VISION 2000

INTERNATIONAL R&D COLLABORATIVE PROGRAMS

Department of Communications
Communications Development & Planning
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INTRODUCTION

Since the early 1980's there have been a number of collaborative research and development programs (between industry, government and academia) in information and communications technologies, initiated mostly in Japan, Europe and the U.S. These research programs are generally aimed at the pre-competitive level, i.e. generic research areas rather than specific product developments. For the most part programs in Japan and Europe have been initiated and led by government, with considerable financial support. Programs in the U.S. have been generally led by industry although, in many cases, Department of Defence has provided substantial funding.

Japan was the earliest country to start such programs through its Ministry of International Trade and Industry (MITI). These programs are believed to have had considerable success in terms of enhancing Japanese Industry's competitive situation. For example, their joint industry-government VLSI program of late 1970's is believed to be responsible for Japanese current world leadership in semi-conductor technology.

Even though Japan had a number of joint R&D programs in the late 1970's, it was the announcement of the Fifth Generation Computer System (FGCS) project in 1981 that had a dramatic impact in Europe and the U.S. in terms of initiating similar programs such as ESPRIT (European Strategic Program for Research and Development in Information Technology) and Alvey in Europe and MCC (Microelectronics and Computer Technology Corporation) in the U.S. The positive results achieved by these initial programs in terms of increased R&D activity and cooperation among various industrial, government and academic players subsequently led to many other similar programs such as SEMATECH (Semiconductor Manufacturing Technology) in the U.S. and RACE (Research and Development in Advanced Communications Technologies in Europe) and JESSI (Joint European Submicron Silicon) in Europe.

This note describes these programs in terms of their background rationale, program objectives, research areas, program budget and time frame, program assessment and implications for Canada if any. Based on the discussion of these programs, a number of initial observations and conclusions are drawn as to whether Canada should also respond in terms of similar program taking into account our similarities and differences with other countries. Annex 1

summarizes these programs in terms of tables and. Annex 2 gives the selection criteria and the process of consensus building for various programs.

It is expected that the information provided in this note will be useful in the preparation of the Vision 2000 MC.

EXECUTIVE SUMMARY

A. BACKGROUND AND RATIONALE

Japan was the earliest country to start collaborative R&D programs in the 1970's. These programs were little known at the time outside Japan.

The announcement of the Fifth Generation Computer Project by Japan in 1981, aimed at developing the next generation of computers for the information society of the 21st century, had dramatic impact in Europe and the U.S. in terms of initiating similar projects.

U.S. companies dominate the area of information technologies (IT). In 1981, of the top twenty IT companies worldwide, U.S. companies had a market share of 80 %, the rest being split between Europe and Japan. Japan's rationale to start the Fifth Generation project was simply an effort to catch up with the U.S., whereas the U.S. and Europe saw it as a Japanese design to dominate the computer field.

Although, in overall terms, U.S. companies have always dominated the market for information technology products and services, Japan has made significant inroads in certain specialized areas such as semiconductor chips. This has created somewhat of a fear of Japanese domination and the U.S. industry has responded in terms of collaborative R&D programs such as MCC and SEMATECH.

European companies have always done poorly in information technology in terms of market share. In fact, they command only about 40 % of their own (European) market. This factor, plus the perceived strategic importance of information technology to the information economy, and the foreign initiatives have all been driving forces behind most of the European initiatives such as ESPRIT and ALVEY.

Although the U.S. government does not directly fund industrial R&D, it spends huge sums of money through DOD on research which is carried out by private industry. For example, DOD, through its Strategic Defence Initiative (SDI) program, has already spent (between 1984-1989) $ 15 billion on the Definition Phase alone and expects to spend up to $ 57 billion by 1993 to complete the definition phase. A further $ 250-$ 450 billion will be spent on developing the system in case the Definition Phase results in a positive decision. Even though such R&D is aimed at developing products and systems for defence, there are considerable civilian spin offs. Europeans and Japanese see this as an

unfair advantage to the U.S. companies and have, therefore, started collaborative programs to provide an equivalent competitive advantage to their industry. In fact, EUREKA was initiated by Europeans as a direct response to SDI.

Firms are thought to require collaboration to achieve the scale necessary in research and in market size. For example, to successfully compete in the telecommunications switching market, it is believed that a company should have at least 10 % of the world market to allow it to undertake the necessary R&D.

Most R&D programs are in the area of computer technology. More recently, programs have been started in communications technologies as well. The most notable in this regard are the RACE program in Europe and Frontier Program in Japan. These are forward looking programs and are aimed at developing the next generation of integrated and broadband systems of Communications needed for the 21st Century.

B. INTERNATIONAL R&D COLLABORATIVE PROGRAMS

WESTERN EUROPE

ESPRIT (European Strategic Program for Research and Develoment in Information Technology)

Esprit is a ten year program (1984 to 1992) of collaborative pre-competitive research in information technology. The program is co-founded by the European Community and organized in close cooperation with industry, national governments and academic research community.

Phase I (1984 to 1988) of the program cost the Commission $ 1.1 billion (Cdn) with matching funds from industry. For the second phase (1988 to 1992), the community has set aside $ 2.2 billion (Cdn) with equal contribution from industry.

RACE (Research and Development in Advanced Communications Technologies in Europe)

Race is a European initiative in the field of telecommunications.
It's aim is to develop key technologies required for the introduction of an Integrated Broadband Communications (IBC) network in Europe by 1995. A total of $ 700 million (Cdn) will be spent by the Commission

over five years (1987 to 1992) with matching funds from the private industry.

ALVEY PROGRAM

The Alvey program is a five year program of pre-competitive, collaborative research in information enabling technologies which started in 1983. It is sponsored by the Department of Trade and Industry (DTI), the Ministry of Defence (MOD) and the Science and Engineering Research Council (SERC), together with Industry. Total government funding is $ 400 million (Cdn) over five years with industry contributing a further $ 300 million.

EUREKA (European Research Coordination Agency)

Eureka was triggered in large measure as a response to the United States Strategic Defence Initiative (SDI) which was announced in 1983. Even though SDI is a defence initiative, it is expected to help the U.S. industry through its huge budget. A sum of $ 15 billion has already been spent and if the program continues, an estimated $ 300 to $ 500 billion will be spent over the next ten years. Eureka was initiated by European governments in order to put their companies on equal footing with their American counterparts.

EUREKA contributes no funding to the projects. The partners are expected to arrange the entire funding through their own means and/or assistance provided to them through their respective governments and European Commission. Public funding (on average 35 % to 40 %) varies from one country and project to another. As of June 1989, 297 projects have been approved with funding commitment of $ 6.4 billion ECU ($ 8.96 million Cdn) over a number of years depending upon the project duration. Approximately, 1600 firms and research institutes are involved with these projects.

DELTA (Development of European Learning through Technological Advance)

Delta is a collaborative research and development program of the European Community, aimed at advancing the use of communications and informations technologies in education and training. Phase I, called the Exploratory Action, was approved by the Council of Ministers in June 1988. The actual work started in March 89, and Phase I is expected to be finished in two years. Depending upon the results of Phase I, the main phase will be undertaken in 1991.

The Commission will contribute $ 20 million ECU ($ 28 million Cdn) for Phase I (March 89 - March 91). This amount represents half of the cost of projects to be launched. The other half would come from project partners in the commercial, public and academic field. DELTA projects require the participation of at least two independent partners in two different member states. One of them must be a commercial enterprise. Also one partner must represent the requirements of learning. Research to be carried our under DELTA must be pre-competitive meaning that cooperation aims at the development of emerging technologies rather than at the development of marketable products.

JAPAN

Frontier Research in Telecommunications for the Twenty First Century

The Ministry of Post and Telecommunications began its program of frontier research in 1988. The program's objective is to meet future telecommunications needs which includes communications of any type of information anytime, anywhere and with anybody with easy to use user interfaces.

The Fifth Generation Project

In 1981, the Japanese Government announced that it will spend $ 450 million (U.S.) over the next decade with industry contributing $ 400 million to develop the next generation of computers - computers that will be able to converse with humans in natural language and understand speech and pictures. These will be computers that can learn, make decisions and otherwise behave in ways we have always considered the exclusive province of human reason.

THE U.S.

Strategic Defence Initiative (SDI)

Officially called the U.S. Strategic Defence Initiative (SDI), Star Wars became a prominent issue in March 1983 when President Reagan announced a long-term research and development program to begin to achieve our ultimate goal of eliminating the threat posed by strategic nuclear missiles.

Following the speech, a defence technology study team, known as the Fletcher Panel, was established to define a long-term research and development program aimed at eliminating the ballistic missile threat. In January, 1984 the Secretary of defence established a research program based on the Fletcher Study and called it the Strategic Defence Initiative.

Approximately $ 15 billion has already been spent on this project between 1985 and 1989. It is estimated that up to $ 57.5 billion (including $ 15 billion spent already) will be spent before an informed technical decision could be made in 1993 whether to proceed to full scale engineering development of the system.

If it is decided to proceed with the system, there will be three phases. The total cost of all phases is expected to be between $ 250 and $ 450 billion. Phase I will take about ten years.

SEMATECH (Semiconductor Manufacturing Technology)

SEMATECH is a consortium of American semiconductor manufacturers working with government and academia to sponsor and conduct research aimed at assuring leadership in semiconductor manufacturing technology. Results of this research will be transfered to consortium members who will use them for commercial and military applications.

SEMATECH has an annual budget of $ 200 million with half of the funding provided by member companies and half by federal government (DOD). The government involvement helps to offset the considerable advantage enjoyed by foreign companies who have benefited from a variety of assistance provided by their respective governments.

MCC (The Microelectronics and Computer Technology Corporation)

MCC was launched in 1982 as a permanent institution, explicity as an American reaction to the Japanese Fifth Generation Project by ten U.S. companies : Control Data Corporation, DEC, Honeywell, National Semiconductor, Motorola, NCR, RCA, Sperry, Harris and Advanced Microdevices. IBM, AT&T and Texas Instruments are not part of this consortium. MCC is not only a reaction to the Japanese initiative, it is also an effort by U.S. medium-sized companies to compete against the industry giants such as IBM.

The stated objective of the MCC is to strengthen and sustain America's competitiveness in information technologies through application driven research, development and timely deployment of innovative technology.

MCC's research programs share a common goal - provide the technology necessary to make computers, applications and processes faster, more reliable and capable of performing more complex tasks at a higher level of quality and at a much lower cost. It's annual budget is approximately $ 400 million.

C. HAVE THESE PROGRAMS BEEN EFFECTIVE?

The total resources committed to these programs are fairly small compared to R&D budgets of individual private companies (less than 5 % of the R&D budgets of private companies). Their main effectiveness has been the marked increase in collaboration and cooperation and the development of a collaborative culture.

Standards is an obvious area which benefits from increased collaboration. Acceptance of common standards, of course, opens up wider markets to individual companies and affords them the economies of scale.

A number of evaluations have been carried out for these programs and they have generally given a positive endorsement. Also a number of new programs have been started as a result of the success of the earlier programs.

D. WHERE DOES CANADA STAND?

Currently we have a number of small scale government led initiatives aimed at enhancing the competitiveness of our industry through increased R&D. The Strategic Technologies Program of ISTC in information technology, $ 30 million is available over five years (1989 to 1993) to support the formation of alliances among information technology firms, users and universities to conduct pre-competitive research and development and to undertake pre-commercial technology applications. The Artificial Intelligence R&D fund ($ 10 million over five years) also administered by ISTC, is aimed at enhancing the international competitiveness of our AI industry. The fourteen Networks of Centres of Excellence announced in 1988 and to be implemented in 1990 will have a total budget of $ 240 million spread over five years. The program is aimed at long-term research to be carried out mostly by Canadian Universities in consultations with the industry. One of these networks called the Telecommunications Research Institute, will have an approximate budget of $ 15 million and will deal with broadband and mobile communications.

The government of Ontario established a Premier's Council in April 1986 to assist in developing long-term strategies for improving the provincial economy. The Council has developed a number of programs which are now operating under the $ 1 billion Technology Fund, to be spent over ten years (1986 to 1996).

Quebec's strategy for supporting R&D by the private sector has been to establish a number of programs and the tax system to bolster technological development in Quebec

Of all these programs, the Technology Development Fund, which will receive funding of $ 300 million over 1989 to 1994, is the most relevant to Vision 2000 type projects.

The federal government established a five-year western diversification fund of $ 1.2 billion to diversify the economic base of the four western provinces. Assistance for R&D needed to develop a specific product and or service would be considered under this fund. A similar fund ($ 1.05 billion over five years) has been set up for the four Atlantic provinces.

E. IMPLICATIONS FOR CANADA

Compared to the international collaborative R&D programs, the Canadian programs are on a much smaller scale, fragmented across various subject areas and lack a national focus in many cases. A logical question is : "Should we be concerned?". If we analyse our situation, we find that our concerns are not the same as those of U.S., Japan and Europe. The areas of computer and communications are analysed separately below :

Computer Industry

The U.S, is an information technology giant. Japan and Europe have considerable strengths. Canada has very little indigenous capabilities. In fact, Canadian companies receive only 30 % of our market share for information technology products and services and this is mostly in the area of software and services and retail distribution. Our share of the hardware sector is very small - less than 5 %.

Canada does not have an indigenous computer hardware industry which needs government support (we are not a player in the game).

Considering Canada's industrial strengths and weaknesses, it is, therefore, concluded that programs aimed at general purpose semiconductors or computer hardware will not provide us with the biggest bang for the buck.

Communications Sector

Our situation is different in communications technology. We do have a strong domestic capability. In fact, we have generally had a trade surplus in the communications sector. At present our trade balance, in this sector, is reported as either slightly positive or slightly negative depending upon the elements that are included in this sector.

Unlike the computer equipment market where 90% of the market (for the top 20 companies) is controlled by foreign companies, in the case of telecommunications equipment, over 90% of the market is controlled by Canadian companies.

In the case of computers, 65 % of the software market is also controlled by foreign companies whereas in the case of telecommunications, service suppliers are mostly Canadians.

Both information and communications technology are considered as strategic not only in terms of being big industries but also being critical to the competitiveness of the other economic sectors. Given that we are fairly weak in the computer technology area, it is imperative that we maintain our strength in the communications technology area.

Considering the number of collaborative R&D programs undertaken by our trading partners and their demonstrated effectiveness in terms of increased cooperation and collaboration and beneficial side effects such as common standards, we cannot simply sit still.

Given our limited resources compared to the U.S., Japan and Europe, we cannot afford to undertake a broad program aimed at basic research, without some degree of market focus. Our resources will be utilized more effectively in terms of a more focused, applications oriented program.

The area of mobile communication has been the largest growing sector of communications. In fact, its recent growth rates have been considerably more than were forecast by many industry pundits. This area is expected to continue to grow at a very high rate over the foreseeable future.

CONCLUSION

In recognition of the strategic importance of information and communication technologies, many developed countries have instituted national and international collaborative R&D programs in these areas. Although the monetary resources allocated to these programs are quite small compared to what is spent by private industry, they are not insignificant especially when we consider that they are focused in specific areas. In addition to advancing the development rate of technologies, these programs have many other useful effects such as fostering collaboration among industry, university and government and common standards.

When we study the rationale for instituting these programs, we find that the same rationales apply to Canada. While we cannot simply argue for a "Me Too" approach we also cannot ignore all these initiatives.

Based on the analysis of these initiatives and analysis of our C&I industries, a case can be made for a collaborate R&D program in Canada. While information technology is very important, we do not have an indigenous computer hardware and are fairly weak in the computer technology area, except for software and services industry. In communications technologies, Canadian firms predominate and mobile communications is the highest growth area. Unlike fixed communications where a large R&D effort is spent by BNR, there is no equivalent R&D effort in mobile communications. Thus a collaborative R&D program in mobile communications may be an appropriate Canadian response.

The purpose of such a program would be to assist our industry to stay competitive and obtain a larger share of an increasing international pie.

COLLABORATIVE R&D PROGRAMS IN WESTERN EUROPE

ESPRIT

European Strategic Program for Research and Development in Information Technology

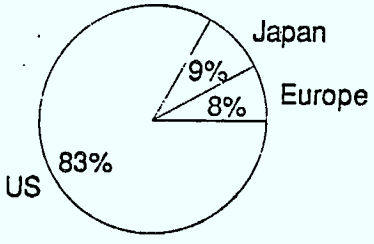
BACKGROUND

Esprit is a ten year program (1984-1992) of collaborative pre-competitive research co-funded by the European Community and organized in close co-operation with industry, national governments and the academic research community.

In order to appreciate the context in which Esprit originated, it is constructive to look at Table 1 which gives the market shares of the top twenty manufacturers of information processing products, worldwide.

Table 1

Market Shares for the 20 largest Worldwide IT Manufacturers, 1983



Total Market = $75 Billion

Source : A. D. Little

In 1983, the European companies (Siemens, ICL, Olivetti, Nixdorf, Bull) had a share, of only 8 % as opposed to the U.S. companies which had a combined share of 83 %. Even in Europe itself, the European companies commanded less than 40 % of the market share.

The poor performance of the European IT industry in light of perceived strategic importance of this sector to the European economy and the announcement of the Japanese initiatives in the area were the driving forces for the launch of this program.

ESPRIT OBJECTIVES

1. To provide the European IT industry with the basic technologies to improve their market share.

2. To contribute to the development of international standards. Standards are important strategic marketing tools. For example, IBM has been fairly successful over the past years in locking customers to the use of IBM products through its proprietary standards. The European companies see OSI (Open System Interconnect) as a competitive strategy to break into IBM shops and to thus increase their market share.

3. To promote European industrial co-operation in precompetitive R&D.

PROGRAM FUNDING

Phase I of the program cost the Commission $ 1.1 billion (Cdn) over the first five years (1984-1988) with matching funds from industry. Thus the annual government cost was $ 220 million for the twelve member community or $ 18 million per country, per year.

This is a small amount compared to private industry's own R&D budget. The R&D budget of IBM alone is something like $ 4 billion plus per year. For the second phase, (1988-92), the community has set aside $ 2.2 billion (Cdn) for five years with equal contributions from industry.

Although ESPRIT II is a larger scale operation, it still preserves the mechanisms used in ESPRIT I; the cost-sharing between community and partners, the consensus-building, the workplan and the on-going assessment principles. The following tables show the national participation in ESPRIT.

Participation by Nationality in Esprit I 1983-1987

Country	Projects	% of Total Projects
UK	154	68.4
France	154	68.4
Germany	127	56.4
Italy	96	42.7
Netherlands	49	21.8
Belgium	49	21.8
Denmark	31	13.3
Greece	22	9.7
Spain	15	6.6
Portugal	6	2.4
Ireland	3	1.2

Esprit I total Projects = 225

Source: Esprit Data Bases

Note: Larger countries and companies are the biggest participants. Projects must include partners from more than one European country.

Participation by Nationality in Esprit II 1988-1992
(In First Year)

Country	Projects	% of Total Projects
UK	121	79.1
France	116	75.8
Germany	108	70.2
Italy	77	50.1
Netherlands	57	37.0
Belgium	34	27.1
Denmark	25	16.3
Greece	42	27.3
Spain	72	46.8
Portugal	28	18.2
Ireland	31	20.2

Esprit II total projects = 153

Source: Esprit Data Bases

RESEARCH AREAS

Esprit projects are funded in the following areas :

Microelectronics
Software Technology
Advanced Information Processing
Office Systems
Computer-integrated Manufacturing

While the research areas for ESPRIT II are same as those for ESPRIT I, ESPRIT II emphasizes more applications specific projects as is shown in the following table :

Distribution of Esprit Projects by Function

	ESPRIT I 1983-87	ESPRIT II 1988-92
Pre-competitive R&D	65 %	53 %
Application Projects	23 %	35 %
Standards Setting	12 %	12 %

Source: ESPRIT Data Bases

PROGRAM EVALUATION

Program evaluation was done between October 1988 and May 1989 by a Committee chaired by A.E. Pannenberg, Vice-President of Phillips. The evaluation was based on interviews with 210 organizations, the analysis of 949 questionnaires, the support of external consultants as well as desk studies of published information. The following gives a brief discussion of evaluation results.

PROGRAM MANAGEMENT

The program was generally well managed. Each project was reviewed by independent experts at intervals of at least six months.

COOPERATION IN RESEARCH

The evaluation committee found the most striking result of the ESPRIT program to be the influence it has exerted on several thousand researchers and engineers in terms of increasing mutual cooperation. It has also created strong connections between university and industry.

CREATION OF STANDARDS

Twelve percent of all Esprit projects were devoted to standards and on this point, Esprit program helped European companies move from the rank of followers to that of leaders in the evolution of standards.

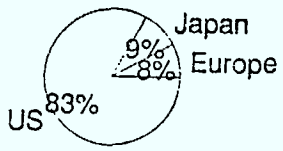
POSITION OF EUROPEAN INDUSTRY

The Committee notes that, in the area of microelectronics, the trade balance remained negative with no improvement. In the case of information processing products, the European companies still stayed weak.

Table 2 below shows the relative market share of the world's twenty largest worldwide manufacturers of information processing products for 1983 and 1988. While European companies increased their share from 8 % to 12 %, the Japanese companies increased their share even more, from 9 % to 21 %. It is hard to say whether the improved market share of European companies is due to the ESPRIT Program as there are other factors involved. For example, Honeywell, a major U.S. IT company was bought by Bull, a French company during this period, thus enhancing the European share.

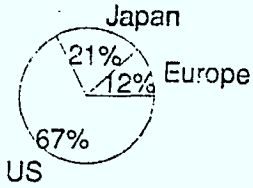
Table 2

Market Shares for the twenty Largest Worldwide Manufacturers of Information Processing Products



1983

Total Market: $75 billion



1988

$165 billion

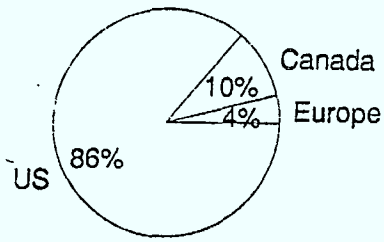
Source : A. D. Little

RELEVANCE TO CANADA

A. IT INDUSTRY

The market share for the top twenty Canadian information processing companies is shown below.

Table 3



Total 1988 Revenue = $ 7 billion

Source: Evans Research Corp.

Of the 10 % share for the Canadian companies, 5 % was due to a distribution company and the other 5 % was due to two computer service companies. In other words, the IT sector is almost entirely dominated by U.S. multinationals.

Thus unlike Europe, we do not have any significant IT companies whose market share needs to be increased. In other words (except for software and services) Canada is not a player in the computer technology game.

COMMUNICATIONS INDUSTRY

In the communications technology area, mobile communications has been the largest growth area. There are Canadian suppliers with a market share of 10 % to 20% of the total 1988 estimated market of $ 500 million or so. With the emergence of personal communications, a dramatic increase in equipment sales is expected in this sector. Our situation in mobile communications is somewhat similar to the European IT market structure - where the European companies have 40 % share of the European IT market. Thus a pre-competitive R&D program in mobile communications in Canada, such as Vision 2000 may help the Canadian companies to increase their market share.

RACE

(1987-1992)

RESEARCH AND DEVELOPMENT IN ADVANCED COMMUNICATIONS TECHNOLOGIES IN EUROPE

BACKGROUND

RACE is an European initiative in the field of telecommunications. Its aim is to develop key technologies required for the introduction of an Integrated Broadband Communications (IBC) network in Europe by 1995.

DRIVING FORCES

The following may be considered as the three driving forces responsible for the RACE initiative.

Economics

Telecommunications is an important sector of the economy. The worldwide market for telecommunications equipment is estimated by EC as $ 136 billion (Cdn); over $ 25 billion in Europe. Revenue from services is $ 420 billion worldwide and over $ 80 billion in Europe.

Technology

Technological developments especially in digital communications, VLSI, chips, and fibre optics are pushing the networks towards having higher capacity and more intelligence. While market demand for wideband services, remains illusory the telecommunication industry feels more and more obliged to investigate, develop and introduce such services over the evolving broadband networks. A consortia type approach rather than individual initiative is perceived as more appropriate in this kind of environment.

International Initiatives

A number of broadband initiatives have been underway for sometime in Japan and the U.S. The Information Network System (INS) was announced by NTT in Japan in 1983. Development of universal information systems by AT & T in the U.S. began in 1985. International bodies are already studying standardization requirements for broadband digital communications systems.

High Costs of R&D

It is becoming harder for individual companies to afford the required R&D to stay competitive. A collaborative approach seems an attractive solution.

Thus the initiation of the RACE program is in response to the above factors : economic significance of the telecommunications sector, technical developments, international initiatives and high costs of R&D.

PROGRAM OBJECTIVES

The overall goal of the program is the introduction of Integrated Broadband Communication (IBC) network, taking into account evolving ISDN, offering community wide services by 1995.

The following are other objectives of this program :

- To promote the Communities telecommunications industry equipment manufacturers and service operators.
- To support the formation of a single European market (through common functional specifications and standards) for all IBC equipment and services.
- To make new services available at a cost and on a timetable at least as favourable as in U.S. and Japan.

THE RACE BUDGET

The total investment by the Commission will be about $ 700 million (Cdn) over five years or $ 140 million per year or $ 14 million per year for member countries. These funds will be matched by the private industry for a total investment of $1.4 billion.

THE PROGRAM STRUCTURE

The RACE program consists of three concurrent parts, each involving a number of projects managed by international consortia of manufacturing companies, telecommunications operators and universities.

Part 1 : Definition Phase

The main objectives are to reach consensus on common functional specifications so that appropriate areas can be defined to pursue R&D work. About 10 % of the total funds will be devoted to this phase.

Part 2 : Technology R&D

About 70 % of total funds will be spent on cooperative precompetitive R&D in the development of required technologies such as optical switching and transmission. This phase will also contribute towards the formulation of common specifications and standards.

Part 3 : Pilot Applications

About 20 % of the effort will be spent on this phase.

Some of the specific RACE projects now underway are :

- Digital HDTV transmission
- Low cost flat panel displays
- Integrated optical networks
- Optical switching

Mobile Communications in the Context of RACE Program

Compared with the fixed network, public Mobile Communications are in their infancy, but they are evolving very quickly, driven largely by commercial pressures. Ideally any IBC (Integrated Broadband Communications) service available on the fixed network should also be available to the mobile user. However, frequency-spectrum and economic constraints limit the practical possibilities.

Mobile services are expanding dramatically as the cost of mobile terminals falls, and before the end of the century a low-cost pocket telephone will be both possible and highly desirable.

In terms of the RACE program, two of the 91 projects are in the area of mobile communications. These are described below:

1. The Race Mobile Project R1043

This project covers two main classes of mobile service :

•Universal Mobile Telecommunications System (UMTS)

To provide speech and low-to-medium rate data services. This aims to achieve virtually complete geographical coverage.

The UMTS concept is an approach within RACE which is expected to evolve during the course of the program.

•Microwave Broadband

To provide very high bit-rate connections to mobile units. Such systems cannot in the foreseeable future provide complete geographical coverage but will be important for certain specified applications.

2. Mobile Applications Pilot Schemes R1063

This project aims to establish four applications pilot shcemes. These pilots will demonstrate both the need for, and the utility of, the mobile aspects of Integrated Broadband Communications Network (IBCN).

It is intended that all the pilots will be led by users of mobile communications services rather than manufacturers or service providers and will be based on the use of existing technology. The four pilot projects will be undertaken in the following areas :

•Broadcaster's production communications/major event coverage;
•Courrier service
•Public utilities: operations and maintenance;
•Rail transport

PROGRAM REVIEW

All tasks are carried out by consortia of companies, administrations and universities with costs shared equally between the consortia and the Commission. Each project will be evaluated each year.

An independent strategic audit of the situation in Europe with respect to needs and opportunities for integrated telecommunications services

will also be commissioned each year. It will assess the prospects for development and implementation of an IBC network, taking into account other industrial developments, the economic and social climate, political constraints and opportunities.

A major review of the RACE program is scheduled for mid-1990, thirty months after its start, and a comprehensive report on the program and its results will be issued in 1993.

RELEVANCE TO CANADA

The same rationale (economic size of the telecommunications sector, technological developments and response to international initiatives) apply to Canada and indicate the need for a similar program in Canada.

Considering the uncertainty in the demand for broadband services and our limited resources, a program in personal communications, where the demand has been proven in the market place, would appear to be a better choice for Canada provided there are also other compelling reasons such as large technology risks, large R&D required and uncertain market demand.

ALVEY PROGRAM

BACKGROUND

In the autumn of 1981, the Japanese Government announced its support for a collaborative research project entitled "Fifth Generation Computing". Fifth Generation computers were intended to be speedier than previous generations, more powerful, friendlier and more intelligent in terms of the range of applications they could tackle. This announcement is usually described as the one event which set in motion the deliberations which led to the Alvey Program.

In terms of IT industry, the UK was doing fairly poorly. Import penetration had increased to 45 %. In terms of trade balance, a trade surplus of some $ 200 million in 1975 had become a deficit of more than $ 4 billion by 1983.

Other countries with more successful growth records than the UK, provided government support - often substantial - for industrial investment, R&D and innovation. It was recognized that the UK industry would be at a competitive disadvantage if UK government assistance were significantly less than that provided in other countries.

As a result of these factors, the UK government announced the Alvey Program, a five year program of pre-competitive collaborative research in information technology which commenced in 1983. The case for the Alvey Program rested on four assessments :

- IT is a strategic technology with the potential to increase competitiveness in a multitude of user sectors.
- It is desirable to have a indigenous IT capability.
- R&D capability in Information Technologies is vital to the existence of an indigenous capability.
- UK capability in IT enabling technologies was fragmented and weak and needed to be strengthened.

PROGRAM OBJECTIVES

- To increase the competitiveness of the UK IT suppliers.
- To assure a measure of self reliance in key technological areas for commercial and defence purposes.
- To strengthen the R&D base by rationalizing and uniting fragmented resources, particularly by encouraging industry and academia to work together.

PROGRAM BUDGET AND TIMING

The Alvey program is a five year program of pre-competitive, collaborative research in information enabling technologies which started in 1983. It is sponsored by the Department of Trade and Industry (DTI), the Ministry of Defence (MOD) and the Science and Engineering Research Council (SERC), together with Industry. Total government funding is $ 400 million (Canadian) over five years with industry contributing a further $ 300 million.

PROGRAM RESEARCH AREAS

The principal research areas for Alvey include :

- **Very large scale integration - VLSI**

  The rationale for the VLSI program was that the UK lagged behind in a crucial area of technology and needed to improve its international competitive position and maintain a strategic defence capability. The principal specific short term goal was the development of micron silicon capability at pilot production level.

- **Intelligent Knowledge Based Systems - IKBS**

  In the early 1970's, university funding for Artificial Intelligence (AI) was reduced. This lowered the British capability in AI. The goal of Alvey's IKBS program is to promote the growth of the AI technical community and coordinate industrial and academic research.

- **Software Engineering**

  The aim of the Software Engineering program is to provide an infrastructure within the UK for the provision of world-class software intended to support UK industry and increase its competitiveness.

- **Man Machine Interface (MMI)**

  MMI incorporates four sub-programs: Human Interface, Image Analysis, Speech Analysis and Displays.

PROGRAM EVALUATION

A series of evaluations have been conducted on the Alvey program. The most recent assessment was made in 1987. The following summarizes some of the findings of these evaluations.

- Alvey has lead to a marked increase in the scale and extent of collaboration between industry and academic institutions.

- The program had a significant affect on research activities in a number of areas.

- A more positive attitude has emerged towards involvement in government support programs.

- The emphasis on pre-competitive research was justified but there is now a feeling that this should be tied more closely with initiatives designed to support development and market stimulation.

- Most academics believe that Alvey has substantially accelerated and expanded their work.

- Alvey has catalysed and accelerated industrial research and has not in general substituted directly for previously ear-marked in-house funding.

- The most important impact has been the development of a collaborative culture. Also important have been the creation of an awareness of new technologies and information of research communities.

RELEVANCE TO CANADA

In Canada, information technology products are supplied primarily by foreign multinationals. The overall market share of Canadian companies is only 30 %. This is mostly in the areas of retail, consulting, computer services and software. In the case of hardware, over 90 % of the market requirements are met by foreign multinationals (IBM, UNISYS, DEC, APPLE, etc).

Although the rationale for instituting the ALVEY Program in the UK (strategic importance of IT, high trade deficit, response to foreign initiatives) also applies to Canada for developing a similar initiative, unlike UK, Canada does not have a significant computer industry except perhaps in software and services. It might be better to support such a program in communications (rather than information) technology where we do have better domestic strengths and capabilities.

EUREKA

(European Research Coordination Agency)

BACKGROUND

Eureka was an initiative of the French government which was set up by a conference of Technology Ministers on July 17th, 1985. There are nineteen European countries and the Commission of the European communities (EEC) participating in the initiative. It was launched as a program of civil research to support and coordinate industrial and service projects in an attempt to increase the competitiveness and productivity of European high-tech industries.

Eureka was triggered in large measure as a response to the United States Strategic Defence Initiative (SDI) which was announced in 1983. Even though SDI is a defence initiative, it is expected to help the U.S. industry through its huge budget. A sum of $ 15 billion has already been spent and if the program continues, an estimated $ 300 to $ 500 billion will be spent over the next ten years. EUREKA was initiated by European governments to help their companies in order to put them on equal footing with their American counterparts.

PROGRAM OBJECTIVES

The program objectives are outlined in fairly general terms only.

"The objective of EUREKA is to raise, through cooperation among enterprises and research institutes in the field of advanced technologies, the productivity and competitiveness of Europe's industries and national economies on the world market, and hence strengthen the basis for lasting prosperity and employment".

Eureka projects will serve civilian purposes, and be directed at both the private and public sector market.

EUREKA is also expected to accelerate ongoing efforts to :

- establish joint industrial standards at an early stage,
- eliminate existing technical obstacles to trade by mutual recognition of inspection procedures,
- open up system of public procurement.

PROGRAM FEATURES

- International cooperation - all projects involve at least two partners from at least two countries.
- EUREKA is essentially an instrument of cooperation between industries - 80 % of partners are industrial companies.
- The outcome of a project is generally a marketable product.
- The ideas come from the partners. The partners, not EUREKA, have full control of the project.
- Partners fund the projects entirely through their own means or through assistance obtained from their respective governments and European Commission.

RESEARCH AREAS

Table 1 shows the breakdown of projects into different areas :

Table 1

Breakdown of Projects into Different Areas, January 1990

Area	Number of Projects	Investment (million ECUs*)	% of total project	% of total investment
Info-technology	**39**	**903**	**18**	**24**
Robotics	**50**	726	24	19
Communications	**13**	**490**	**6**	**13**
Environment	11	421	5	11
Transport	18	375	9	10
Biotechnology	41	346	19	9
Lasers	11	240	5	6
New Materials	18	185	9	5
Energy	10	135	5	4
Totals	211	3821	100	100

* 1 ECU = $ 1.4 (Cdn)

Communications and information technologies accounted for 37 % ($ 1950 million) of total funding commitment over a number of years depending upon project duration.

PROGRAM FUNDING

EUREKA contributes no funding to the projects. The partners are expected to arrange the entire funding through their own means and/or assistance provided to them through their respective governments and European Commission. Public funding (on average 35 % to 40%) varies from one country and project to another. As of June 1989, 297 projects have been approved with funding commitment of 6.4 billion ECU over a number of years depending upon the project duration. Approximately, 1600 firms and research institutes are involved with these projects.

ROLE OF EUREKA OFFICE

EUREKA has a small secretariat in Brussels. The Secretariat reports to what is called the Council of Ministers which represents Ministers of various member countries. Although EUREKA does not fund any projects, it contributes through the following activities :

- EUREKA facilitates project collaborations by acting as an information clearing house. It has a computerized database containing information about all projects. The access to this database is free (except for telecommunications charges). The Secretariat helps to find potential partners as well as suitable projects to those who are looking to join a project. EUREKA's function has often been described as one similar to a "marriage bureau".

- Although EUREKA does not contribute direct funding, its stamp of approval helps partners to receive public assistance from their respective governments.

- Any product developed under EUREKA's program has a better chance to sell in all countries belonging to EUREKA through the help of state Ministers belonging to the Council.

PROGRAM ASSESSMENT

There was no formal mechanism put in place for assessing either the program as a whole or individual projects. However, a number of observers have commented on the usefulness of EUREKA including the European Parliament.

The following points summarize their observations.

- Because the projects are undertaken on a European basis, EUREKA enhances the climate for industrial and technological cooperation.

- EUREKA has resulted in some 297 projects so far with a potential investment of 6.4 billion ECU. In the case of Communications and information technologies, 1.4 billion ECU has been committed. Many see this as a fairly successful record for EUREKA.

- On the negative side, an analysis carried out by European Parliament criticizes the program on a number of grounds :

  - The initiative for selective projects remain with industry. Official endorsement through EUREKA is a pure formality. There is no technology strategy provided by EUREKA to serve the objectives of the European Technology Community.

  - The proportion of public money in EUREKA projects is estimated at 35 % to 40 % in spite of recent efforts by EUREKA to attract more respectable percentage of private financing. Furthermore, a large part if not most of the public funds going to EUREKA projects is not new money, leaving EUREKA open to the charge of being "name-plate" technology, i.e. a convenient label for projects that would in any case have been carried out.

  - The evaluation of projects, either quantitative or qualitative, is not undertaken on any systematic basis.

RELEVANCE TO CANADA

EUREKA is an attempt by Europe to help its high technology industry. An investment of 1.4 billion ECU has already been committed to the sectors of communications and information technologies. This obviously puts Canadian companies at a competitive disadvantage. While we cannot match EUREKA in terms of its budget or the range of participants (EUREKA is a multicountry program), it is important to note that action is required to help Canadian industry to offset the competitive disadvantage which EUREKA may create.

DELTA

Development of European Learning Through Technological Advance

INTRODUCTION

Delta is a collaborative research and development program of the European Community, aimed at advancing the use of communications and information technologies in education and training. Phase 1, called the Exploratory Action, was approved by the Council of Ministers in June 1988. The actual work started in March 89, and Phase 1 is expected to be finished in two years. Depending upon the results of Phase 1, the main phase will be undertaken in 1991.

BACKGROUND RATIONALE

The rapid changes in the use of technologies in daily life are changing the skills needed to function satisfactorily in a modern economy. In the industrialized world, it has been estimated that over the coming five years, four out of five people will be doing work differently from the way it has been performed in the previous fifty years. During the course of their working life many people will face changes of occupation and will, therefore, need three or even four cycles of retraining. The most economical way of achieving this is by the use of the very technologies causing these changes.

PROGRAM OBJECTIVES

The overall objective of the program is to enhance the use of communications and information technologies in education and training. The following are the sub-objectives :

- Prepare industry for the coming common market in educational tools and services;
- Increase the cost effectiveness of learning;
- Create quality systems for effective learning by the user;
- Develop a basic infrastructure at a European level.

PROGRAM RESOURCES

The Commission will contribute 20 million ECU ($ 28 million Cdn) for Phase I (March 89-March 91). This amount represents half of the cost of projects to be launched. The other half would come from project partners in the commercial, public and in the academic field. DELTA projects require the participation of at least two independent partners in two different member states. One of them must be a commercial enterprise. Also one partner must represent the requirements of learning. Research to be carried out under DELTA must be pre-competitive meaning that cooperation aims at the development of emerging technologies rather than at the development of marketable products.

RESEARCH AREAS

Research projects are organized into five areas, each area being known as an action line. The five action lines are described briefly below :

Action Line 1 :

The main purpose of this action line is information exchange - inform the outside world about DELTA projects and inform the DELTA contractors what is going on in the outside world. The major outputs of this action line are : an interactive newsletter, a multimedia scientific journal, and an annual conference. In addition, specific technical needs and requirement studies will also be carried out.

Action Line 2 :

This line deals with technology development - examples of projects to be carried out in this area are : courseware engineering system, student modelling, intelligent courseware, and knowledge-based authoring systems.

Action Line 3 :

To analyze the telecommunications requirements for the learning systems (especially the distant learning) and to arrange for such requirements. Examples of projects in this are : video-audio conferencing, satellite educational channel, use of ISDN.

Action Line 4 :

This action line deals mainly with the standards issues.

Action Line 5 :

This action line deals with user needs and other studies such as government role in education and training.

PROGRAM ASSESSMENT

A Delta Review Seminar was held in Brussels in December 1989 to discuss and review the results of the Exploratory Phase. The following gives the main conclusions of this seminar :

- the rationale stands up
- trans-national cooperation works
- cooperation between universities-educators and PTTs is working
- the tools/infrastructure are being produced

Subject to both a strategic and technical audit, a new framework program is expected to be approved. Phase II will be in place in 1991.

IMPLICATIONS FOR CANADA

Canada is fairly active in this area. In fact, DOC has been involved with the development and applications of educational technologies over many years - through satellite educational applications program and videotex applications. More recently, the department created the Commonwealth network and the International Francophone Centre for Distance Education. The Department is in the process of establishing a joint Canada/EC project as a part of the DELTA program.

COLLABORATIVE R&D PROGRAMS IN JAPAN

FRONTIER RESEARCH IN TELECOMMUNICATIONS FOR THE TWENTY FIRST CENTURY

A JAPANESE NATIONAL PROJECT

BACKGROUND

Frontier research refers to basic, but advanced and creative, interdisciplinary study in undeveloped areas with the ultimate goal of upgrading telecommunications services.

Since such research will have to be done on a long-term basis and not all of it will necessarily produce practical, marketable results; a high level of risk is involved. It is, therefore, not expected that the private sector will be able to undertake all of this research. Ministry of Post and Telecommunications (MPT) consequently began its programs of frontier research in 1988.

OBJECTIVES

- To foster the scientific and technical seeds expected to bear fruit in the 21st century.

- To meet the future needs of telecommunications which includes communications of any type of information anytime, anywhere and with anybody with easy to use user interfaces.

•Anytime, anywhere, and with anybody

To accomplish this, highly advanced communication connections through intelligent software is necessary so that users can freely select and connect with their desired communications channels.

•Any type of Information

In order to transmit images containing large amounts of information at a high speed, the transmission capabilities need to be highly upgraded.

•Easy to use

This will require user friendly interfaces like voice recognition, speech understanding and intelligent expert interfaces.

Future Needs	Research Goals
Anytime, Anywhere, Anybody	Intelligent Networks (Fixed and Mobile)
Any Type of Information	Expansion of Transmission Capacity
Easy to Use	User Friendly Interfaces

PROGRAM FEATURES

- Long term basic and creative research
- Interdisciplinary
- Cooperation among industry, university and government

PROGRAM FUNDING AND DURATION (1988-1998)

The research is conducted on a cooperative basis by MPT's Communications Research Laboratory, and the research organs of private corporations and universities.

RESEARCH AREAS

- **Intelligent Networks (any type, anywhere, anybody)**
  - Advanced integrated fixed-and-mobile networks
  - Network control based on intelligent software
- **High Capacity Transmission**
  - Unexploited electromagnetic spectrum
  - Optical communications
  - Application of super conductivity

- **User Friendly Interfaces**

  - Voice recognition
  - Speech understanding
  - Multimedia information processing technology
  - Neuro-computing based on how the brain works

PROGRAM EVALUATION

Since it is a basic program, evaluation in terms of tangible results achieved might be hard to do.

RELEVANCE TO CANADA

Canada is a highly technologically developed society as is Japan and our communications needs for the 21st Century will be. The Japanese, with a budget surplus, are probably in a better position to focus on more basic and long term research. Considering Canada's budgetary situation, a more focused and applied program will be necessary.

THE JAPANESE FIFTH GENERATION PROJECT

INTRODUCTION

In 1981, the Japanese Government announced that it will spend $ 450 billion (U.S.) over the next decade with industry contributing $ 400 million to develop the next generation of computers - computers that will be able to converse with humans in natural language and understand speech and pictures. These will be computers that can learn, make decisions, and otherwise behave in ways we have always considered the exclusive province of human reason.

As we move from an industrial society to one based on services, information technology is expected to play an important role. For example, the number of persons employed in the service sector in Canada increased from 41 % of the total labour force in 1946 to 71 % in 1986. Most countries now recognize the strategic role of information technology in economic development.

While information technology is becoming more closely linked to economic competitiveness, the Japanese companies were not doing that well in the area. For example, in 1983, considering the top twenty companies which supply information processing products, Japanese companies had a share of only 8 % as compared to a share of 80 % for U.S. companies.

These two factors led the Japanese Government to launch its Fifth Generation Computer Project in order to increase the competitiveness of its IT industry.

THE PROGRAM RESEARCH AREAS

Within the broad area of intelligent computing, a number of research themes were selected to pursue. These are outlined below :

- Knowledge based machines
- Intelligent human-machine interface systems
  - -Natural language processing
  - -Speech processing
- Machine Translation Systems
- Intelligent programming systems

PROGRAM BUDGET AND TIMING

The Fifth Generation Computer Systems (FGCS) project was initiated in 1982 as part of a major program supported by Japan's Ministry of International Trade and Industry.

As the central organization responsible for the execution of this national project, the Institute for new Generation Computer Technology (ICOT) was established in April 1982. ICOT has mapped out a research and development program for ten years; a three year initial stage (1982-1984), a four year intermediate stage (1985-1988) and a three year final stage (1989-91).

Funding for this project is as follows :

Initial Phase	:	$ 50 Million by MITI
Second and Third Phases	:	$ 400 Million by MITI $ 400 Million by Industry
Total Funding	:	$ 850 Million over ten years.

PROGRAM EVALUATION

According to Gartner Group, a U.S. based consulting firm, the Fifth Generation Computer Project is already a success. Not only is it a success in that it has changed the course of computing history, but it is also a success because it has unquestionably built an AI infrastructure in Japan. And in the years ahead, that infrastructure will find ways to incorporate and extend the concepts and technologies from FGCS into commercial products made by Japanese companies, especially those which have participated most actively in the project.

The experience gained by the participating companies will provide a springboard for the subsequent commercialization of the research, especially in areas such as software engineering and natural language understanding. The FGCS project has succeeded in moving Japan from it's position as a virtual nonentity in the field of artificial intelligence and turn it into a world class player in less than a decade.

RELEVANCE TO CANADA

C&IT is just as important to Canada as it is to Japan. The only difference is that whereas Japan has domestic IT industry which it wants to nurture, Canada has very little (except in the area of software and services). To address this gap, the Department of Industry, Science and Technology Canada has set up a program in the area of artificial intelligence. The program has funding of $ 10 million and is spread over five years.

COLLABORATIVE R&D PROGRAMS IN THE U.S.

STRATEGIC DEFENCE INITIATIVE (SDI)

BACKGROUND

Officially called the U.S. Strategic Defence Initiative (SDI), Star Wars became a prominent issue in March 1983 when President Reagan - asking whether we would not be more secure if "we could intercept and destroy strategic ballistic missiles before they reached our own soil or that of our allies" - announced a "long-term research and development program to begin to achieve our ultimate goal of eliminating the threat posed by strategic nuclear missiles".

Following the speech, a defence technology study team, known as the Fletcher Panel, was established to define a long-term research and development program aimed at eliminating the ballistic missile threat. In January 1984 the Secretary of Defence established a research program based on the Fletcher Study and called it the Strategic Defence Initiative.

PROGRAM OBJECTIVE

- Defend the United States and the Allies against accidental or fanatic Third Country attacks.
- Create an immediate surge in the high technology sector of the United States economy.

PROGRAM BUDGET AND TIMING

Approximately $ 15 billion has already been spent on this project between 1985 and 1989. It is estimated that up to $ 57.5 billion (including $ 15 billion spent already) will be spent before an "informed technical decision" could be made in 1993 whether to proceed to full scale engineering development of the system.

If it is decided to proceed with the system, there will be three phases. The total cost of all phases is expected to be between $ 250 and $ 450 billion. Phase 1 will take about ten years.

RESEARCH AREAS

Although the focus of this program is not information technology as such, it will be an important component of the program. Communications links must be established to transmit data. There will be some 300 satellites employed in Phase 1. Computer networks must be designed to process voluminous amounts of data and complex algorithms and software must be developed.

PROGRAM EVALUATION

According to DOD, during its five years of operation, SDI has made substantial progress. The progress achieved so far has produced evidence that sophisticated defences against ballistic missiles may be achievable. The work over the next few years is aimed at determining if effective defences are feasible and if they are, to form the basis for their development and deployment.

RELEVANCE TO CANADA

We obviously do not have the military might of the U.S. and the tradition of huge defence initiatives. Our industry is, therefore, at a disadvantage against U.S. companies which have traditionally received large sums for R&D from defence programs and this research results in civilian products (We are now seing signs that this tradition is changing in the U.S. and government is now being asked to support industry through civilian-based programs). The Europeans and Japanese have initiated civilian-based and government funded programs to provide a similar competitive edge to their companies. There is an obvious case for a comparable program in Canada to give the same competitive edge to our companies. Since our resources are limited, our program will have to be more focused.

SEMATECH

(Semiconductor Manufacturing Technology)

WHAT IS SEMATECH

SEMATECH is a consortium of American semiconductor manufacturers working with government and academia to sponsor and conduct research aimed at assuring leadership in semiconductor manufacturing technology. Results of this research will be transferred to consortium members who will use them for commercial and military applications.

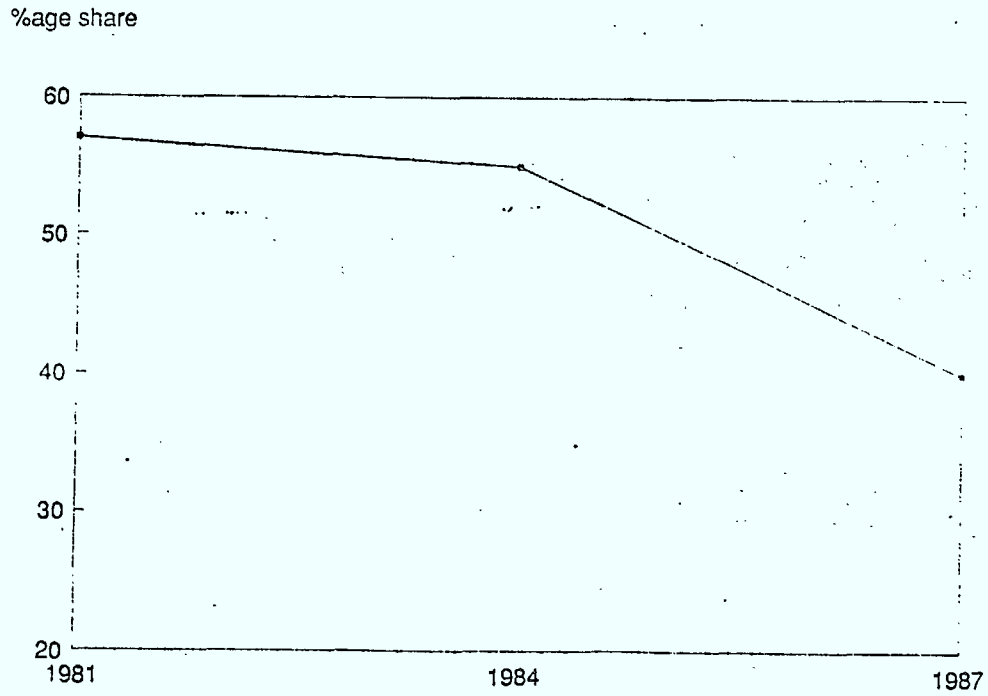
BACKGROUND

A number of factors were responsible for the creation of SEMATECH. Among the most notable were the following three :

1. **Declining Market Share of U.S. Companies**

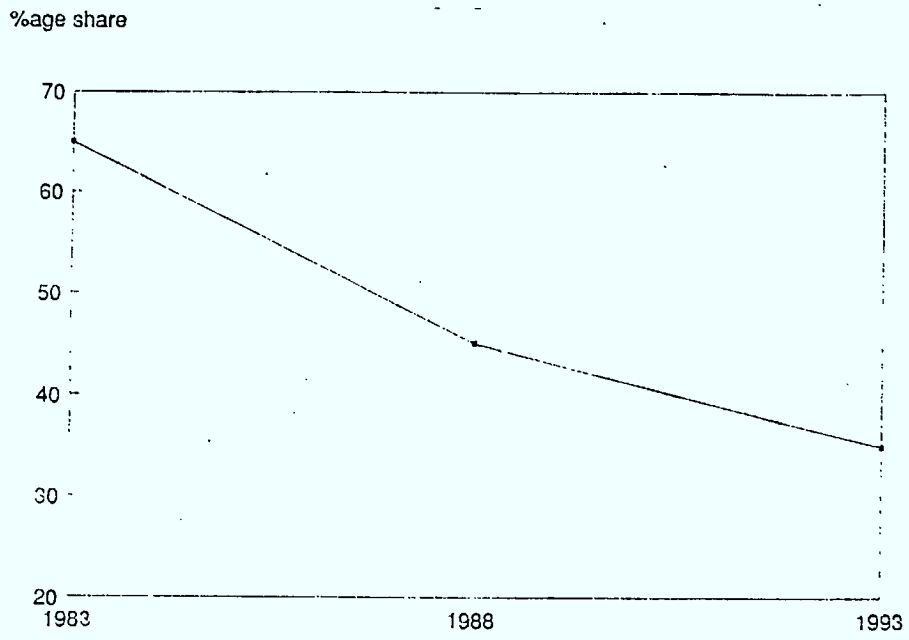
Figure 1

Semiconductor Market Share of U.S. Companies



Source: VLSI Research Inc.

Figure 2
Semiconductor Equipment Market Share



Source: VLSI Research Inc.

The Semiconductor industry was born in the U.S. and the U.S. lead its production and market share until fairly recently.. As shown in Figure 1, the semiconductor market share for U.S. companies decreased from 55 % in 1984 to 40 % in 1987. In the case of semiconductor equipment, the market share of U.S. companies has been falling steadily from a high of 65 % in 1983 to 45 % in 1988 and is expected to decrease further to 35 % by 1993. Japan has already taken the lead in terms of semiconductor sales. The objective of SEMATECH is to reverse this trend and restore the semiconductor leadership to the U.S.

2. Importance of Semiconductors to Overall U.S. Economy

Semiconductors, the nucleus of many electronic products, hold a strategic position at the centre of information and defence technologies vital to the U.S. economy and its national security. One view is that the semiconductor chip means as much to the nation's well being in the Information Age as did resources like iron, coal, and water in the earlier industrial age.

According to the American Electronic Association, the U.S. electronics industry accounts for $ 279 billion in sales a year. Electronics is a $ 620 billion a year industry worldwide. Semiconductors are vital ingredients of practically every

modern electronic system from microwave ovens to satellites. It is thus important to have a competitive domestic semiconductor production capability.

3. Japanese Initiatives

Many believe the Japanese success in semiconductors is due to joint industry government projects like the VLSI program of the late 1970's. U.S. industry is also in need of government help to compete fairly with the Japanese companies.

PROGRAM OBJECTIVE

The overall program mission is to provide the U.S. semiconductor industry the domestic capability for world leadership. Specifically, the program goal is to enable U.S. industry to achieve parity with and then overtake Japan in semiconductor manufacturing by 1993.

SEMATECH has defined quantifiable goals for the first three phases and is now defining future phases.

Phase 1 : To demonstrate manufacturing capability at the current level of technology, at circuit linewidth of .8 micron.

Phase 2 : To achieve manufacturing at the narrower linewidth of .5 micron. At phase 2, the U.S. will achieve manufacturing parity with Japan.

Phase 3 : Targets the unprecedented achievement of .35 micron manufacturing. By achieving this goal, the U.S. expects to reclaim worldwide semiconductor manufacturing leadership.

Phases 4 and 5 are now being defined. Phase 4 further extends leadership to take advantage of technical breakthroughs. Phases 1, 2, and 3 are expected to be finished by 1993.

PROGRAM BUDGET AND TIMING

SEMATECH has an annual budget of $ 200 million with half of the funding provided by member companies and half by federal government (DOD). The government involvement helps to offset the considerable advantage enjoyed by foreign companies who have benefited from a variety of assistance provided by their respective governments.

The fourteen member firms represent approximately 80 % of the semiconductor manufacturing base in the U.S. and combined revenues of $ 157.7 billion in 1988. The member companies include companies such as IBM, Digital Equipment, Hewlett-Packard, Intel, Motorola, Texas Instruments, Rockwell International and AT & T.

PROGRAM AREAS AND PRIORITIES

SEMATECH has the following four major program areas :

- **Tool Application Program**

  This is designed to decrease the equipment life cycle - by providing facilities to suppliers to test their equipment in an actual manufacturing environment. It is to be noted that SEMATECH's emphasis is on manufacturing capability, not on chip design. SEMATECH does not produce chips for sale.

- **Equipment Improvement Program**

  Helps supplier improve existing tools.

- **Manufacturing Specialist Program**

  Provides a comprehensive training program for manufacturing operations specialists

- **New Graduate Training Program**

  Recruits recent college graduates to participate in this program. Within three years, the graduate trainees will move to member companies.

PROGRAM ASSESSMENT

Although it is still too early to judge the effectiveness of this program, Dataquest Inc., a U.S. based consulting firm, has made some initial observations. According to Dataquest Inc., SEMATECH has already achieved impressive results in a very short time. The most notable results include the following :

- The development of a collaborative organizational structure that will maximize the capabilities of industry, government and universities in the U.S.

- The program is expected to shorten the equipment development cycle by at least six months

- Increasing levels of communications cooperation and team work between various players

- Quick growth
  in the organization : 40 people in January 1988
  400 people in December 1988
  524 people in March 1989

RELEVANCE TO CANADA

Other than telecommunications chip manufacturers (Northern Telecom and Microtel Pacific Ltd.), we do not have any other significant semiconductor manufacturers. Both Northern and Microtel Pacific make specialized chips to be used in communications products and do not compete in the market place to sell these chips to other electronic equipment manufacturers.

Therefore, we do not have the same concern as the U.S. in the area of semiconductor technology. It is interesting to note that one of the major advantages of SEMATECH is an increase in cooperation and communications among various players.

THE MICROELECTRONICS AND COMPUTER TECHNOLOGY CORPORATION (MCC)

BACKGROUND

MCC was launched in 1982 as a permanent institution, explicity as an American reaction to the Japanese Fifth Generation Computer Project announcement by ten U.S. companies : Control Data Corporation, DEC, Honeywell, National Semiconductor, Motorola, NCR, RCA, Sperry, Harris and Advanced Microdevices. IBM, AT&T and Texas Instruments are not part of this consortium. MCC is not only a reaction to the Japanese initiative, it is also an effort by U.S. medium size companies to compete against the industry giants such as IBM.

PROGRAM OBJECTIVES

The stated objective of the MCC is to strengthen and sustain America's competitiveness in information technologies through application driven research, development and timely deployment of innovative technology. MCC's research programs share a common goal - provide the technology necessary to make computers, applications and processes faster, more reliable and capable of performing more complex tasks at a higher level of quality and at a much lower cost.

RESEARCH AREAS

MCC conducts research in a number of areas including the following three :

- Advanced Computer Technology

  To develop technologies that will allow the design of complex knowledge-based systems

- Computer-Aided Design

  To provide a means to greatly reduce the time and improve the resulting design quality of complex microelectronics circuits and systems.

- Software Technology

  The mission of MCC's Software Technology Program is to develop tools and methods that will significantly improve the productivity of the software development process and the quality of software products.

PROGRAM RESOURCES

MCC was chartered in August 1982. Austin was selected as its headquarters in May 1983. Research began in early 1984, and by mid-1984 research was fully underway in all of MCC's research programs. The box below shows resources committed to the program.

MCC RESOURCES

YEAR	BUDGET $ Million	PEOPLE January
1983	0	1
1984	19	72
1985	45	400
1986	65	473
1987	67	428
1988	62	435
1989	70	435

Source: MCC Public Affairs

MCC's staff fall into two categories : direct hires from industry, university and government; and shareholder's representatives who are sent to MCC by participating companies.

PROGRAM OUTPUTS

MCC develops generic technology and development tools which are transferred to its shareholders for use in their products and processes.

According to information provided by MCC, it has :

- delivered 84 technologies to its shareholders
- has been awarded 11 patents (50 more have been filed)
- transferred more than 1500 technology reports.

In five years shareholders have :

- made multimillion dollar equipment decisions based on MCC results
- created internal manufacturing and design capabilities based on knowledge obtained from MCC
- caught up with international competition in areas of semiconductor packaging/interconnect

According to Gartner Group, a U.S. based consulting firm, MCC has been successful only in the narrow sense of developing specific technologies. It has not really addressed the wider issue of research infrastructure i.e. relationship between industry, government and academia. The ability of MCC participants to quit with only one year's notice is, in Gartner's opinion, antithetical to the idea of long-range research. Backing an agency which can, like Japan's MITI, woo major corporations into participating in cooperative research projects judged to be in the national interest, the government's principle contribution to date has been to get out of the way.

IMPLICATIONS FOR CANADA

Unlike the U.S., Canada does not have many companies involved with computer hardware manufacturing, although we do have a reasonable software sector. While we cannot really justify a R&D program aimed at the hardware sector, we could consider one for the software sector. In fact, there is already one in place called the AI R&D fund administered by ISTC. The fund is worth $ 10 million to be spent over five years.

COLLABORATIVE R&D PROGRAMS IN CANADA

CANADIAN COLLABORATIVE R&D PROGRAMS

Although we do not have collaborative R&D programs as large as those of our trading partners, we do have a number of programs on a small scale. This section describes some of these programs.

1. ARTIFICIAL INTELLIGENCE R&D FUND

INTRODUCTION

The Artificial Intelligence Research and Development Fund is a recent initiative of ISTC. The Fund, which has a budget of $ 10 million over five years (1989-1994), exists to encourage federal government departments and agencies to develop AI systems and applications, which will have high payoffs in terms of improved government productivity and effectiveness of operation. At the same time, this will increase the competitiveness of the private sector through the contracting-out of research and development, through the transfer of technology and know-how, and through collaboration of system implementation.

STRATEGY

The strategy is to use the Federal Government as a test-bed to develop and subsequently apply artificial intelligence technology in innovative, risky applications which are expected to result in high payoffs in terms of enhanced government operations and services, as well as enhanced national competitiveness through contracting-out and technology transfer and application in the private sector. Federal departments and agencies will be required to contract-out R&D projects, thereby bringing together industry-led teams to develop both capability and capacity in the private sector. The Fund will be used to share project costs. Collaboration between departments in applications of common interest is encouraged.

It is intended that resources from the fund be used to contract out the development of artificial intelligence systems to profit-seeking private sector companies. However, other forms of private sector participation as well as contracting-out to universities, Crown corporations, provincial research organizations and others is not excluded and will be considered on a case-by-case basis. A principle consideration would be the contractor's plans for the exploitation of the technology developed as a result of the project.

Departments are encouraged to co-sponsor projects; under such circumstances, the fund will contribute up to a maximum of fifty percent of eligible expenses.

OBJECTIVES

The objectives of the fund are to :

Strengthen the capability and capacity of Canadian industry to supply artificial intelligence technology for industrial and social applications;

Improve the quality and productivity of government operations and services to the public, and;

Enhance the competitiveness of the economy through the application of artificial intelligence technology.

AREAS OF APPLICATION

Initial priorities for the development and application of artificial intelligence under the fund are :

- The management and exploitation of renewable and non-renewable resource;
- Language translation;
- Improving the safety and cost-effectiveness of the national transportation infrastructure;
- The training and re-training of the workforce (Intelligence Tutoring Systems).

These priorities may change over the lifetime of the fund. The four initial priorities are interpreted as including the promotion of the health and safety of Canadians and protection of the environment. Criteria for defining these priorities will be the same as the criteria used in the assessment of proposals, namely the areas which are most likely to bring economic benefit to the federal government and help to strengthen the competitiveness of Canadian industry.

PROGRAM ASSESSMENT

The program is in its first year of operation and it is therefore, still too early to judge the effectiveness of the fund. ISTC plans to carry out an on-going program evaluation.

COMMENTS

The program was set up in recognition of the strategic importance of artificial intelligence to the Canadian economy as well as a partial response to similar programs in other countries.

2. NETWORKS OF CENTRES OF EXCELLENCE

BACKGROUND

In May 1988, the federal government (ISTC) approved a budget of $ 240 million for the Networks of Centres of Excellence Competition. The program was announced as part of the new Federal Science and Technology Strategy, Innovaction, and within the context of the National Science and Technology Policy, then just negotiated with the provinces.

A total of 158 proposals had been submitted, involving some 4,000 Canadian researchers and totalling over $ 2 billion in requests. An internationally renowned jury was set up to review the proposals. The 23-member International Peer Review Committee, chaired by Mr. Stuart Smith, was made up of experts from the industrial, academic and government sectors. Rating by the committee took place on the following basis :

- Institute for Telecommunications Research (ITR)
- Institute for Robotics and Intelligent Systems (IRIS)
- Microelectronics, Ultra-Large Scale Integration (ULSI)
- Canadian Network for Space Research

Every region of Canada, and virtually every major university, are part of the networks, as are a good number of private sector companies and government research laboratories from across the country.

PROGRAM OBJECTIVES

- To boost Canada's performance in science and technology and the country's involvement in long-term basic and applied research;
- To develop world class engineers and scientists;
- To pass on to industry new technical knowledge gained;
- To begin a new era of collaboration and "networking" between researchers at different institutions and companies across the country.

PROGRAM FUNDING AND TIMING

The program's budget of $ 240 million will be administered by the three granting councils (Natural Science and Engineering Research Council, Medical Research Council and Social Sciences and Humanities Research Council) and will provide funding for the networks for the next five years.

The research agreements and funding arrangements of each network will receive a funding of about $ 17 million over five years, the actual amounts will be different for different networks.

RESEARCH AREAS

The research areas for the four networks, that we are concerned with, are given below :

INSTITUTE FOR TELECOMMUNICATIONS RESEARCH

Grant $ 14.7 million

The research program includes two components:

- Broadband Communications
  - broadband networks and services
  - optoelectronic devices
  - systems and communications software engineering

- Wireless Communications
  - mobile communications
  - microcellular networks
  - source and channel coding

INSTITUTE OF ROBOTICS AND INTELLIGENT SYSTEMS

Grant $ 23.8 million

- Computational perception
- Knowledge-based system
- Intelligent Robots

MICROELECTRONICS, ULTRA-LARGE SCALE INTEGRATION

Grant $ 10.8 million

- Semiconductor technologies in the one micrometer and submicrometer range

CANADIAN NETWORK FOR SPACE RESEARCH

Grant $ 17 million

- Atmospheric Research
- Space Astronomy

COMMENTS

- The program is aimed at long-term research both basic and applied;
- Although industry and government research institutes are involved in various networks, bulk of the research is to be done by universities;
- Participating by industry in advisory committees as well as actual research teams will ensure that the research will be relevant to industry and will help increase our industrial competitiveness;
- Although an effort is made to make the research more responsive to the industrial needs, the bulk of the program is aimed at long-term research to be carried out by universities. While it is an important and much

needed program it does not really off-set the competitive advantage enjoyed by our international competitors through their R&D programs. These international programs are aimed much more directly at helping the industry and, in fact, most of them require the industry to do most of the R&D work.

STRATEGIC TECHNOLOGIES PROGRAM OF ISTC IN INFORMATION TECHNOLOGY

Information Technology, Biotechnology and Advanced Industrial Materials are termed as strategic technologies by ISTC because they are considered vital to sustain economic growth in Canada. The Strategic Technologies Program is designed to strengthen the capability of industry to develop and to apply these technologies.

PROGRAM BUDGET

The information technology component of the program is worth $ 30 million and is meant to be spent between 1989-1993. A total of $ 10 million has already been committed to Precarn, an industry based consortium created to carry out pre-competitive long term research.

PROGRAM ELEMENTS

Research and Development Alliances

This component will support the formation of alliances among information technology firms to conduct pre-competitive research and development.

Technology Application Alliances

This component will support alliances of the developers and users of information technologies to undertake pre-commercial technology applications.

Feasibility Studies

This component provides support for feasibility studies, for example, to investigate projects to be undertaken by a potential alliance.

SELECTION CRITERIA

Proposals receiving support will be research, development or application projects in leading-edge fields of information technologies (including artificial intelligence and advanced manufacturing technologies) that have not been previously exploited in Canada. They will be characterized by high technological risk, significant commercial potential for the participants and potential impact on the international competitiveness of several firms in the sector.

Proposals will be assessed in terms of : linkages being created, relevance to the objectives of the program, quality and leadership, and competitive viability. More specifically, the selection will be based on the extent to which projects:

- involve various corporations, universities and research institutes in R&D Projects or involve producers and users of technology in application projects;
- entail significant technological innovation and risk;
- enhance Canada's scientific and technological skills, knowledge, and personnel;
- improve Canada's industrial infrastructure and the international competitiveness of developers and users of the technologies; and
- create linkages for the broad diffusion of information technologies and applied knowledge acquired through the alliance.

AVAILABLE SUPPORT

Under a program, R&D alliances or technology application alliances may receive non-repayable contribution of up to fifty percent of the eligible costs for each project. These costs must be directly attributable to the project and may include :

- salaries of scientists, engineers, analysts, programmers and technical staff;
- a portion of management salaries when acting in above capacities;
- the cost of project materials, components, and special purpose machinery and equipment;
- test and evaluation prototype costs;
- travel and communication costs;
- sub-contract costs;
- certain fees related to the filing in North America of applications for the protection of intellectual property rights arising from the project.

Feasibility studies may be eligible for a contribution of up to $ 50,000, which is to be at least matched by the proponents of the alliance.

RELEVANCE TO VISION 2000

This program appears to be extremely relevant to the Vision 2000 project. There is still $ 20 million left in the fund and there are not very many consortia (to our knowledge) competing for it.

ONTARIO'S TECHNOLOGY FUND

BACKGROUND

The government of Ontario established a Premier's Council in April 1986 to assist in developing long-term strategies for improving the provincial economy.

Chaired by Premier David Peterson, the 34-member Council is composed of leaders of the business, labour, and academic communities, as well as a number of government ministries.

The Council meets regularly to discuss ways of improving the development and use of new technology, strengthening the existing industrial infrastructure and encouraging entrepreneurship. As a result of these deliberations, the Council has developed a number of programs which are now operating under the $ 1 billion Technology Fund, to be spent over ten years (1986-1996). Although these programs are meant to address all technology areas, information technology figure prominently in most of them.

VARIOUS PROGRAMS UNDER THE TECHNOLOGY FUND

- Centres of Excellence
- The University Research Incentive Fund
- The Industry Research Program
- Centres of Entrepreneurship
- Technology Adjustment and Research Program
- Technology Personnel Program
- The Supplier Development Program

1. CENTRES OF EXCELLENCE

Objectives

- To stimulate the production of advanced research
- To train and develop world-class researchers
- To encourage the transfer and diffusion of technology to industry

Funding and Timing

A government funding of $ 204 million over five years. The centres were announced in June 1987. Funding includes the full costs of the

research and may be extended beyond the five-year period, following the 1992 review.

Type of Research : Long-term Scientific and Technological Research.

Responsibility

The Ministry of Industry, Trade and Technology has primary responsibility for the program in collaboration with the Ministry of Colleges and Universities. A sub-committee of the Premier's Council meets on a quarterly basis to monitor the development and effectiveness of the Centres of Excellence.

An independent review of each centre's programs will be conducted in 1990 and 1992.

The Centres

Each Centre of Excellence is a non-profit corporation, managed by a board of directors that is responsible to the Ontario government for the program and its financial management. Six of the seven centres undertake research either directly or indirectly in information technology. The centres described briefly below :

The Centre for Advanced Laser and Lightwave Research at the University of Toronto conducts research in fields such as laser spectography, lightwave engineering and non-linear optics - significant areas for the electronics, aerospace, robotics, communications and remote sensing industries.

The Centre in Space and Terrestrial Science confirms Ontario's long-term commitment to the support of its space industry by bringing several university and industry partners together to investigate such areas as atmospheric and solar-terrestrial physics, space astrophysics, space technology and human space behaviour.

The Centre for Integrated Manufacturing is laying the groundwork for the next generation of computer-aided manufacturing systems through research in intelligence and flexible automation, improved design processes and systems management.

The Centre for Groundwater Research, based at the University of Waterloo, is conducting research into such areas as waste technology

and management of hazardous substances to protect one of Ontario's most precious resources - a pure water supply.

The Centre in Information Technology is investigating artificial intelligence, microelectronics, communication mathematics, software and graphics to keep Ontario competitive in the information age.

The Centre for Material Research carries out basic and applied research in areas which include biomaterials for medical applications, composites and new materials, and optoelectronics.

The Telecommunications Research Institute of Ontario undertakes research in digital networks, radar and satellite systems, photopic networks and electromagnetic capability to maintain Ontario's leadership on telecommunications.

2. UNIVERSITY RESEARCH INCENTIVE FUND (URIF)

The University Research Incentive Fund is designed to encourage co-operative research ventures between universities and the private sector. Administered by the Ministry of Colleges and Universities, this fund matches, dollar for dollar, investment by the private sector in university-based contract research.

Increased cooperation between industry and the universities is mutually beneficial and industrial communities, industry gains better access to leading-edge research. At the same time, financial support from the private sector can result in greater expertise and research capacity in the universities.

Projects receiving URIF funding cover a broad cross-section of research - including medicine, pharmacology, agriculture, acoustics, telecommunications, mining, chemical engineering and integrated manufacturing.

Every application made for funding from URIF is assessed by a selection committee consisting of members from the private sector, the universities and the government. All Ontario universities and the Ryerson Polytechnical Institute are eligible. Private-sector participants can include Canadian corporations, foreign-owned subsidiaries operating in Ontario and industry-sponsored research organizations. Crown corporations receiving less than fifty percent of their revenue from the government are also eligible. A formal research contract is signed by both the private-sector and academic partner. The funds are given to

participating universities which can either apply them directly to the costs of the project or use them to expand its scope. Each project can continue for a maximum of three years.

The total government funding available for this program is $ 50 million over a period of six years. As of February 1990, URIF had approved a total funding of more than $ 30 million for 400 projects. It is to be noted that the industry contribution can be either in cash or in kind.

3. THE INDUSTRY RESEARCH PROGRAM

The goal of the Industry Research Program is to stimulate industry-based research collaboration between private companies and other partners in areas that will improve the competitiveness of Ontario business.

Projects must be based on sound scientific principles and display a degree of scientific risk, as well as economic and social benefits. Projects must have more than one partner, must contribute to training and development and must demonstrate a potential for the production of tradable goods and services. The funding is in the form of grants of up to 50 percent of allowable costs. Applicants must be able to demonstrate their ability to finance their part of the program. Government will spend a total of $ 300 million over ten years on this program.

Eligible applicants and collaborators are :

- Canadian companies or subsidiaries of foreign-owned firms which operate in Ontario;
- Crown corporations and research organizations which receive more than fifty percent of their operating funds from private sources;
- Ontario post-secondary institutions and ministries of the Ontario government.

All projects are reviewed by an assessment panel chaired by a member of the Premier's Council. Members are drawn from industry, government and academia. Advice is also obtained from external scientific reviewers and several government departments and agencies.

Applications approved so far under this program cover a wide range of industrial projects. Listed below are selected examples :

Canadian Astronautics Ltd. of Ottawa is to work with Environment Canada, the federal departments of National Defence and Communications and Queen's and Carleton Universities to develop a new form of radar. The Fund's contribution will be $ 2.48 million.

American Standard Inc. of Toronto was awarded a grant of $ 3.81 million towards research in computer-aided design and manufacturing processes for industrial ceramics. Partners are Spar Aerospace Ltd., Canadian General Electric Co. Ltd., IBM Canada Ltd., McMaster University and the University of Western Ontario.

Broadcast Technology Project is a collaborative venture of five companies from the broadcast equipment manufacturing industry to develop new studio equipment for advances in satellite transmission and computer-based advertising. A $ 6.3 million grant from the Technology Fund is to be provided for this project which will be administered in cooperation with the Ministry of Culture and Communications.

4. CENTRE OF ENTREPRENEURSHIP

Entrepreneurs are indispensable to Ontario's economic health and vitality. In recognition of this, six Centres of Entrepreneurship have been established in colleges and universities across the province.

The centres are dedicated to championing entrepreneurship and innovation. They offer training courses in innovation and enterprise, and develop curriculum materials. Visits are sponsored from practising entrepreneurs, venture capitalists and researchers, who discuss their experiences, practices and principles with students from all disciplines. The centres also stimulate research into entrepreneurial strategies and areas with potential for development by entrepreneurs.

Administered by the Ministry of Colleges and Universities, the entrepreneurship program has funding of $ 3.6 million over a four-year period. The six designated centres can receive government grants on a three-to-one ratio against matching private-sector contributions.
Based on a private-sector contribution of $ 50,000, the maximum government grant would be $ 150,000.

Designated Centre are : York University in Toronto; Ryerson Polytechnical Institute in Toronto; Queen's University, Kingston, in conjunction with St. Lawrence College in Cornwall and Loyalist College in Belleville; Lakehead University and Confederation College in Thunder Bay; Canadore College and Nipissing College in North Bay; and Centennial College in Scarborough.

An Entrepreneurship Advisory Committee will evaluate the Centres after they have been operating for two years and at the end of the four-period.

5. TECHNOLOGY ADJUSTMENT AND RESEARCH PROGRAM

The purpose of this program is to provide financial support to research projects that deal with the effects of technological change on the workforce and the workplace. The research will be carried out by organized labour, preferably in co-operation with employers and other interested or relevant partners such as government and post-secondary institutions. The program will provide a total of $ 5 million in funding over five years for eligible research projects.

6. TECHNOLOGY PERSONNEL PROGRAM

A total of $ 38 million has been allocated for this five-year program, which is designed to assist small manufacturing firms in hiring up to 1,000 new engineering, scientific and technical staff. These people will be able to use and apply advanced technology to strengthen the research and development in Ontario's small-and medium-sized companies.

7. THE SUPPLIER DEVELOPMENT PROGRAM

The Supplier Development Program has been established to award research contracts to companies with the potential to become competitive suppliers of selected goods that the Ontario government and its agencies will need to purchase in the years to come. The Technology Fund will provide $ 25 million over five years for this purpose.

Relevance to Vision 2000

Have the Vision 2000 companies made use of these programs? If so, in what manner and to what extent? Which of their R&D needs can not be met by these programs, and require support through the Vision 2000 Consortium?

QUEBEC'S STRATEGY FOR SUPPORTING R&D BY THE PRIVATE SECTOR

Quebec's Strategy for supporting R&D by the private sector consists of the following five components :

1. The Tax System
2. The Technology Development Fund
3. Hydro-Quebec's Farming-Out Policy
4. The Risk-Sharing Loan Program
5. R&D Spending Programs of Various Government Departments and Agencies.

The following table shows the financial contribution to the private sector R&D due to each of the above five components, as estimated by Quebec government.

Contribution of the Quebec Government to R&D for the next five years in millions of dollars

	Contribution (5 years) 1989-90 to 1993-94
Tax System	910
Technology Development Fund	300
Hydro-Quebec Farming out Policy	495
Risk-Sharing Loan Programs	120
R&D Expenditure Programs of Government Department and Agencies	1150
Total Assistance	2975

The first two components. Tax System and the Technology Development Fund are particularly be relevant to the Vision 2000 project.

1. TAX SYSTEM

The tax system has the following advantages :

- Business firms generally prefer to receive tax concessions rather than subsidies for reasons of simplicity and confidentiality.
- The tax system minimizes the steps which must be taken to obtain government assistance, and thereby reduces delay.
- Tax credits cut down on administrative costs and thereby allow firms to receive more assistance, for every public dollar invested in R&D, than they do when they receive subsidies under programs.

Since 1986, the government has implemented a number of fiscal measures. Among other things they are intended to :

- Stimulate industrial research by granting a refundable tax credit of 20 % on wages for R&D projects carried out by large businesses; this credit is increased to 40 % in the case of small and medium firms.
- Establish collaboration between universities and business firms by granting a refundable tax credit of 40 % on all R&D spending in universities.

2. TECHNOLOGY DEVELOPMENT FUND (TDF)

Direct subsidies are effective in promoting the implementation of large-scale projects; they also support fiscal measures. For this reason the government created the Technology Development Fund.

Objectives of the Fund

- Support Quebec's economic development by basing technological development activities on the needs of businesses competing for international market share.
- Stimulate collaboration among businesses, universities and government.

- Increase the level of industrial and public expenditures on scientific research and technological development.

Budget and Timing

The fund has an overall budget of $ 300 million over five years, beginning in 1989-90.

Government Contributions under the TDF

R&D Expenditures

A TDF project, also known as MOST (Major Opportunities to Stimulate Technology) project, once approved, is eligible for Quebec's 40 % tax credit for R&D expenditures. Other tax benefits, at the federal and Quebec levels, may also apply.

Other Eligible Ependitures

The expenditures which fail to qualify for tax relief will be taken into account in calculating a 50 % grant.

The combination of the grant and tax measures to assist R&D raises the level of government financing to almost 70 %.

Other Government Contributions

The TDF can also match federal assistance dollar-for-dollar to fund project expenditures.

Financial participation by government of other countries may be involved in some projects promoted by consortia.

Business Contribution

The net cost to the business is about $ .32 per dollar invested in the project. This amount remains relatively stable, regardless of the size of the R&D investment.

Eligible Expenditures

Design and Start-Up Stage

- Market Research
- Feasibility Studies
- Collaboration Among Partners
- Project Administration

R&D Activity Stage

- Costs of acquiring patents and licenses
- Cost of building labs

Implementation Stage

- Market Research (based on project results)
- Costs prior to final commercialization

Nature and Eligibility of Projects

A MOST Project unites industrial partners who operate it and set its broad objectives. A project will generally last from two to five years. It is eligible for TDF assistance if it satisfies the following six criteria:

- Partnership between businesses and university and other researchers.
- Project leadership by business
- Net additional research and technological development effort by businesses
- Marketable technological advance
- Structural economic effect
- Well defined operational structure

Evaluation Criteria

Project proposals will be evaluated according to the following criteria:

Technical Merit

- Technical and scientific feasibility of the project
- Innovative nature of technology as opposed to existing techniques
- Soundness of the principles and objectives of the project

Industrial Impact

- Ability of partners to commercialize the results successfully
- Commercial benefits to partners with particular reference to their competitiveness

Economic Impact

- Wider economic benefits to various economic sectors
- Impact of the project on human resources development

Project Management

- Realism of the technical plan
- Quality of the partnership and collaboration proposed
- Management ability of project managers
- Experience of personnel involved

Relevance to Vision 2000

Based on the available data, it would appear that Vision 2000 would meet the criteria to qualify for this program. Only that portion of the project which will be carried out in Quebec could qualify for this support.

OTHER PROVINCIAL R&D PROGRAMS

Advanced Technology Program (ADP) of Saskatchewan

Within the Advanced Technology program there are seven programs with a combined total budget of $ 2.5 million. The ADP started in 1984 and is an ongoing project until the funds run out. To be eligible for funding assistance, firms must be based in Saskatchewan and must engage in advanced technology.

Below are a list of the seven programs in ADP :

1. The Industrial Research Program

This program takes up 75 % of the $ 2.5 million budget. The government will contribute up to a maximum of 25 % of funding. Under this program, assistance may be provided to encourage research, development, and new product activities by Saskatchewan firms. It is intended to complement the National Research Council's IRAP, L, M, and P programs as well as the federal IRDP program, and provide support where these programs are deficient. There are approximately twenty projects under this program.

2. The Joint High Technology Program

Under this program, assistance may be provided to support projects in technology fields of high provincial priority where the Province is the customer. The program fills a niche not covered by any other and is extremely innovative in its concept. The program provides support for industry to carry out research activities in areas of mutual government and industry interest. Funding is provided up to 50 % of the eligible research costs. There are three projects underway in this program.

3. The Request for Proposals Program

This program provides the opportunity for more Saskatchewan companies to compete for large projects originating outside the province. The high cost of preparing proposals in response to a request for proposal dissuades many Saskatchewan companies from actively pursuing large research opportunities in response to a RFP at present. With support from this program companies can offset their costs, compete with other national firms and obtain more

contracts. This is intended to develop greater capability in the province and more employment. It provides funding up to one third of the cost of preparation for proposals where that cost exceeds a total of $ 10,000. There are four projects under this program.

4. The Feasibility Studies Program

This program is designed to help small companies with little marketing capability and limited technical capability. Given limited personnel and financial resources, small companies unable to accurately assess whether a proposal is technically feasible and will sell, can obtain outside assistance to answer these questions and avoid wasted effort in the development of a product which may not be viable. Support is limited to a maximum of $ 2,500 for both a technical and commercial feasibility study.

5. The Research Infrastructure Program

This program provides the means of creating necessary support functions to facilitate a viable advanced technology industry in Saskatchewan. When industry requires services available in an industrialized province which must be created in a developing province, government support is available, complementary to federal programs, to provide incremental funding over and above that which is available from other sources. There are five projects in this program.

6. The Capital Equipment Program

Under this program, the Saskatchewan government will provide up to 50 % of the cost of specified high technology equipment that may be required to perform specific research contracts initiated by industry. The eligible institutions are two Saskatchewan universities and the Saskatchewan Research Council. However, they must require 50 % or more of the funding from the contracting firm.

7. The Information Transfer Program

This program provides opportunities to bring industry-oriented technological information into the Province through such activities as seminars, conferences, invited guest speakers, etc. The support levels are negotiated on a cost-sharing basis between government and industry.

Technology Commercialization Program of Manitoba

This program is broken up into separate parts with a total budget of $ 2 million. It started in 1984 and is ongoing until the funds run out. Approximately 150 companies are involved in the program.

A. The first part of the program supports market studies of technological ideas that might lead to production of products into the market place. All funding is done on a cost share basis.

B. Technology Transfer

The provincial government will assist the transfer of technology from anywhere in the world to Manitoba, up to $ 75,000. The average life of these programs is two years.

Technology Commercialization Program of Alberta

This program was established in 1986 to assist in the diversification of Alberta's economic base by encouraging the development of advanced technology products and processes. It supports industry/university related centres for R&D; institutional research through shared projects with industry, innovation; and support for feasibility and opportunity studies.

Funding for 1989/90 is approximately $ 2.276 million, disbursed normally in the form of conditional grants that cover up to 50 % of eligible costs in 1986, more than $ 7.9 million has been committed to ninety six individuals and organizations.

Canadian Distance Learning Development Centre (CDLC)

The CDCL was created in 1987 by a consortium of six partners : Athabasca University, AT&T Canada Ltd., AGT, Access Network, Alberta Advanced Education and Alberta Technology, Research and Telecommunications. Its mandate is to research, develop, manufacture and market products to support the delivery of distance education.

The Alberta government's share of funding is a maximum of $ 5.1 million to 1991-92.

Each consortium member is to provide revenue in cash and kind for each of the five years of the research and development phase. Eighty percent of all development centre funds will be utilized for R&D and less than seven percent for administration. At the end of the five year agreement the consortium is to become a profit-based corporation.

WESTERN DIVERSIFICATION FUND

INTRODUCTION

Canada's four western provinces have enormous economic growth potential founded on agriculture, forestry, energy, mining, and fisheries. Throughout this century, primary resources have contributed to the rapid development of our country.

The West is vulnerable, however, to the uncertain demands of international commodity markets and fluctuating prices for its primary products. The result has been the creation of a "boom and bust" economy which has impaired business development, industrial growth and social stability.

To provide a counterforce to the periodic cycles of the marketplace, and to broaden and strengthen the economic base of the West, the federal government established a five-year, $ 1.2 billion diversification fund in August 1987.

A new federal government department, Western Economic Diversification Canada (WD), administers the fund through the Western Diversification Program. The Department is responsible for promoting the diversification of the Western Canadian economy and for advancing the West's interests in national economic policy.

PROJECT ELIGIBILITY

The most important factor determining whether a new project will receive assistance under the Western Diversification Program is the effect it will have on the diversification of the Western Canadian economy. In evaluating projects, the following questions are raised :

- Will the project introduce a new product or service to Western Canada?
- Does it take a Western Canadian product or service into a new export market?
- Will it introduce a new technology to Western Canada?
- Will it improve productivity throughout an industry in the West?
- Will it help Western Canadians replace imports from outside Canada with their own products?

If a project passes one or more of these "diversification test", it may be eligible for assistance. Projects also must conform to the following program principles.

1. Risk Sharing

The role of the Western Diversification Program is to "top up" - not replace funding available from other sources.

The projects WD assists will have significant equity participation by the applicant, and typically will include bank financing, venture capital or other government funding. In other words, WD will share the risk on a "last in" basis with other funding sources.

2. Incrementality

Western Diversification Program assistance must be necessary for the project to proceed. If the project could proceed in the absence of WD support, no assistance will be offered. Normally, applicants will be required to show that they are unable to raise sufficient financing from their own resources, conventional lenders, other equity partners or other government programs.

3. Committed Expenditures

If the applicant already is committed to a significant portion of the overall project costs, WD may interpret this to mean that the project likely would proceed in the absence of the Program's financial support and, consequently, no assistance will be offered. Western Diversification normally will not assist any project cost incurred prior to the applicant's acceptance of a Letter of Offer outlining financial support.

TYPES OF PROJECTS WD ASSISTS

The Western Diversification Program is designed to be flexible, and any project that meets the criteria will be given serious consideration. However, most assisted projects will be in the areas of :

- new product development/commercialization
- plant establishment
- new market development
- Industry-wide productivity improvement
- feasibility studies examining the market potential of new products, the commercial viability of new or expanded facilities and new technology

(provided a business plan has been completed and considerable preliminary market research work has been done)

- new technology

Projects of these types will be considered for WD funding providing :

- the applicant demonstrates an acceptable level of equity
- the project is not in a fully competitive industry where a Canadian competitor could be adversely affected as a consequence of WD assistance
- the project does not involve refinancing existing businesses or assistance to help complete an existing contract
- there is clear evidence of economic or employment benefits within the four western provinces

RELEVANCE TO VISION 2000

The companies located in the west can obviously apply for this fund to develop products and services in mobile communications. Assistance for RAD needed to develop a specific product and/or service would appear to qualify for consideration by the Program office. In fact, this program has already funded (partially) the construction of the following three reasearch facilities in the west :

- WESTAIN or Western Advanced Industrial Materials Initiative in Saskatchewan
  The $ 140 million project is being funded with $ 70 milion from industry, $ 30 million from the Government of Canada and $ 40 million from the Province of Alberta. The $ 30 million from the federal government includes $ 15 million from the WD fund, $ 10 million from NRC and $ 5 million from NRC.

- CFER or Centre for Frontier Engineering Research

  WD contributed $ 7.75 million towards the construction of an $ 18 million research facility in Edmonton. The Centre has been designed to facilitate low temperature structural and material testing in a unique combination of environments.

- Forest Research Establishment in Vancouver

  This centre will cost $ 30 million.

ATLANTIC CANADA OPPORTUNITIES AGENCY (ACOA)

This agency is similar to the Department of Western Diversification except its mandate is to help the economic diversification of the four Atlantic provinces. ACOA will receive $ 1.05 billion from 1987 to 1996.

It would appear that companies located in the Atlantic provinces could make use of this fund to undertake R & D needed to develop new products and services in mobile communications.

CONCLUSION

The world is changing, It is changing from an industrial based society to one based on information. Information and communication technologies will be as important to this society as transportation - railroads and highways were to the industrial society.

Information and communication technologies for the developed countries, have been growing at a rate much faster than the growth in GNP. In recognition of the strategic importance of technologies, many developed countries have instituted national and international collaborative R&D programs in these technologies. Although the monetary resources allocated to these programs are quite small compared to what is spent by private industry, they are not insignificant especially when we consider that they are focused in specific areas. In addition to advancing the development rate of technologies, these programs have many other useful effects such as fostering collaboration among industry, university and government and developing common standards.

When we study the rationale for instituting these programs, we find that the same rationales apply to Canada. While we cannot simply argue for a "Me Too" approach we also cannot ignore all these initiatives. Based on the analysis of these initiatives and analysis of our C&IT industries, a case can be made for a collaborate R&D program in Canada. While information technology is very important, we do not have much industry (except for software and services) which would benefit from an R&D program. This leaves us with communication technology. In communications technologies, mobile communications is the highest growth area. Unlike fixed communications where a large R&D effort is spent by BNR, there is no equivalent R&D effort in mobile communications. Thus a collaborative R&D program in mobile communications may be an appropriate Canadian response.

ANNEX 1

Summary tables for various programs

INTERNATIONAL R & D PROGRAMS IN C & I TECHNOLOGIES

WESTERN EUROPE

PROGRAM	ESPRIT	RACE	ALVEY	EUREKA	DELTA
FUNDING	$ 2.2B Cdn Phase I $ 4.4B Cdn Phase II 50 % Gov't 50 % Partners	$ 1.4B Cdn over 5 years 50 % Gov't 50 % Industry	$ 700M Cdn over 5 yrs $ 400M Gov't $ 300M Industry	$ 6.4Billion 35-40 % Gov't Share 60-65 % Partners	$ 56M Cdn 50 % Gov't 50 % Partners
TIMING	1983-1987 Phase I 1988-1992 Phase II	1987-1992	1983-1988	1985-	1989-1991 Explanatory Phase 1991-Main Phase
TYPE OF RESEARCH	Pre-competitive R & D-I More applications Oriented-II	Pre-competitive	Pre-competitive research	Product and service development	Applied product development
RESEARCH AREAS	Microelectronics Software Office Systems CAD/CAM AI	Integrated Broadband communications - Technology - Standards - Implementation	VLSI AI Software Eng. Man machine interface	Biotechnologies communications Energy Environment IT Lasers New materials Robotics Transport	Intelligent Courseware Authoring Systems Distant Education Communications Infrastructure
PARTICIPANTS	Gov't Labs Industry Universities	Industry Universities Gov't	Industry Universities Gov't Labs	Industry 80 % Universities Research Institutes Gov't	Industry Gov't Universities
# OF PROJECTS	225 ESPRIT-I 153 ESPRIT-II 1st year	306 firms Over 100 projects	300 + projects 115 firms 24 Research Institutes 68 Universities	297 June '89 1600 Firms and Research Initiatives	30 projects
BACKGROUND	Poor performance by industry Strategic importance of IT Japanese Initiative	Large telecom sector Technology push International initiatives	Japanese 5th Generation Poor IT Industry Performance Strategic importance of IT	As a response to SDI	Skills upgrading becoming more critical in the information society

INTERNATIONAL R&D PROGRAMS IN C&I TECHNOLOGIES

U.S.

PROGRAM	SDI	SEMATECH	MCC
FUNDING (Gov't Share)	$ 15B 1985-1989 $ 42B 1989-1993 $ 250 to $ 450B 1993- 100 % Government	$ 200M per year 50 % - DOD 50 % - Industry	$ 70M 1989 Mainly Industry DARPA sponsors some projects
TIMING	1985-1993 Definition Phase 1993-2003 Phase I 2003 + Phases II and III	1989-1990 Phase I 1989-1992 Phase II 1990-1993 Phase III 1993 + Phases IV & V	1982- Permanent Entity
TYPE OF RESEARCH	Mission Oriented	Applied Research	Longterm application driven
RESEARCH AREAS	Artificial Intelligence Software Engineering Lasers Computer Communications Satellites	Semiconductor Chips Manufacturing Techniques Training	Computer technology Chip Design Software Engineering
PARTICIPANTS	Government Industry Universities	Industry Universities Government Labs	Industry mainly Some University contracts
# OF PROJECTS	150 contracts by 1987	Owns its own research centre	Owns its own research centre
BACKGROUND	Part of Defence Strategy	Poor Performance by U.S. companies	As a response to Japanese Fifth Generation Project

INTERNATIONAL R&D PROGRAMS IN C&I TECHNOLOGIES

JAPAN

PROGRAM	FIFTH GENERATION PROJECT	FRONTIERS RESEARCH
FUNDING (Gov't Share)	$ 850 U.S. $ 450 Government $ 400 Industry	
TIMING	1982-1991	1988
TYPE OF RESEARCH	Mission Oriented Pre-competitive Has a centralized research facility	Longterm Basis
RESEARCH AREAS	Fifth Generation Computer Knowledge-Bsed Machines Machne Translation etc...	Intelligent Networks High Capacity Transmission User Friendly Interfaces
PARTICIPANTS	Industry Government Universities - Advisory Function	Industry Government Universities
# OF PROJECTS		
BACKGROUND	Poor performance of IT companies Strategic importance of IT	Technology Push

ANNEX 2

Selection Criteria

ESPRIT

ESPRIT is open to anyone in the Community who can contribute to it within the terms laid down;

1. Participants must already be established in the EEC and carrying out R&D in information technology in the Community.

2. ESPRIT participants must have a partner in another EEC country. Contracts are awarded to research teams that, as a rule, include at least two independent industrial partners from different Member States. This ensures industry's involvement and the transfer to technology across at least one border.

In ESPRIT I, only 20 % of all project proposals were accepted. In ESPRIT II, 25 % were selected. Two of the common characteristics of successful projects noted were : a) the strong financial and moral commitment by industry participants and b) the intergration of academics within the project.

Most projects were financed on a cost share basis between industry and the European Commission. It usually takes one to two years for a project to get approved within ESPRIT.

RACE

The two points of criteria for the RACE program are the same as the ESPRIT program.

EUREKA

1. EUREKA projects must relate primarily to products processed in the following areas of advanced technology : information and telecommunication, robotics, materials, manufacturing, biotechnology, marine technology, lasers, environment protection and transport technologies.

2. Cooperation between participants in more than one European country.

3. Appropriately qualified participants - technically and managerially.

4. EUREKA project involvement, management, cooperation, finance, nature of project, will result from the consultations among relevant parties. The participants in the project will finance the project from their own funds, the capital market and any public funds made available to them.

5. Governments of countries of enterprises/institutes participating in an agreed project, and the Commission of the European Communities when appropriate, will establish its compliance with the objectives and criteria laid down for EUREKA. They will then jointly inform the Conference of Ministers through the High Representatives meeting as a group. Such information will include a project description, an analysis of compliance with the objectives and criteria of EUREKA, and an indication of any additional members involving third parties.

EUREKA is much simpler to become a participant than ESPRIT. If the criteria is met, you will be allowed to enter EUREKA, whereas with ESPRIT there is a selection process and only 20 % of all projects submitted are chosen.

DELTA

1. Like other programs organized through the Commission, DELTA requires the participation of at least two independent partners in two different Member States. One of them must be a commercial enterprise.

2. Research carried out in the DELTA program must be pre-competitive meaning that cooperation aims at the development of emerging technologies rather than marketable products.

ALVEY

ALVEY is a national project within the UK. To submit a project ther must be at least two participants. The firm or institute must be based within the UK. The projects are submitted to the Directorate. The ALVEY Directorate has not operated a regular deadline system for the receipt of proposals, dealing with them instead when they arrive and when resources are available. The Directorate has received 666 projects : accepted 267, rejected 218 and is considering 181.

STRATEGIC DEFENCE INITIATIVE (SDI)

SDI is wholly operated through the Department of Defense (DOD). The DOD contracted out over 900 SDI projects to industry in 1987 alone. DOD decides on the research to be done and obtains contracts through competition (ie. for one contract two contrators could be selected for one year, in the second year one of the two will be selected to continue the project).

SEMATECH

SEMATECH is an industry/government funded program with fourteen corporations involved. To become a participant, a minimum of $ 1 million is required, plus an additional and unnecessary support for Semiconductor Research Corp., a North Carolina university research effort.

MICROELECTRONICS AND COMPUTER TECHNOLOGY (MCC)

Any company which is substantially owned and controlled by U.S. citizens is eligible to become an MCC shareholder. When a company becomes a shareholder, it purchases one share of stock and agrees to participate in at least one of MCC's research programs. The companies which have chosen to participate in a program, equally share the annual cost of the program.