadian Graduates.

Domestic Supply of New Graduates

The Supply Model for Engineering Graduates of Canadian Institutions is given in flow-chart form in Figure 2. For illustrative purposes the data for 1978-79 have been shown.

Considerable research and analysis has been done by the Federal Ministry of State for Science and Technology on the supply of engineering graduates. The data reported herein has been drawn from MOSST Background Paper 14--Recent Trends in Degrees Awarded and Enrolments at Canadian Universities and MOSST Background Paper 18--The Requirements for Engineering Graduates to 1985.

SUPPLY/DEMAND MODEL - PERSONS IN ENGINEERING OCCUPATIONS

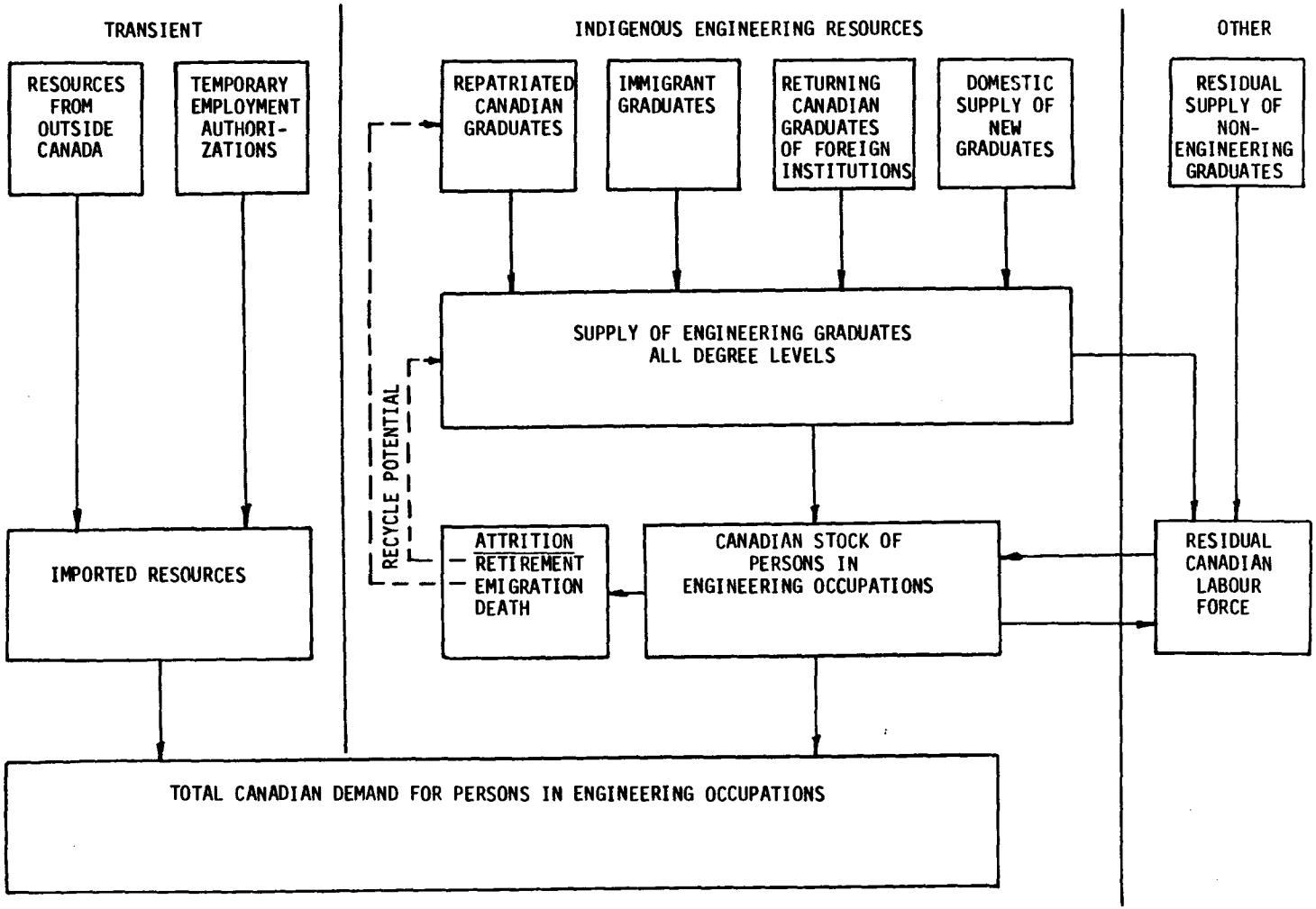


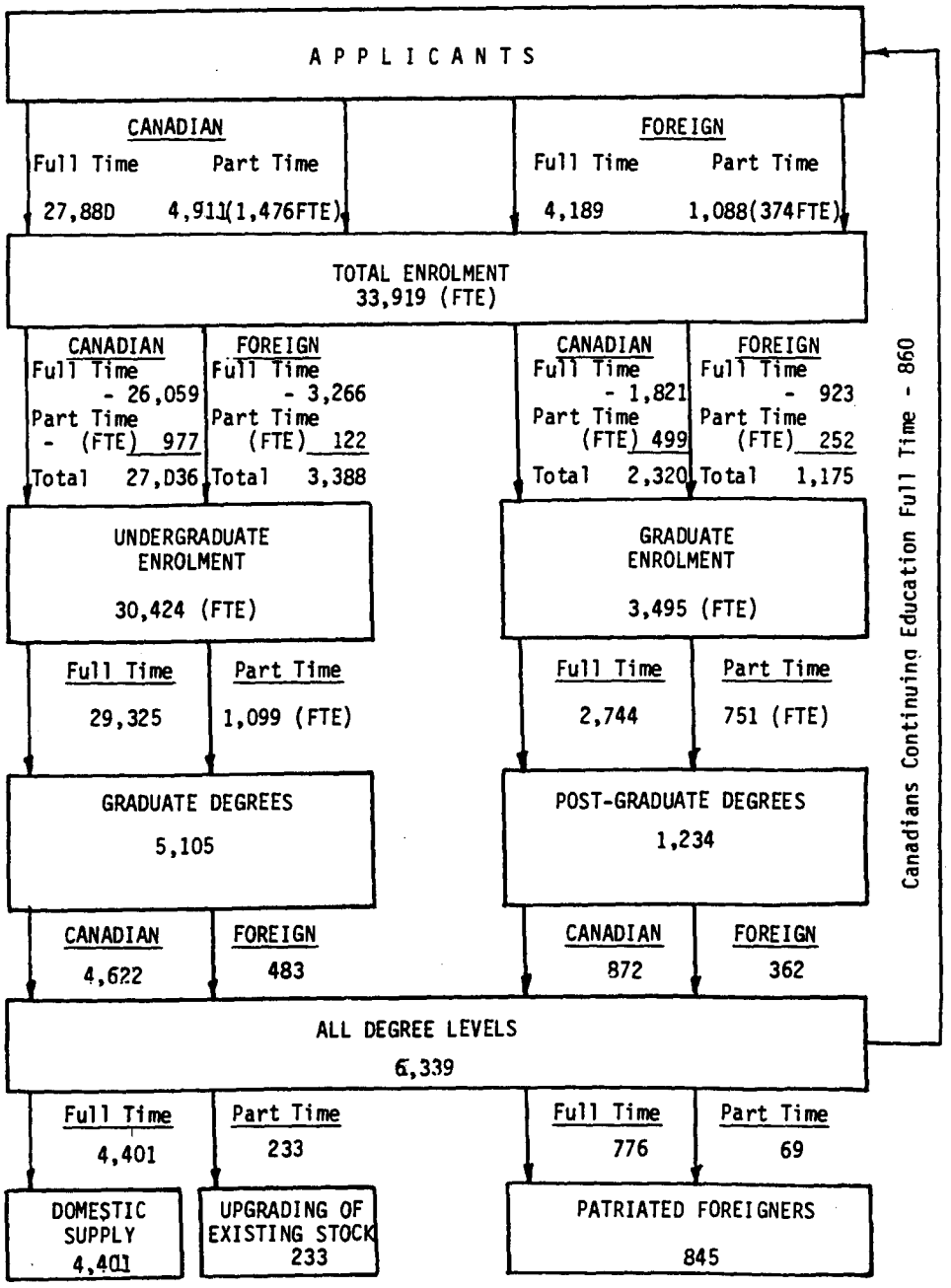
Figure 1

Figure 2

SUPPLY MODEL

ENGINEERING GRADUATES - CANADIAN INSTITUTIONS

(1978-79 DATA SHOWN FOR ILLUSTRATION)



Note: FTE - Full-Time-Equivalent

Table 1

FULL-TIME ENROLMENTS AND DEGREES AWARDED IN ENGINEERING*

1972-73 to 1978-79

	Undergraduate		Graduate		Total	
	Enrol-ments	Degrees Awarded	Enrol-ments	Degrees Awarded	Enrol-ments	Degrees Awarded
1972-73	19,790	4,222	2,919	1,221	22,709	5,443
1973-74	19,965	4,205	2,766	1,211	22,731	5,416
1974-75	21,631	4,175	2,914	1,164	24,545	5,339
1975-76	24,155	3,894	3,164	1,023	27,319	4,917
1976-77	26,414	4,134	2,958	1,118	29,372	5,252
1977-78	28,148	4,513	2,921	1,236	31,069	5,749
1978-79	29,325	5,105	2,744	1,234	32,069	6,339

Source: MOSST Background Paper 18, Table 3, page 5.

*Excludes Forestry and Architecture

Table 1 shows full-time enrolments and degrees awarded in engineering for the period 1972/73 to 1978/79. In addition to the full-time enrolments shown, part-time enrolments have increased significantly over the period. Degrees awarded to part-time students in 1972/73 were equivalent to 2.5% of total degrees awarded. By 1978/79 this had risen to 4.8% of degrees awarded.

The relative increase in degrees awarded beginning in 1977/78 reflects the increase in enrolments which began three years earlier.

Not all of the graduates receiving degrees each year are available to the domestic market. Foreign student enrolment has been rising steadily over the period and, as illustrated in Table 2, amounted to 13.1% of total full-time enrolment by 1978/79.

Table 2

Foreign Student Enrolment (Full-Time)--Engineering*
1972-73 to 1978-79

	Student Visas		Student Visas as a Percentage of Full-Time Enrolment	
	Undergraduate	Graduate	Undergraduate	Graduate
1972-73	1,337	517	6.8	17.7
1973-74	1,262	458	6.3	16.6
1974-75	1,280	595	5.9	20.4
1975-76	2,153	753	8.9	23.8
1976-77	2,341	735	8.9	24.9
1977-78	3,036	920	10.8	31.5
1978-79	3,266	923	11.1	33.6

Source: MOSST Background Paper 18, Table 6, page 8.

*Excludes Forestry and Architecture

In addition to these foreign graduates who return home, some of the new Canadian graduates continue their education while others have been pursuing part-time studies and are assumed to already have a job. Table 3 gives an analysis of the supply of engineering graduates including the derivation of "Available Domestic Supply". It is this element, located in the lower left hand corner of the chart in Figure 2, which contributes the "domestic supply of new graduates" found in Figure 1.

Table 3

Analysis of Supply of Engineering Graduates[a][b]
(all degree levels)

		1972	1973	1974	1975	1976	1977	1978
	Degrees awarded	5,443	5,416	5,339	4,917	5,252	5,749	6,339
Less:	Part-time graduates	136	161	178	168	173	215	233
Less:	Foreign graduates returning home	641	678	684	640	720	785	845
Less:	Graduates Continuing Education	937	853	788	727	789	805	860
Equals:	Available domestic supply	3,729	3,724	3,689	3,382	3,570	3,944	4,401

It has been noted that the "relatively slow growth in the number of student places offered by the Canadian university system is due, in part, to enrolment controls. For example, engineering programs have restricted enrolments in Alberta, Saskatchewan, Manitoba, Toronto, Queens and Montreal. In most universities this is accomplished through a quota system and a floating grade requirement[c]". Further it is noted that "although student demand for entry to the engineering and applied science programs is high and will likely remain high through the decade (of the 80's) the overall constraints imply that special efforts will be required by the universities to meet these increased demands."[d].

It has been assumed therefore, that, notwithstanding other indications of static or declining growth in university enrolments in general, enrolments in engineering will

Sources: MOSST Background Paper 14 -- (a) see Appendix B
MOSST Background Paper 18 -- (b) see Table 7, page 9
(c) see page 8
(d) see page 15

remain at the levels experienced in 1978/79 and that the constraint to further growth will be the capacity of the universities.

The projected supply of engineering graduates to 1985 is as adopted in MOSST Background Paper 18, i.e.--

Period 1979/80 through 1984/85 (six years)

Degrees awarded	38,000	(6,333/yr)
Less		
Part-time graduates	1,370	(228/yr)
Foreign graduates	5,070	(845/yr)
Graduates continuing education	5,160	(860/yr)
Available domestic supply	26,400	(4,400/yr)

Returning Canadian Graduates of Foreign Institutions

The number of Canadians receiving engineering degrees abroad and returning to Canada were determined by MOSST Background Paper 14, Appendix B as follows:

Year	Graduate Degrees	Post Graduate Degrees	Total
1972/73	140	270	410
1978/79	170	273	443

In projecting the number of returning Canadian graduates for the period from 1979/80 to 1984/85 it is assumed that they will remain at the 1978/79 level, i.e., 440/year or 2,640 over the six years. This component of supply is, at least in part, an inverse function of the ability of Canadian universities to meet the demand for enrolment.

Immigrant Graduates

The number of immigrants to Canada with engineering degrees was determined by MOSST Background Paper 14, Appendix B as follows:

Year	Graduate Degrees	Post Graduate Degrees	Total
1972/73	1,492	235	1,727
1978/79	1,228	307	1,535

Elsewhere MOSST Background Paper 18, page 9 states that "the number of immigrants with an engineering degree averaged about 2,000 per year from 1972 to 1975 and fell to about 1,500 per year from 1976 to 1979."

The Canadian Engineering Manpower Council reported in its issues of Manpower News for August 1980 and February 1981 the following data for immigration of engineers identified by intended occupation:

Year	Immigration of Engineers
1969	2,739
1970	2,186
1971	1,687
1972	1,855
1973	2,014
1974	2,058
1975	1,965
1976	1,475
1977	1,160
1978	712
1979	819
1980	1,310

The differences between the two sets of data are accounted for by the fact that some immigrant engineers who possess engineering degrees do not intend to occupy engineering positions.

Projected immigrant graduates will depend upon the combined factors of:

- government policy
- demand
- availability.

For the purpose of analysis we have assumed an immigration rate of 1,500 per year or 9,000 over the six-year period which represents maintenance of the status quo.

Repatriated Canadian Graduates

It has not been possible to discover any useful and dependable data on this source of supply. It would appear that from time to time this source has been a significant short-term factor in helping to meet special

demands. One example would be the repatriation of numbers of aerospace engineers who were lost through emigration in the fifties and regained again in the seventies when Canada's domestic aerospace industry experienced a resurgence. A similar recovery is likely to occur in the petroleum exploration and development sector when Canada's economy recovers sufficiently to attract emigrés who went to the United States in 1981. In any case it would appear that this is not a recurrent dependable source of supply.

Projected Supply of New Graduates

The combined totals for the four available inputs are:

Period 1979/80 through 1984/85 (six years)

Domestic supply	26,400	(4,400/yr)
Returning graduates	2,640	(440/yr)
Immigrant graduates	9,000	(1,500/yr)
Repatriated graduates	N/A	
Total	38,040	(6,340/yr)

Canadian Stock of Persons in Engineering Occupations

Information on the stock of engineers is available from several sources, but none is comprehensive and each suffers from certain shortcomings. The Canadian Engineering Manpower Inventory (CEMI) being developed by the Canadian Engineering Manpower Council (CEMC) of the Canadian Council of Professional Engineers (CCPE)[a][b] should make such comprehensive data available in a few years. Meanwhile the best available information on the stock of engineers is the CCPE membership data and MOSST Background Paper 18.

CCPE[c] membership data for all provinces and the Yukon are:

Sources: (a) Engineering Manpower News, March, 1981
(b) A Statement on Engineering Manpower
(c) Supply of and Demand for Engineers in Canada, 1980, Technical Service Council, Exhibit A:2

1973	74,349
1974	78,485
1975	83,583
1976	89,200
1977	95,390
1978	98,035
1979	101,144

This data has the following shortcomings when used to determine the stock of Canadian engineers:

- some engineers hold duplicate or multiple registrations in more than one provincial association;
- retired members and those who are non-residents of Canada are included;
- not all qualified Canadian engineers are registered professional engineers;
- some persons within the total membership hold degrees in fields other than engineering or hold no degrees;
- membership includes engineers who do not make up part of the "engineering personnel" definition adopted for this report.

For these reasons the CCPE membership data has been discarded in favour of the estimates developed by MOSST Background Paper 18.

MOSST Estimates of the Stock of Engineers

The MOSST Background Paper 18--Requirements for Engineering Graduates to 1985 uses information derived from the MOSST HQM (Highly Qualified Manpower) data base and projection model. Details of the methodology used in the development of this model are contained in a separate technical paper*, MOSST HQM Demand Model Methodology.

The MOSST HQM Demand Model was used to prepare estimates of the occupational stocks for the engineering occupations defined by the OCM classifications described in Section 3. These estimates were calculated using the occupation/ employment coefficients by industry based on adjusted 1971 census data and applying these coefficients to industry employment projections to 1985 (further information on the

* See Bibliography

demand - projection method is provided in the following section on Total Canadian Demand for Persons in Engineering Occupations).

Annual attrition estimates were calculated starting with the 1971 sex and single year of age distributions obtained from the Census and applying death and retirement rates and estimates of emigrants. This total replacement demand was added to the annual change in the stock to obtain an estimate of the number of new entrants required each year. These data are summarized in Table 4.

Table 4

Estimate of the Stock of Persons in the Engineering Occupations

(1972 to 1978)

	Number of Persons			
	Total Engineers	Annual Increase	Replacement Demand	New Entrants Required
1971	46,100	--	--	--
1972	49,900	3,800	1,100	4,900
1973	53,900	4,000	1,100	5,100
1974	57,600	3,700	1,100	4,800
1975	61,100	3,500	1,150	4,650
1976	64,100	3,000	1,150	4,150
1977	66,600	2,500	1,200	3,700
1978	69,100	2,500	1,250	3,750

Source: MOSST Background Paper 18, Table 1, page 3.

Data was obtained from the 1973 Highly Qualified Manpower Post-Censal Survey (HQMPS) to determine the educational background of entrants to all occupations. This provided an estimate of the number of persons likely to be required with or without an engineering degree in all occupations, including engineering occupations.

The result of this analysis is presented in Table 5.

Table 5

Requirements for Engineering Graduates

(1972 to 1978)

Requirements (all degree levels)

	Engineering Graduates for Eng. Occs.	Engineering Graduates Other Occs.	Total Engineering Graduates
1972	4,070	2,610	6,680
1973	4,230	2,830	7,060
1974	3,990	2,900	6,890
1975	3,860	2,530	6,390
1976	3,500	2,610	6,110
1977	3,070	2,700	5,770
1978	3,110	2,840	5,950

Source: MOSST Background Paper 18, Table 2, Page 4.

The total number of engineering graduates in the two occupational categories can be inferred from the MOSST data as follows:

	Stock of Engineering Graduates in Engineering Occupations	Stock of Engineering Graduates in Other Occupations	Total Stock of Engineering Graduates
1971	35,500 (55.5%)	28,500	64,000
1972	39,570 (56.0%)	31,110	70,680
1973	43,800 (56.3%)	33,940	77,740
1974	47,790 (61.5%)	36,840	84,630
1975	51,650 (56.7%)	39,370	91,020
1976	55,150 (56.8%)	41,980	97,130
1977	58,220 (56.6%)	44,680	102,900
1978	61,330 (56.3%)	47,520	108,850

It is noted that the growth in the stock of engineering graduates over the eight-year period from 1972-78 corresponds with the supply data which is summarized under "Supply of Engineering Graduates" in this report.

A comparison of the total stock of persons in the engineering occupations with that fraction which were engineering graduates follows:

	Total Stock	Engineering Graduates	Percentage
1971	46,100	35,500	77.0
1972	49,900	39,570	79.3
1973	53,900	43,800	81.3
1974	57,600	47,790	83.0
1975	61,100	51,650	84.5
1976	64,100	55,150	86.0
1977	66,600	58,220	87.4
1978	69,100	61,330	88.8

Total Canadian Demand for Persons in Engineering Occupations

The MOSST HQM Demand Model is based on a solution of the casual relationships between the following elements:

- Population estimates by sex and single year of age, 1971-1985;

- Estimates of employment by industry, as defined by the Standard Industrial Classification (SIC) for the years 1971-1985. The employment projections are obtained with the aid of the CANDIDE econometric model(a);

- The most up-to-date estimates available of the number of persons in the various HQM occupations by sex and single year of age, and by industry. The HQM occupations are those from the OCM which require a combined General Educational Development and Specific Vocational Preparation (GED/SVP) factor of at least 12 (Table 6 shows the GED/SVP average for each of the occupations which make up "Engineering Personnel". Note that by this definition OCM numbers 2160, 2161, 2163, 2165 and 2169 do not qualify as "Engineering Occupations" but would fall into the category of "Related Engineering Occupations");

Source: (a) An overview of CANDIDE Model 10, Candide Project Paper No. 1.

- Technological relationships, describing the proportion of HQM functions in total employment, by industry (contained in an occupation by industry coefficient matrix). These coefficients can be varied when there is evidence of technological change that can be quantified.

Table 6

GED/SVP Averages for Engineering Occupations

OCM No.	Occupations	GED/SVP Average
2141	Architecture	14
2142	Chemical Engineering	14
2143	Civil Engineering	14
2144	Electrical Engineering	13
2145	Industrial Engineering	13
2147	Mechanical Engineering	13
2151	Metallurgical Engineering	13
2153	Mining Engineering	13
2154	Petroleum Engineering	13
2155	Aeronautical Engineering	13
2157	Nuclear Engineering	14
2159	Architects and Engineers, n.e.s.	13
2160	Supervisors Other Engineering and Architecture	-
2161	Surveyors	11
2163	Draftsmen	10
2165	Architectural and Engineering Technologists and Technicians	11
2169	Other Occupations in Architecture and Engineering, n.e.s.	11

Source: MOSST HQM Demand Model Methodology, Table 4, pages 28 and 29.

MOSST Background Paper 18 describes how the HQM Demand Model was used to project the requirements for engineers to 1985. It is noted that these projections are based on CANDIDE generated employment projections for the Canadian economy with the impact of major projects removed. For this reason the MOSST projections provide a convenient baseline demand upon which one can superimpose the impact of major projects.

Projected Stock of Persons in the Engineering Occupations

Table 7 indicates that the number of persons employed in engineering occupations is expected to rise from 72,000 to 92,000 or by 20,000 persons over the period 1979 to 1985. During this same period total replacements due to attrition of the stock are estimated at 9,000 for a combined total demand of 29,000.

Table 7

Estimates of the Stock of Persons in Engineering Occupations

(1979 to 1985)

Number of Persons

	Total Engineers	Annual Increase	Replacement Demand	New Entrants Required
1979	71,900			
		3,200	1,450	4,650
1980	75,100			
		3,200	1,450	4,650
1981	78,300			
		3,200	1,450	4,650
1982	81,500			
		3,400	1,550	4,950
1983	84,900			
		3,400	1,550	4,950
1984	88,300			
		3,600	1,650	5,250
1985	91,900			

Source: MOSST Background Paper 18, Table 8, page 10.

Projected Requirements for Engineering Graduates

Of the 29,000 persons required to fill engineering jobs, about 80% or 24,000 are expected to require degrees in engineering. A further 21,400 engineering graduates are expected to be required for HQM jobs other than engineering (e.g., administration, teaching, research and development). Thus in total it is estimated that about 45,000 engineering graduates will be required over the

period 1979 to 1985 (or an average of 7,500 per year). Table 8 summarizes the annual requirements.

Table 8

Requirements for Engineering Graduates

(1979 to 1985)

Requirements (all degree levels)

	Engineering Graduates for Engineering Occupations	Engineering Graduates Other Occupations	Total Engineering Graduates
1979	3,850	3,200	7,050
1980	3,850	3,350	7,200
1981	3,900	3,550	7,450
1982	4,000	3,650	7,650
1983	4,100	3,750	7,850
1984	4,300	3,900	8,200
1985			

Source: MOSST Background Paper 18, Table 9, page 11.

Thus by 1985 it is expected that Canada will have about 157,000 graduate engineers of whom about 88,000 or 56% will be employed in engineering occupations.

Impact of Major Projects

Chapter VII, "Major Project Capability", gives a manpower forecast of the impact of the planned major projects. Table 2 of the chapter summarizes the total manpower requirements for the decade. It is noted that the forecasts are based on an assumed manpower profile which approximates the historical experience of the Canadian Consulting Engineering Industry (see section on Methodology). On this basis it is possible to translate

these forecasts into forecasts of engineer requirements, as summarized in Table 9.

Table 9

Manpower Demand from Major Projects
(including B.C. Hydro, Ontario Hydro, and AECL projects)

Year	Total Manpower Demand*	Demand for Persons in Engineering Occupations	
		Total Demand	Annual Incremental Demand
1981	22,526	6,758	
1982	29,927	8,978	2,220
1983	36,578	10,973	1,995
1984	38,828	11,648	675
1985	39,131	11,739	91
1986	37,096	11,129	(610)
1987	33,633	10,090	(1,039)
1988	30,721	9,216	(874)
1989	25,979	7,794	(1,422)
1990	19,780	5,934	(1,860)

* Source: Chapter VII, Major Project Capability, Table 2.

In preparing projections the construction dates for the major projects were reviewed and revised to reflect the best available judgement. It is assumed therefore that manpower resources which were forecast for 1981 reflect the best estimate of resources which have been deployed already and are therefore part of baseline activity. It is suggested moreover that the Annual Incremental Demand data given in Table 9 is representative of the impact of the major projects on baseline demand as developed previously in this section.

It should be emphasized that these incremental demand figures represent the impact of staffing the engineering, management and field supervision of the actual construction of the major projects. They do not reflect the further demands which will be placed on the country's resources as a result of activity in the manufacturing sector and other sectors both during and following construction.

Impact of the Export of Engineering Services

Chapter VI, "The Export Opportunity" indicates significant growth in exports of services by the Canadian Consulting Engineering Industry during the seventies. Further significant growth is forecast in the first half of the eighties.

It is noted that the studies carried out by MOSST have not considered the impact of significant growth in the export of services and the CANDIDE model is not equipped to handle such a small element in the overall scheme of economic growth. It appears reasonable therefore that the impact of such growth in export will be incremental to the baseline activity developed previously in this section.

Export earnings by Canadian Consulting Engineers are the result of the application of both Canadian resources and resources maintained abroad. In 1978 industry exports totalled $220 million. It is estimated that this required the deployment of about 1,793 engineers. In that year a total of 373 engineers employed by Canadian consulting engineers were reported as residing outside Canada which infers a total of some 1,420 engineers in Canada who were employed on export work. This represents about 14% of the total stock of Canadian engineers employed by the industry in 1978.

Export trade now accounts for about 20% of the industry's billings and the value of exports was $340 million for 1980 and will rise to more than $500 million by 1985. If the historical ratio between work performed in Canada and outside Canada prevails, this implies a Canadian engineering work force of 2,195 in 1980 and 3,230 in 1985 which is devoted exclusively to the export of engineering services. Furthermore, the foreign engineer work force employed by Canadian consulting engineers will grow from 580 in 1980 to 850 in 1985, and many of these will be Canadian engineers who will swell the emigration figures beyond the historical trends.

It is estimated that the export of engineering services will contribute an incremental demand for persons occupying engineering positions of some 250 a year or 1,500 over the six-year period from 1979-85.

Impact of Imported Engineering Services

The chapter on "Exports" reports certain trade figures in relation to the import of engineering services and estimates the current situation. The value of imports in 1973 was $89 million and, based on the Canadian industry's 1974 revenue per engineer, this would have been equivalent to about 950 engineers. In 1977 the analogous figures are $130 million and 1,060 engineers (using 1978 revenue/engineer).

It is estimated that 10 per cent of the domestic market for consulting engineering services is now supplied by imports. Thus it is estimated that in 1980 imports totalled $190 million and accounted for a demand of approximately 1,285 engineers.

It is assumed that the portion of the demand now being met by the importation of engineering services will grow at a rate equivalent to the growth in the projected stock of persons in the engineering occupations (Table 7), i.e.,

	Total Engineers
1980	1,285
1981	1,365
1982	1,450
1983	1,530
1984	1,615
1985	1,700

Some data is available on employment authorizations for engineers on temporary assignments in Canada. The figures cannot be translated directly into people since individual authorizations can involve periods of three months to one year and an individual can receive more than one authorization (i.e., extensions and renewals). It has been estimated, however, that the average period represented by an authorization is four months. On this basis the following information can be imputed.

Year	Number of Employment Authorizations for Engineers*	Imputed Number of Engineer Manyears
1973	3,192	1,064
1974	3,006	1,002
1975	3,396	1,132
1976	3,105	1,035
1977	2,977	992
1978	2,683	894
1979	3,030	1,010
1980	2,957	986

*Source: Engineering Manpower News, No. 27, February 1981, CCPE.

While employment authorizations have been used by Canadian consulting engineers to supplement domestic resources, most of the temporary workers have been brought in by foreign firms. It is apparent that these resources constitute a significant percentage of the resources used by foreign firms who account for the importation of engineering services.

Total Canadian Demand

The foregoing requirements are summarized in Table 10. The indicated total demand figures are indicative of the element at the bottom of the chart in Figure 1.

Table 10

Total Canadian Demand for Persons in Engineering Occupations

	Base Line Demand (Table 7)	Major Project Demand (Table 9)	Export Demand	Import Demand	Total Demand
1980	75,100	-	250	1,285	76,635
1981	78,300	-	500	1,365	80,165
1982	81,500	2,220	750	1,450	85,920
1983	84,900	4,215	1,000	1,530	91,645
1984	88,300	4,890	1,250	1,615	96,045
1985	91,900	4,981	1,500	1,700	100,081

Given the data provided in Table 10 it is possible to calculate the number of new entrants required each year in

order to maintain a stock of persons in engineering occupations sufficient to meet any combination of the four individual demand categories. For example, Table 11 illustrates the number of new entrants required in order to meet the entire demand with indigenous resources.

Table 11

Estimated Stock of Persons in the Engineering Occupations Required to Meet the Entire Canadian Demand

	Total Engineers	Annual Increase	Replacement Demand*	New Entrants Required
1980	76,635	4,735	1,450	6,185**
1981	80,165	3,530	1,480	5,010
1982	85,920	5,755	1,485	7,240
1983	91,645	5,725	1,634	7,359
1984	96,045	4,400	1,673	6,073
1985	100,081	4,036	1,795	5,831

* For simplicity replacement demands have been assumed to increase pro rata with the increase in stocks over those shown in Table 7.

** The figure for new entrants in 1980 is based on the assumption that replacement of the entire amount of the import demand is accomplished in one year, which, of course, is not possible.

Total Canadian Demand for Persons in Related Engineering Occupations

With reference to the makeup of "engineering personnel" described in the section on Methodology above, it is possible to impute the probable demand for persons in related engineering occupations. Tables 12 and 13 provide imputed projections based on these ratios and the data in Table 10.

Table 12

Total Canadian Demand for Non-Engineer Professionals in Related Engineering Occupations

	Base Line Demand	Major Project Demand	Export Demand	Import Demand	Total Demand
1980	16,238	-	54	278	16,570
1981	16,930	-	108	295	17,333
1982	17,222	480	162	314	18,178
1983	18,357	911	216	331	19,815
1984	19,092	1,057	270	349	20,768
1985	19,870	1,077	324	368	21,639

Table 13

Total Canadian Demand for Engineering Technicians and Draftsmen in Related Engineering Occupations

	Base Line Demand	Major Project Demand	Export Demand	Import Demand	Total Demand
1980	111,635	-	372	1,910	113,917
1981	116,392	-	743	2,029	119,164
1982	121,149	3,300	1,115	2,155	127,719
1983	126,203	6,266	1,486	2,274	136,229
1984	131,257	7,269	1,858	2,386	142,770
1985	136,608	7,404	2,230	2,527	148,769

These projections assume that the relative proportions of engineers, other professionals and technical staff remain the same throughout the forecast period. Technological change would have an effect upon this mix and would change the projections accordingly.

Supply/Demand Balance

Conclusions on the probable supply/demand balance can be made for engineers only due to the lack of adequate supply data for the other components of engineering personnel.

From the section "Projected Supply of New Graduates" above, it is found that the projected supply of new graduate engineers over the six-year period from 1980-85 is 38,040. This figure includes an allowance of 9,000 immigrant graduates, based on historical levels.

The data shown in Table 8 indicates that the combined baseline requirement for new graduates over the same six year period is 45,500. Thus there is a projected shortfall of 7,360 or 1,227 engineers a year just to meet the baseline demand.

A comparison of Tables 7 and 11 provides an estimate of the additional new entrants which would be required to meet the other demands which are summarized in Table 10. It is assumed that 80% of these new entrants would have to be graduate engineers and the resulting requirement for these additional graduates is summarized in Table 14.

Table 14
Requirements for Engineering Graduates
Resulting from Additional Demands

(1980-1985)

Demand	Additional New Entrants	No. of Engineering Graduates	Average Annual Requirement
Export	1,582	1,266	211
Major Projects	5,254	4,205	701
Import	1,793	1,434	239
Totals	8,629	6,905	1,151

It is apparent from these comparisons that, even with the continuation of historical immigration levels, there will be a significant shortfall in Canada's ability to meet the baseline demand for graduate engineers. When additional demands are considered, it seems clear that Canada will continue to place short-term reliance on imported engineering services to meet the near-term demands.

Capacity of the Canadian Consulting Engineering Industry in Relation to Supply of and Demand for Engineering Personnel

Reference to the data given in Table 4, and the Stats Can surveys of 1974[a] and 1978[b] indicates that the Canadian Consulting Engineering Industry has accounted for 18.2% (1974) to 14.6% (1978) of the Canadian stock of persons in the engineering occupations. Similar ratios can be imputed for persons in related engineering occupations.

It is estimated that the industry in 1980 accounted for 16.7% of the Canadian stock of persons in the engineering occupations and 16.4% of the total Canadian demand for persons in Engineering Occupations. In order to maintain this market share the industry would have to grow at an average annual rate of 5.7% to 1985. This rate is consistent with the projections of the Barnard Report of March 1981.[c]

This growth rate, however, would be sufficient only to maintain the same share of the baseline demand and accommodate the export demand. No penetration of either the major project demand or the import demand could be made at this growth rate without giving up a share of the baseline demand and/or foregoing growth in export demand.

If the industry were to secure a 50% share in the major project demand by 1985 while maintaining its share of the baseline demand and export demand, it would have to grow by a further 24% over the period for a new average annual growth rate of 9.2% Since the first two years of the period have already been experienced, probably at growth rates of less than 9%, the next three years will have to see even higher growth rates in order to accomplish such a target.

Sources: (a) Consulting Engineering Services, 1974, Statistics Canada
(b) Engineering and Scientific Services, 1978, Statistics Canada
(c) Consulting Engineering in Canada, An Update, Peter Barnbard Associates, page 22.

Apart from these considerations, any penetration of the market demand which now is represented by imported engineering would require even greater rates of growth.

Factors Favouring the Supply of Needed Engineering Personnel by the Canadian Consulting Engineering Industry

The shortfall in the supply of engineering personnel indicated in the previous section will have two main effects upon the Canadian market for these resources. The first will be a need for highly mobile and flexible individuals who are project oriented. The second effect is likely to be a lack of suitable personnel in the traditional baseline activities as engineering personnel migrate to the larger high profile and probably more lucrative activities. The Canadian Consulting Engineering Industry is well placed to meet the needs generated by these effects.

Mobility and Diversity -- Canadian Consulting Engineering firms have long provided the most mobile engineering resource that Canada possesses. Engineering personnel in the industry tend to be those individuals who seek challenges in diverse project types and locations. The track record accomplished by individual firms makes it possible for them to attract the kind of people who will be needed for Canada's growth.

Long-Term Career Prospects -- Employees of Canadian Consulting Engineering firms can look forward to long-term careers while enjoying the benefits of mobility and diversity. In this environment Canadian engineering personnel are more likely to remain in Canada rather than seek employment elsewhere when major projects wind down.

Geographical Representation and Local Knowledge -- Wherever engineering personnel are drawn away from traditional baseline engineering activities, a local consulting engineering firm that is able to furnish alternative engineering services to fill the gap will always be found.

Access to Worldwide Sources of Potential Immigrants -- The larger Canadian Consulting Engineering firms in particular have access to international sources of engineering personnel and are able to act quickly in circumstances where immigration is warranted.

Exportability of Skills -- It is essential that the new engineering personnel who are attracted by the major

projects are retained as part of Canada's permanent technical work force following completion of the major projects. This can only be accomplished by ensuring that there is a continuing market for their services and the key element in this process will be an increased export market. It is clear that the firms who are given the task of mobilizing the resources for the major projects must also be charged with the task of exporting the technology which has been gained in the process and thus retain the capability in Canada. Canadian Consulting Engineering firms have the capability, capacity and demonstrated experience in this field.

Factors Impeding the Canadian Consulting Engineering Industry's Ability to Meet the Demand for Engineering Personnel

Scheduling Uncertainty -- The recent period of uncertainty, in particular with respect to energy policy and revenue sharing, has made it difficult or impossible to carry out effective manpower planning. If Canada is to carry out a massive program of construction over the next two decades while maximizing the net benefit to the country it will be essential that such planning be allowed to go forward in a climate of reasonable certainty.

Emigration -- Canadian engineering personnel are emigrating in response to the more attractive remuneration and tax packages offered by foreign engineering projects. In particular, significant numbers of experienced Canadian engineers have been recruited by United States firms for work in the Middle East although this situation is expected to moderate in reaction to improved tax treatment for U.S. citizens employed abroad.

Immigration -- Canadian immigration policies should be directed toward recognizing shortages in the engineering personnel categories and should permit block approvals in approved categories in response to initiatives taken by Canadian firms.

Need for Coordination of Government/Industry Efforts -- The Canadian Engineering Manpower Council (CEMC) is recognized by the Canadian engineering profession as the focal point for the coordination of efforts on engineering

manpower planning. The CEMC recently published a statement setting out its intentions in this area.[a]

On November 1, 1981, the Canadian Council of Professional Engineers (CCPE) signed a memorandum of agreement[b] with the Canada Employment and Immigration Commission (CEIC) covering their cooperative efforts to ensure the continuing supply and quality of engineering manpower in Canada.

The Canadian Consulting Engineering Industry has the opportunity, through the CEMC, to make an active contribution to the manpower planning process.

RECOMMENDATIONS

Recommendation 42

That the Canadian Consulting Engineering Industry give active support and assistance to the Canadian Engineering Manpower Council (CEMC) in the establishment of the Canadian Engineering Manpower Inventory (CEMI) and in carrying out its manpower planning role.

Recommendation 43

That the current Major Projects Inventory and Manpower Forecast be updated by the Department of Regional and Industrial Expansion yearly and thereafter published.

Recommendation 44

That Canada's facilities for graduating engineers from universities and engineering technicians from colleges be reviewed with reference to the foreseen requirements for these personnel and steps be taken to increase capacity.

Sources: (a) A Statement on Engineering Manpower, January 1982, Canadian Engineering Manpower Council.
(b) Memorandum of Understanding between the Canadian Council of Professional Enginners and the Canada Employment and Immigration Commission.

Recommendation 45

It is recommended that:

a) The Minister of Employment and Immigration be urged to adopt the recommendation of the Task Force on Labour Market Development[a] to make adjustments "in policy, procedures and resources related to both domestic and overseas elements of the immigration system to permit prompt and accurate identification of foreign skill requirements and to recruit and process ... immigrants to meet specific labour market needs".

b) The Canadian Consulting Engineering Industry arrange liaison with the Minister of Employment and Immigration to identify the industry's requirements and the sources available.

Recommendation 46

That the Canadian Employment and Immigration Commission (CEIC) consider ways in which Canada might mobilize its latent engineering personnel resources as represented by qualified engineers and allied technical personnel who are employed in non-engineering occupations.

Source: (a) Labour Market Development in the 1980's, a report of the Task Force on Labour Market Development, July 1981, page 205.

CHAPTER XI

THE FUTURE

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THE FUTURE

Throughout its lengthy history the Canadian Consulting Engineering Industry has made rapid and extensive progress. Led in many instances by exceptional individuals, supported by excellent engineering schools and benefitting, especially in Quebec, from the enlightened contracting-out policies of public agencies, the industry today is highly developed and self-assured in its capabilities, several of which extend to world leadership in important industrial sectors.

What then of the future of this industry? With what degree of confidence can the industry itself regard its future? What directions will its development take in terms of its structure and performance at both the level of the sector and the level of the individual firm? And, perhaps most importantly, how will the industry maximize its contribution to the economy of Canada in the next ten or twenty years and in the distant long term.

By any standard of measurement, the future of Canada's Consulting Engineering Industry must be regarded as very bright indeed. Even in this current economic recession which is creating unprecedented hardship for the industry in all ranges of company size and in all locations in Canada, the industry's leaders look to the future with great confidence.

Their confidence is well founded. Its basis is both explicit and implied in this report. Its ingredients include first rate technological capability and competitiveness in an extensive range of industrial activity which the industry is called to address; strong marketing orientation; widespread international acclaim and respect not only for spectacular achievements as exemplified by the Canada Manipulator Arm for the Columbia Space Shuttle, but for the efficient, effective completion in distant locations of myriad assignments, great and small, that have extended the reputation of Canadian firms far beyond the locale of the individual project.

Among other considerations upon which this confidence is based and nourished are the following. First, the immense amount of work available to the industry from major developments expected to commence in Canada during the next twenty years. These can and will provide the

industry with a series of launching pads to new heights of advancing technology and managerial skills that will border on being unique.

Second, the fact that the Canadian industry is strategically positioned to offer leadership in engineering services to a world where the great majority of people endure comparatively low living standards but whose aspirations demand geometric progress toward adequate food and potable water production, supply and distribution, good shelter and, in general, municipal and health services comparable with those of Western societies. In this milieu Canada's moral credibility is an attribute of outstanding importance, and consequently Canadian firms have often demonstrated a facility to offer North American technology with political and cultural empathy that is appreciated in developing countries.

Third, Canada's technical colleges and universities comprise a structure ranking high on the list of such institutions among advanced countries. This institutional structure has supported the industry's need for graduates with increasingly higher educational attainments in the past and is well structured to continue and expand its essential contribution. Moreover, the managements of these institutions appear to have a full appreciation of the role of today's engineering graduates and of the requirement for expansion of engineering training to meet future needs.

Fourth, the Canadian Consulting Engineering Industry appears to be better served than most by its professional and business associations. The Association of Consulting Engineers of Canada, the Canadian Council of Professional Engineers and the Engineering Institute of Canada deserve particular reference. The industry's professional and business groups have been extremely effective in helping to foster the kind of climate that is most hospitable to its development.

Against this background, how will the industry structure itself in order to meet future challenges in ways that will fully justify the confident attitude of its present leaders?

One of the outstanding characteristics of the Canadian Consulting Engineering Industry is its flexibility in terms of its survival, growth and adaptability to change. These characteristics will become in all likelihood much more apparent in the future, which, it is anticipated,

will be subject to new political and market trends. While this report was being written, when world oil scarcity turned to an oil glut, interest rates soared to previously uncharted heights and several major military conflicts began and continue to rage in widely separated geographical locations.

The flexible attitude of Canadian firms to the domestic and world marketplace in the face of changing market conditions and requirements will become in a structural sense more important than ever to the welfare of the industry. This attitude will be characterized by flexible manpower planning corresponding to changing objectives within the industry and the individual firm. It will mean a rapid growth in the number of firms with specialist expertise. The maintenance of "in-house" specialist expertise by government and industry clients will become increasingly the exception rather than the norm. The resultant structural change will meet the growing need for greater technical competence while at the same time contributing to the industry's competitive edge. Also, the necessity to assuage, as far as possible, the Canadian and worldwide scarcity of superior expertise will be served by this change in structure.

Such structural change in the industry will lead to change in the firms where flexible attitudes to corporate purpose and objectives will alter the traditional view of Canadian consulting engineering. Greater appreciation of the need for applications of specialist technologies and methods by the "engineer's engineer" will reinforce this tendancy. One of the more visible areas, in this context, is the burgeoning utilization of computers in practically every aspect of engineering design and drafting and in the spectrum of activities associated with the realization of large projects downstream of the engineering and drafting stage.

At the level of the individual firm there appear to be two clearly discernible trends, the inevitable rise of local firms, and the growth through corporate mergers of large engineering enterprises. The first trend will include many specialist operations but will also reflect Canada's regional developmental policies as well as the servicing of local needs in the vicinity of major developments. The growth of large engineering enterprises is already a well established trend. Through the process of corporate mergers within Canada and across national borders, several of the world's largest engineering concerns are now based in Canada and they continue to expand.

The profile of the senior management of these so called engineering enterprises is expected to change with greater emphasis being placed on managerial skills including cost effective use of financial and physical resources. They will differ greatly from the many firms which are still expected to follow the traditional route of the owner practitioner.

There are at least two schools of thought about the expansion of the large corporate "giants" of the industry into the engineer/procure/construct (EPC) mode of operations. Some contend that it is a logical extension of the industry's development to increasingly assume EPC responsibilities. Indeed there is considerable evidence to this effect in the emerging structure of some larger firms. Others, with equally solid logic, contend that most firms, even those in the top 40 list, will not be willing to share or assume construction and supply risks, nor will they be tempted by diversification into ownership and control of other activities such as manufacturing and finance.

Based on what has happened in other parts of the world it seems justifiable to forecast a growing trend toward the development of a strong EPC capability in the Canadian Consulting Engineering Industry. It would seem that the future demands of both the domestic and international markets will dictate significant needs for Canada's consulting engineers to provide EPC services. The attributes of flexibility that have characterized the industry's development in the past can be counted upon to ensure that the appropriate paths will be chosen in the future.

In terms of performance, the Consulting Engineering Industry of Canada has built and retains a solid credibility from its domestic and international achievements. Today, the industry can compete with confidence in nearly every sphere of industrial activity in Canada with excellent expectations of success. Abroad the multilateral lending and development agencies have become accustomed to the uniformly high competence of Canada's consulting engineers, and firms can approach these agencies in the knowledge that the solid performance record is recognized and highly regarded.

For this well-won reputation to be sustained and nurtured to the more general benefit of the industry requires two conditions, improved profitably and enhancement of the climate in which the industry operates. The importance of

"climate" can scarcely be over emphasized in any consideration of the future.

An appropriately hospitable climate will require not only vigilance on the part of the industry but recognition, especially by governments, of the industry's potential to dramatically increase its contribution to the country's economy. The policies of governments and major industrial and crown corporations and their respective agencies, as they apply to the use and support of Canadian consulting engineering capabilities in both domestic and export endeavours, will be of vital importance. Also important, will be the degree to which those policies provide for contracting-out to Canadian consulting engineers, work which they have previously been doing with employed staff. Under present economic conditions it is becoming increasingly more costly to maintain such in-house expertise. Greater efficiency can be achieved by engaging consultants.

The performance by the Canadian Consulting Engineering Industry of research and development work as a continuing, integral part of its operations will take on added significance. The often articulated research and development objectives of the government, together with the appreciable reservoir of research and development capability in Canada's consulting engineering community, hold opportunities of high potential in terms of meeting the government's objectives and of contributing to the future development of the industry domestically and internationally. This means a highly satisfactory condition for both government and the industry. On the one hand, the prospects for achieving government objectives will be enhanced and additional rewarding jobs provided for Canadians, and on the other, a valuable contribution will be added to the growth of specialist expertise in the industry.

Summary

As noted, the climate within which the industry must work is crucial to its ability to maximize its contribution to the economy in the coming years. It is therefore essential that both the industry and governments work energetically and cooperatively to help ensure that the right climate is established and is continued.

The main factors contributing to a desirable climate are:

- a general recognition of the potential of this industry to provide highly satisfying jobs to Canadians whose educational attainments lead to expectations of such jobs;

- a recognition on the part of governments of the industry's potential for economic growth and for contributing to the economic well-being of other industrial sectors;

- a full appreciation of the industry's ability to help achieve the government's stated research and development objectives; and

- a general appreciation of the industry's potential for generating export sales of goods and services following its export assignments.

If these climate-influencing factors are allowed full sway the industry's potential will be realized.

In this realization there will be a continuing trend, especially through corporate mergers, toward the development of large broadly-based firms, national and international in scope and outlook, and having in some instances fully developed EPC capabilities.

Medium-size firms and smaller firms will also characterize the industry and will pursue traditional municipal and infrastructure work but there will be significant growth in medium and small firms with specialized expertise.

The industry will develop major profit earning centres in the field of research and development while its export assignments may be expected to level off at about 25% of total billings.

Building upon their considerable credibility in international markets and further cultivating the export dimension so essential to the industry's prosperity, skillful exporters of engineering services will organize themselves increasingly in ways that reflect a full understanding of export marketing and experience gained in the profitable performance of contracts abroad. Where and by whom the work is carried out, will be dependent upon successful marketing and contract performance and, of course, the bottom line.

Also in its export work the industry will become increasingly sensitive to the need for opening

opportunities to additional exports of goods and services, thereby multiplying its contribution to Canada's economy.

The result can be an industrial sector increasingly respected both nationally and internationally for its reputation of achievement and an industry that in terms of its contribution to Canada can be the model to which other sectors may aspire.

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