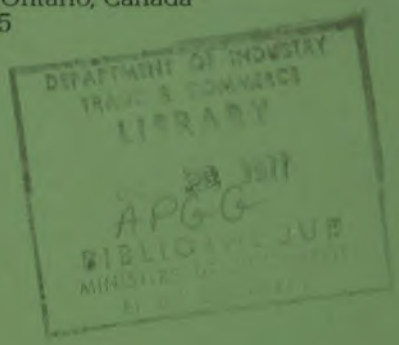
Computer-Aided Design and Manufacturing in Canada

Directory of Canadian Companies Computer-Aided Design/Computer-Aided Manufacturing

Prepared by: Technology Branch
Department of Industry, Trade and Commerce
240 Sparks Street
Ottawa, Ontario, Canada
K1A 0H5



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FOREWORD

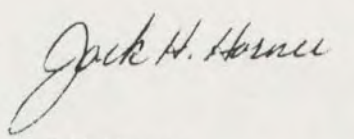
Canadian industry is facing increased competition for its products in international markets. Accordingly, more importance must be placed on greater productivity in both the private and public sectors to ensure that the Canadian economy can meet this challenge. More emphasis must, therefore, be placed on increasing investment in production facilities, on shifting existing productive resources to more efficient uses and on effectively deploying both new indigenous and imported technology.

In this latter regard, the Department of Industry, Trade and Commerce has identified a number of emerging technologies that could have a beneficial impact on the Canadian economy if fully utilized. Among these is the use of computers in design and manufacturing operations, particularly in discrete parts manufacturing. The designation, Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM), is widely used to describe these technologies. While not entirely new, these technologies are in the early stages of what appears to be an explosive growth in new applications similar to that which occurred in the field of automated process control in the late 50s and early 60s. The Federal Republic of Germany and Japan are acknowledged leaders in these fields. Both countries have substantial research programs funded jointly by government and industry, which directly support the development of new manufacturing technology. The practical applications resulting from these programs have been impressive and will warrant continuing scrutiny for possible application in Canada.

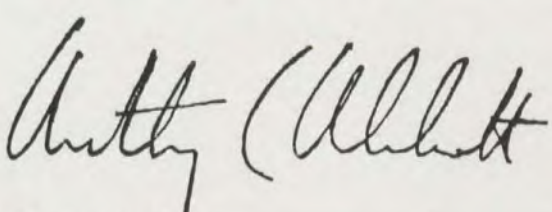
Over the next decade these new applications will affect a major part of Canada's design and manufacturing capability in a number of important areas including the metalworking, electrical and non-electrical machinery, communications equipment, consumer electronics, transportation, furniture and apparel industrial sectors. Surveys show that about 75 per cent of all metalworking products are manufactured in short production runs. This has historically inhibited the widespread use of advanced manufacturing automation and has been a particular problem for Canadian industry due to the wide product variety and short production runs encountered in many Canadian plants. Unlike production line automation of the past, which required product standardization and long production runs in order to justify the large capital investment required, CAD/CAM systems, by virtue of their flexibility, can be economically justified for short run batch production, and therefore present unique opportunities for Canadian business.

However, it is difficult to predict when specific applications of these technologies will be generally available or indeed how they will develop. In the immediate future most applications will be developed for medium and large companies that have the financial and technical resources to manage complex projects. However, as the technological "know-how" becomes more readily available and the applications become more standardized, the benefits of these technologies will flow more and more to the smaller companies.

Earlier this year, representatives of the department visited more than 5,000 Canadian businessmen as part of the *Enterprise Canada 77* program to find out how well existing government programs and services were being received and to identify the major concerns of the business community. Two of the major concerns expressed were associated with the problems of increasing company productivity and the need for government services which would complement existing government programs in helping Canadian industry to improve operational efficiency and profitability. This directory and the companion Maclean-Hunter publication "CAD/CAM and Canada" are directed to these concerns. It is hoped that these publications will be a useful addition to the information available to Canadian business and encourage interest both in the wider use and development of CAD/CAM technologies in Canada.



Jack H. Horner
Minister of Industry, Trade and Commerce



Anthony C. Abbott
Minister of State, Small Business

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Suppliers of Consulting/Design Services

INTRODUCTION

This is the first published directory devoted solely to organizations in Canada active in the field of Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM). It became quickly apparent during the Department's initial investigation of automated design and manufacturing technologies that there was a general lack of information in these areas, particularly on Canadian supplier capabilities. It is hoped that this initial CAD/CAM directory will fill this information gap.

The directory was compiled by Corpus Publishers Services Limited with the technical assistance of the Technology Branch and the Industry Sector Branches of the Department of Industry, Trade and Commerce. The directory contains 127 listings which were prepared from questionnaires supplemented by interviews in a few cases. A number of organizations have been described in some detail to illustrate the variety of products and expertise available in Canada. Listings appear under the following five headings: Suppliers of Equipment, Suppliers of Consulting/Design Services, Research Organizations, Educational Institutions, and Associations and Societies.

The criteria for inclusion in this directory are as follows:

a. The capability to supply complete systems, major equipment components or services directly related to automated design or manufacturing applications.

b. An existing office or business address in Canada.

Because of these criteria many major suppliers of related equipment including suppliers of machine tools, material handling equipment and controls and instrumentation have not been included. Listing for these companies can be found in their corresponding industrial catalogues and directories.

While the listings in this directory are believed to be comprehensive, undoubtedly some organizations have been missed. Applications for future listings, changes to existing listings or general enquiries should be addressed to:

CAD/CAM Directory
c/o Technology Branch
Department of Industry, Trade and Commerce
240 Sparks Street
Ottawa, Ontario, Canada
K1A 0H5

Suppliers of Equipment and Consulting/Design Services

Acco Canadian Material Handling

Division of Welland Forge Ltd.
1100 Blair Road
Burlington, Ontario, Canada
L7M 1K9
Tel: (416) 354-2296
Chief Executive Officer and Senior Marketing Executive: R. P. Lane, General Manager

Activities: Supply computerized parcel sorting, mail handling, equipment, package conveyors, conveyor systems; provide consulting services; design and install systems.

Acres Consulting Services Limited

20 Victoria Street
Toronto, Ontario, Canada
M5C 1Y1
Tel: (416) 362-6131
Telex: 06-217815
Chief Executive Officer: H. Rynard, President
Senior Marketing Executive: G. Warnock, Marketing Manager

Activities: Design systems, provide consulting services, conduct research and development; special expertise in mathematical modelling, graphics and finite element analysis system for product design.

Ahearn & Soper Ltd.

29 Enterprise Road
Rexdale, Ontario, Canada
M9W 1C4
Tel: (416) 245-4848
Chief Executive Officer: J. H. Paul, President
Senior Marketing Executive: P. Fedak, Vice-President

Activities: Sell electrical and electronic instruments and equipment; through affiliate, manufacture computer printer terminals.

This company has a long and interesting history dating back to its formation in 1881 as an electrical contracting company. In 1948 it turned to the marketing of sophisticated electrical and electronic instruments and equipment, and one of the companies it now represents is Versatec, a Xerox company. Versatec produces electrostatic printers and plotters–units used extensively in computer-aided design systems.

The Matrix Electrostatic Writing Technique (MEWT) used by Versatec is particularly practical for design applications, and the plotters' ability to convert massive computer data into revealing graphics makes them specially suited to computer-aided design of integrated circuits and printed circuit boards, as well as architectural and construction simulations. A Versatec plotter or printer/plotter can be used to provide fast "check plots" as well as final drawings.

Through Viditon Corporation Ltd., an affiliated Toronto company, Ahearn & Soper also manufactures and markets a high-performance printer terminal for computer communications. This multiwriter terminal, which incorporates a Diablo Hytype printer, was selected among others by the Ministry of Transport for Canada's new air traffic control system.

The Viditon terminal has obvious applications in the CAD field as an input console to instruct a digitizer, for software program development, or for preparation and editing of NC tapes, using intermediate magnetic tapes. For production or process control, the Viditon terminal is being used for the high-speed print-out of alarm and other conditions.

Alfred Herbert (Canada) Limited

19 Shorncliffe Road
Toronto, Ontario, Canada
M9B 3S4
Tel: (416) 233-3206
Telex: 02-2698
Chief Executive Officer and Senior Marketing Executive: J. E. Farndon, Managing Director

Activities: Supply computer numerical control turret lathes and four lines of numerical control machining centres: Batchmatic; Ooya; Matsuura; and Dainichi.

Allan Crawford Associates Ltd.

6427 Northam Drive
Mississauga, Ontario, Canada
LV4 1J5
Tel: (416) 678-1500
Chief Executive Officer: R. Dunne, President
Senior Marketing Executive: F. Misener, Vice-President and General Manager

Activities: Supply electrostatic printer/plotters produced by Instrument Systems Division, Gould Inc., Cleveland, Ohio; Gerber plotters for line layouts, maps and PCB design; Fluke-Trendar logic board testers: Plexus network analyzers.

Allen Bradley Limited

135 Dundas Avenue
Cambridge (Galt), Ontario, Canada
N1R 5X1
Tel: (519) 623-1810
Telex: 069-59317
Chief Executive Officer: R. K. Thomas, President
Sales Manager: W. C. T. Torrance

Activities: Design, furnish and install complete production-line systems tailored to customer needs; design products and/or systems, manufacture products; provide consulting services; sell products and/or systems; conduct research and development; computer numerical control, direct numerical control, programmable controllers, lathe control systems, programmable control of paper mill processes and machines, transfer lines and automotive industry, numerical control systems in aircraft.

Ammco Industrial Equipment Limited

37 Voyager Court North
Rexdale, Ontario, Canada
M9W 4Y2
Tel: (416) 677-7761
Telex: 06-968718
Chief Executive Officer and Senior Marketing Executive: W. A. MacTavish, President

Activities: Manufacture products; provide consulting services; sell products and/or systems - numerical control equipment, gear hobbing equipment, tracer lathe, gear production, shaft/axle production, boring mills, experimental machining centres; conduct research and development.

Atomic Energy of Canada Limited (AECL)

275 Slater Street
Ottawa, Ontario, Canada
K1A 0S4
Tel: (613) 237-3270
Telex: 053-3126
R and D facilities, containing CAD capability;
Chalk River Nuclear Laboratories
Chalk River, Ontario, Canada K0J 1J0
Chief Executive Officer: J. S. Foster, President
Contact: J. Nelles, Office of Industrial Co-operation

AECL maintains two CAD facilities at its Chalk River Nuclear Laboratories. The electronics group uses an Advanced Design System (A.D.S.) tailored to the specific requirements of electronic design. The Design and Technical Service Branch has a facility which is used as a general design aid.

AECL does not normally offer these facilities to industry. However, organizations directly involved in nuclear programs are welcome to contact the Office of Industrial Co-operation in Ottawa to arrange for access to the personnel and expertise involved. Non-nuclear related organizations will be accommodated on a case-by-case basis.

Autotech Controls Limited

80 Fassett Avenue
Hamilton, Ontario, Canada
L9C 4E7
Tel: (416) 389-4703
Chief Executive Officer: H. C. Wehrfritz, President
Senior Marketing Executive: L. G. Bedford

Activities: Design, furnish and install complete production-line systems tailored to customer needs; design, manufacture and sell products and/or systems; provide consulting services; conduct research and development; provide CAM for tape preparation used with punch presses; provide post processors for various numerical control machines; computer-controlled lathes.

Specializing in state-of-the-art automation, this young company is headed by two engineers with high levels of training and experience in the application of computers to unusual problems. In addition to the custom designing of systems, the company will supply both software and hardware, including the Digital Equipment PDP-8 and PDP-11 computers around which most of its systems are designed.

Autotech has also developed a number of proprietary systems, including a computer-aided NC tape production system intended primarily for punch presses but with certain applications to lathes and milling machines.

Among special features of the system are the incorporation of sequence optimization to minimize unproductive movements, and the ability to use it for the preparation of post-processors. The system uses EIA or ASCII formats, and can accommodate inch/metric, decimals and fractions. Dahlstrom Canada Ltd. is one well-known user of this development.

Another Autotech idea now under development is a graphics display system that would enable designers to optimize the layout of parts to be cut from a sheet of material - metal, wood or textile - so as to minimize scrap.

Autotech has been responsible for the electronic design of the dedicated computer control system for the Mimik Datadrive (see Mimik Ltd.). One of the most unusual features of this system is that the programs can be prepared (and stored) on magnetic tape and then transferred electronically into the system memory. Alternatively they can be prepared on mark-sense cards, or the system can be programmed manually. Whatever program preparation method is used, the programs can be modified manually at any time.

A further indication of Autotech's versatility is the company's development of a sequencing and information display system used by a cable television company for automated programming, and a system used by the local Hamilton television station to monitor, analyze and continuously update election results as they come in, and present them in proper format and sequence.

Aviation Electric Ltd.

200 Laurentian Boulevard
Montreal, Quebec, Canada
H4M 2L5
Tel: (514) 744-2811
Telex: 05-826688
Chief Executive Officer: Earnest Wall, President
Senior Marketing Executive: C. D. Garbutt, Vice-President, Marketing

Activities: Represent Bendix Computer Graphics in Canada; provide computer-aided design and drafting systems; computer input tables for graphic data; free cursor digitizers; high-accuracy, light table digitizers.

Barer Engineering & Machinery Co. Limited

1365 Basin Street
Montreal, Quebec, Canada
H3C 1W3
Tel: (514) 937-3911
Telex: 05-267585
Chief Executive Officer: A. Barer, President
Senior Marketing Executive: K. Fry, Vice-President, Sales

Activities: Provide computer numerical control machining equipment; design, furnish and install complete production-line systems tailored to customer needs; provide consulting services.

Barker Industrial Equipment Ltd.

261 Bowes Road
Concord, Ontario, Canada
L4K 1B1
Tel: (416) 661-2280
Telex: 06-964548
Chief Executive Officer: Grant Horsey, President
Senior Marketing Executive: Ray Bates, Sales Manager

Activities: Provide computer numerical-controlled tooling equipment; represent Heyligenstaedt, Pittler, Butler, Scharmann, and Beaver in Canada.

Bell-Northern Research Ltd.

P.O. Box 3511, Station "C"
Ottawa, Ontario, Canada
K1Y 4H7
Tel: (613) 596-2210
Telex: 053-3175
TWX: 610 562-1914
Chief Executive Officer: Dr. C. D. Hall, President
Senior Marketing Executive: Ray Fortune, Manager of Marketing

Since the early 1970s, Bell-Northern Research (BNR) has been solving increasingly complex design problems through the use of its in-house expertise in computer-aided design (CAD). BNR, the largest private laboratory in Canada, provides the necessary research and development for Bell Canada and Northern Telecom Limited, on a project basis. BNR services and technologies have been made available to outside customers since 1973. Research programs, product development, consulting services and educational programs can be provided.

CAD at BNR grew from the need to provide fast, accurate circuit designs of new custom-built large-scale integrated (LSI) devices for Northern Telecom's advanced telecommunications products. The Computer Systems Technology group responded to that requirement with the development of "GRAPPLE" (Graphics Application Programming Language). GRAPPLE is a self-contained high-level language with which engineers from a wide variety of disciplines, ranging from architecture to buried cable routing, can interact conveniently with a computer database, to create, alter and manipulate graphic information. Since GRAPPLE was announced publicly in 1973, BNR scientists have applied it to several design problems. The company is also making the language available to other users (see Systems Approach Limited).

The first application of GRAPPLE at BNR was LOGIFLEX. This is a design service with which complex integrated circuits can be designed quickly by calling up from memory a wide range of pre-designed functional logic blocks. Since each logic block has been previously tested and verified, the LSI device which results from the interconnection of these circuit elements has a high yield and high reliability. The resulting saving of circuit designer's time has proved extremely valuable to the users of this service.

As part of its computer-aided design programs, BNR has developed a new system that uses the computer to assist in the layout and documentation of printed circuit boards (PCBs). This cuts down on the time between conception and fabrication of a PCB and significantly reduces the chances for errors. The project is known as the Circuit Pack System (CPS) and comprises a System for Placement and Routing using Interactive Graphics (SPRIG), as well as a schematic system (LOKI).

To use SPRIG, the schematic diagram of the PCB is entered into the system, specifying the components and their interconnections. SPRIG then assigns all logic functions to appropriate ICs, places all circuits on the board in the optimal positions and automatically interconnects all components. The user of SPRIG sequentially performs these operations by invoking the appropriate commands from the SPRIG command set. Typically, automatic routing completes between 95 and 98 per cent of the layout of a PCB. The remainder is done manually, using a powerful graphics editing system. The LOKI schematic system permits the layout and routing of aesthetically pleasing schematic diagrams for product documentation purposes.

In support of diverse R and D activities, BNR has developed numerous computer aids in the form of utility packages and application software. Cross Assemblers, a file backup and recovery system, a word processing system, logic simulator, and circuit analysis are but a few of the notable achievements.

At BNR, a multidisciplinary resource incorporating computer hardware and software experts, system and circuit designers, outside plant and mechanical engineers, are available as a problem-solving service to clients. BNR will act as an R and D contractor or as the front-end liaison for the licensing of its technological developments on behalf of Northern Telecom, but is not specifically in the business of creating stand-alone systems on a multi-copy basis.

Beta Machinery Analysis Limited

R.R. 4
Calgary, Alberta, Canada
T2M 4L4
Tel: (403) 286-2121
Chief Executive Officer: Dave Schuh, President

Activities: Design products and/or systems; provide consulting services; conduct research and development; dynamic structural analysis of piping systems for vibration and pulsation control; performance calculations for multistage reciprocating compressors.

CADSYS Limited

205, 10240-124th Street
Edmonton, Alberta, Canada
T5N 3W6
Tel: (403) 482-2357
Telex: 037-3552
Chief Executive Officer: A. M. Lount, President
Senior Marketing Executive: A. D. Turnbull, Executive Vice-President

This company designs and supplies special-purpose computer systems for both CAD and CAM. It has developed a system that combines both design and manufacturing information in one system.

CADSYS Limited was acquired in June 1976 from Great West Steel Industries by the operating staff of its former Taskmaster Computing Systems division. Company president A. M. Lount has been involved in the CAD design field since 1957, and can identify with at least two CAD systems, used in the detailing of reinforcing steel, which he developed in Toronto in the early 1960s and which are still in operation by major U.S. companies.

As a result of the many years of experience of its senior personnel, CADSYS has established a philosophy that says one cannot economically automate production lines unless the production data is captured early in the design phase. A typical application occurs in a steel detailing system which enables a computer to translate basic engineering designs into shop drawings and instructions. For instance, starting with seven basic specifications (load, span, spacing, etc.) for a steel joist, the CAD system developed by GWS produces 32 pieces of information on the size of members in the joist. By adding a further five pieces of clearance data to this information, the design engineer then produces about 95 pieces of shop detail information. A similar approach is used in structural steel detailing developed for general use.

Through collaboration with the Somel company in Paris, France, CADSYS can now take this important CAD technique a stage further - to the computerized preparation of punched paper tapes for numerically controlled machine tools. The company also expects to extend its CAD/CAM concepts into the design and production of concrete beams and slabs, and even to electrical distribution systems and piping layouts. One of the important features of its systems is that engineering intervention is possible at any stage in the chain of events, as opposed to a fully automated system in which the computer assumes full control.

The company can now offer a complete hardware and software package, including an Interdata 732 computer with an extended time-sharing virtual memory. This in effect provides a large organization with its own in-house time-sharing CAD system, at a price well below the cost of renting equivalent time-sharing services and with many additional benefits.

CADSYS now offers its steel detailing service to fabricators around the world, and has had particular success in export markets, notably Mexico (where the system has been employed in the development of three power plants), France and Britain.

For architects, CADSYS is looking toward the development of an original approach to interactive graphics. Instead of basing the system on an interactive tablet, the firm proposes to capture data, put this into a data base, and from this data base develop a file that can then be worked on interactively.

CAE-Morse Limited

6600 Trans Canada Highway, Suite 200
Pointe Claire, Quebec, Canada
H9R 1C2
Tel: (514) 695-0010
Telex: 05-822610
Chief Executive Officer: A. R. Tunis, President
Senior Marketing Executive: M. S. Hayes, Vice-President

Activities: Sell NC machine tools and production automation equipment.

CAE-Morse was formerly the Robert Morse Corporation Ltd., a company founded in 1898 and known then as the Canadian Fairbanks-Morse Company. It became the Robert Morse Corp. in 1958, and was acquired by CAE Industries Ltd. in 1975. Since its earliest days the company has been selling and distributing industrial equipment and machinery. Today it has branches in every major city across Canada.

One of the company's chief principals is the Sundstrand Machine Tool Division of the Sundstrand Corp. of Belvidere, Ill. This manufacturer offers a variety of machine tools, complete with numerical control or direct numerical control. The Sundstrand Omnicontrol DNC system allows basic NC expansion to full DNC, capable of providing control paths for up to 40 machines but built up in modular form as required.

Another CAE-Morse principal is Unimation Inc. of Danbury, Conn., which manufactures "industrial robots." These are designed to perform tasks that are too hazardous, too onerous, too boring or simply too uneconomical for humans. The robots receive "on-the-job-training," being led through the steps they are to perform, point-to-point. These steps are recorded in the machine's solid state programmable memory which has a capacity for up to 1,024 program steps. Unimate robots have been used in machining systems for processing parts from raw castings to finished goods, employing the principles of group technology.

CAE-Morse also represents the Yamazaki Machinery Works, of Florence, Ky., a company manufacturing lathes to which can be fitted numerical controls supplied by other manufacturers. Teledyne Pines, of Aurora, Ill., another CAE-Morse principal, has a range of pipe-bending machines with numerical control. Among the many other companies represented in Canada by CAE-Morse, those of CAD/CAM interest include the Machine Tool Company Division of Giddings & Lewis, in Fond du Lac., Wis., which builds machine tools of various kinds with computer numerical control; American SIP Corporation; the Hydra-Point Division of Moog, Inc., and the Onsrud Machine Works, Inc.

Canadian Advanced Production Consultants Ltd.

15 Greenview Street
Dollard des Ormeaux, Quebec, Canada
H9A 2E6
Tel: (514) 684-6008

968A Wilson Avenue
Downsview, Ontario, Canada
M3K 1E7
Tel: (416) 633-9525
Chief Executive Officer and Senior Marketing Executive: John J. Nassr, President

Activities: Provide management consulting and computer-aided programming; design of manufacturing methods, procedures and tooling.

In 1971, John J. Nassr left Canadair Ltd. and set up a consulting firm that uses computers to solve industrial problems.

Most projects undertaken to date involve the analysis of a customer's automated machining requirements and designing programs, tooling and operating/manufacturing procedures. For computer-aided programming applications, APT/ADAPT source data is fed into a computer which prepares an eight-level punched tape suitable for driving NC machines or automatic drafting equipment. The company rents computer time and machinery to test solutions before turning them over to a client.

Canadian Advanced Production Consultants Ltd. assists clients in selecting tools and machinery if requested and offers time-sharing of its computer systems for NC users.

Canadian Bechtel Ltd.

250 Bloor Street East
Toronto, Ontario, Canada
M4K 3K5
Tel: (416) 928-1600
Telex: 06-23266
Chief Executive Officer: R. H. Paul, President
Senior Marketing Executive: R. P. Ehrlich, Business Development Manager

Activities: Provide computerized drafting, equipment lists and specification editing services.

Canadian General Electric Co. Ltd.

Power Generation Department
Park Street
Peterborough, Ontario, Canada
K9J 7B5
Tel: (705) 742-7711
Chief Executive Officer: R. Abel, General Manager

Activities: Sell systems; design and supply control systems using process computers; provide nuclear reactor refuelling control systems and computerized drafting systems for electrical connections.

Canadian General Electric Co. Ltd.

Communications Systems and Service Department
Information Services Business Section
Manufacturing Branch, Industrial Branch
1420 Dupont Street
Toronto, Ontario, Canada
M6H 2B2
Tel: (416) 534-6511
Senior Executive Officer: Jack Norlen, Ontario District Manager
Senior Marketing Executive: D. E. Burnett, Manager, Manufacturing Branch, Information Services

Activities: Sell GE's MARK III time-sharing system for design, engineering and manufacturing; provide numerical control programming and workshop scheduling on a time-sharing basis; N/C languages available are A.P.T., ADAPT, GETURN (Lathe Programming System); provide other software packages including FORTRAN, data management systems.

Canadian Liquid Air Ltd.

1210 Sherbrooke Street West
Montreal, Quebec, Canada
H3A 1H8
Tel: (514) 842-5431
Telex: 05-268561
TWX: 610-421-3204
Chief Executive Officer: P. Salbaing, President
Senior Marketing Executive: B. Cooper, Vice-President

Activities: Provide automatic welding machine and automatic flame cutting equipment incorporating the USL Linatrol HL 10 TC tractor photoelectric tracer.

Cincinnati Milacron Canada Limited

122 North Queen Street
Toronto, Ontario, Canada
M8Z 2E4
Tel: (416) 233-3216
Chief Executive Officer: Bert C. Taylor, President
Senior Marketing Executive: Ray White, Operations Manager

Activities: Provide computer numerical control systems, computer-controlled machining centres, technical support, mini-computers, CNC hardware, backup equipment, and consulting services.

Computel Systems Limited

1200 St. Laurent Boulevard
Ottawa, Ontario, Canada
K1K 3B8
Tel: (613) 746-4353
Telex: 053-3619
Chief Executive Officer: R. T. Horwood, President

Activities: Provide consulting services; conduct research and development; provide computer resources for CAD/CAM; acquire and support specific CAD/CAM packages or programs; provide terminal equipment on lease back; provide programs - econometrics, engineering, graphics and plotting, linear programming; mathematics/ statistics, simulating, project management, DYNAMO program for compiling and executing continuous simulation models, SYMAP program for production of maps and diagrams which graphically depict spatially-disposed quantitative and qualitative information.

G. A. Computer Inc.

7225 Woodbine Avenue
Markham, Ontario, Canada
L3R 1E4
Tel: (416) 495-9434
TWX: 492-4450
Chief Executive Officer: D. Greene, General Manager
Senior Marketing Executive: Dennis Acton, Sales Manager

Activities: Supply turnkey computerized control systems for numerical control equipment.

Computer Assembly Systems Ltd.

75 California Avenue
Brockville, Ontario, Canada
K6V 5Y6
Tel: (613) 342-5041
Chief Executive Officer: Hugh T. Watt, President
Senior Marketing Executive: David I. Snell, General Manager

Activities: Develop microprocessor-based production equipment for assembly of electronics products. Represent Moducomp in Canada; software development by sister company, NARDAC.

Computer Assembly Systems Ltd. was established in early 1974 to provide a central service to electronics manufacturers not able to make the investment in computer-based equipment for high-volume assembly of electronic components onto printed circuit boards. Its major clients are located in the Montreal-Toronto-Ottawa region, plus a few in New York state.

Central to the Computer Assembly Systems operation are Dyna/Pert computer-controlled insertion systems designed and manufactured by the USM Corporation of Beverley, Mass. The company uses two types of insertion machines: one for integrated circuits in a dual-in-line package; the other for axial lead components that have various distances between the two holes, depending on the physical size of the component. The variable centre machine takes axial lead devices from a pre-prepared components tape and inserts them precisely in their correct positions on the circuit board.

The inserting machines are under the control of a Digital Equipment Corporation PDP-8E computer, driven by a punched paper tape. The currently accepted method for preparing the paper tape involves manual programming with a teletypewriter machine. This method requires about eight programming hours for a 200 insertion program. In co-operation with an associated company, NARDAC, Computer Assembly Systems has designed a microprocessor system that reduces the programming time to about 20 minutes.

A sample printed circuit board is placed on a plotting table with X-Y controllable axes. Using an optical device, the co-ordinates of the zero point are determined. In the case of the paper tapes for the integrated circuit inserting machine, a corner hole of each of the IC devices is located optically. The X-Y plotter is connected to a digital readout device that converts the analog location information to BCD (binary coded digit) format. A special key on the teletypewriter is pushed, and the Moducomp model 80 microprocessor writes a full program line.

For variable centre distance devices, two readings are necessary. One hole is located, and a key pressed; and then the second hole is located, and another key pressed. The processor writes the full program line when the second key is pressed. The program tape can be prepared as quickly as the operator can locate insertion holes on the sample board.

The company had only a working prototype as of the end of 1976, but planned to build a more refined production version. Discussions were also being held with USM Corporation for the possible marketing of the device as the programmer is intimately involved with the computerized automated insertion equipment made and sold by the company.

Computer Assembly Systems plans to seek out other opportunities to solve production problems using microprocessors. The company is not limited to the printed circuit applications, and invites inquiries concerning other areas. Computer Assembly Systems will look after the hardware and NARDAC will develop the software.

Computrex Centres Limited

2000 Elveden House
Calgary, Alberta, Canada
T2P 0Z3
Tel: (403) 263-1190
TWX: 610-821-0964
Chief Executive Officer: G. Martin Kernahan, President
Senior Marketing Executive: D. Young, Eastern Division Manager

Activities: Design and maintain systems; provide consulting services; sell products and systems; conduct research and development; map, store, and retrieve information from map and engineering drawings.

Consolidated Computer Inc.

2421 Lancaster Road
Ottawa, Ontario, Canada
K1B 4L5
Tel: (613) 731-7080
TWX: 610-562-1663
Chief Executive Officer: L. Sellemeyer
Senior Marketing Executive: P. Baines

Activities: Provide a line of data preparation devices using a mini-computer to organize and edit input from terminals and file the data on magnetic tape. Scan-Optics, Inc., of East Hartford, Conn., has adapted CCI's Key-Edit 60 and Key-Edit 1000 models to accept OCR (optical character recognition) input. The Scan-Edit is used for such applications as inventory control, direct input of documentation, or for retail sales applications.

Control Data Canada, Ltd.

50 Hallcrown Place
Willowdale, Ontario, Canada
M2J 1P7
Tel: (416) 492-4000
TWX: 610-492-1356
Chief Executive Officer: G. Hubbs, President
Senior Marketing Executive: W. G. Glover, Senior Vice-President

Activities: Provide, through its CYBERNET computer services network, a wide range of data processing assistance to both large and small businesses, including over-the-counter, remote batch and conversational time-sharing services. Among the many batch application programs available are MRI/STARDYNE - a series of programs for structural analysis; EAC/EASE - an advanced structural analysis system for three-dimensional structures; CDC/NASTRAN for structural analysis of aircraft, spacecraft, shells and pressure vessels, towers, bridges and industrial machinery; and APT for creating NC instructions. In conversational time-sharing, programs include STRU-PAK for structural analysis. SYSCAP II is a circuit analysis program and is available interactively or for batch.

Control Data came to Canada in 1962, under an agency agreement with Computing Devices of Canada Ltd. In 1965, Control Data Canada, Ltd. was formed as a wholly-owned subsidiary of Control Data Corporation of Minneapolis, Minn. Subsequently, in 1969, Computing Devices of Canada was acquired and is now a division of Control Data Canada, Ltd.

In 1970, Control Data signed an agreement with the federal Department of Industry, Trade and Commerce through which the Canadian government shared the cost of moving the technological development of an entirely new series of computers to Canada. The first multi-million dollar STAR 65 computer, developed under the program, and one of the most powerful computer systems ever built, was shipped in 1973.

CYBERNET graphics processing capabilities are backed by a series of terminals that can be leased or purchased. The Interactive Graphics System (IGS) is designed for customers who require solutions to problems represented in symbolic, graphic or geometric form, such as schematics, diagrams, layouts, and lattice structures, or problems described using mathematical functions. Using the Control Data 777 CYBER GRAPHIC terminal, and the IGS, users can carry out a two-way conversation with a powerful CYBER 74 computer. Data stored in the computer can be scanned, "picked" with a light pen, and processed, modified and redisplayed in alphanumeric and graphic form. A three-dimensional option is available.

In addition to its interactive graphics services, CYBERNET offers a batch capability to transmit output to plotters as well as display devices. UNIPLOT permits a customer to produce any type of plot - from a simple graph transforming numerical data into a more useful, meaningful form, to a highly complex drawing too costly and time-consuming to produce by hand.

The Canadian CYBERNET Centre is located at Mississauga, Ontario, and remote service centres are located in Calgary, Montreal, Toronto and Ottawa. The Canadian network is, in turn, connected with data networks in the United States through the Control Data CYBERLINK.

Cosa Corporation of Canada Limited

1586 The Queensway
Toronto, Ontario, Canada
M8Z 1V2
Tel: (416) 255-2301
Chief Executive Officer: T. P. Schutze, Vice-President and General Manager
Senior Marketing Executive: J. Thom

Activities: Sell computer numerical-controlled products and/or systems, represent six international equipment manufacturers: Nakamura Tome Precision Industries, Fridrigh Deckel, Dubied et Cie, A. Montforts & Co, Rigid Ltd., Weiler K. G.

Coyne Associates Limited

(Systems Consultants)
39 Magil Road
Dollard des Ormeaux, Quebec, Canada
H9G 1N4
Tel: (514) 620-0909
Chief Executive Officer: J. J. Coyne, President

Activities: Provide software packages for CTV system design; telephone network design; data network optimization.

D. G. S. Datagraphics

1 Caesar Avenue
Ottawa, Ontario, Canada
K2G 0A8
Tel: (613) 225-0411
TWX: 610-562-1953
Senior Marketing Executive: P. J. Philliban, Vice-President, Marketing

Activities: Design, furnish and install complete production-line systems tailored to customer needs; design products and/or systems; provide consulting services; sell products and/or systems - computer input/output terminals, digital plotters, replacement CRTs, maintenance of data processing equipment.

This Ottawa company has been supplying computer peripherals and computer communication products, and designing systems using these products, for Canadian industry since 1964. The company represents a number of different manufacturers, including Hughes Aircraft (graphics, display terminals), Delta Data Systems (intelligent CRT terminals), Houston Instrument (digital plotters), Tally Corp. (digital printers), Datum (mini-computer systems), Research Inc. (teletypewriter replacement CRT terminals), Summagraphics (digitizers), and Cipher Data Products (digital magnetic tape mechanisms).

A major international corporation provides an interesting example of the use of the Houston digital plotter. In a numerically-controlled steel fabrication process for which Union Carbide holds the patents, and which it licenses out to other fabricators, a Houston plotter is used to check out the NC instructions in what might be called a "dry run."

Digitizers, digital plotters and magnetic tape mechanisms form the basis for automated drafting systems, several of which have been supplied by D. G. S. Datagraphics to well-known Canadian companies. The Summagraphics digitizers incorporate an internal microprocessor and ROMs capable of performing a variety of calculations such as ratiometric proportionality, areas, volumes, etc. A dual system combines a graphic digitizer and data tablet for flexibility in digitizing graphics and entering variable data, with the tablet functioning as an input keyboard.

D. G. S. Datagraphics provides installation and service by factory-trained representatives from its offices in Ottawa and Toronto, and through Westronic Engineering Sales in Calgary and Vancouver. On-site preventive and remedial maintenance are available, and emergency service is also available when needed. Customers enjoy the distinct advantage of warranty and post-warranty service from a Canadian source, and satisfying these customers is the company's major concern.

Datamex Ltd.

14 Leswyn Road
Toronto, Ontario, Canada
M6A 1K2
Tel: (416) 787-1208
Telex: 06-22399
Chief Executive Officer and Senior Marketing Executive: D. K. Haruni, President

Activities: Supply computer and X-ray peripherals; PCB design systems; digitizers; CRT terminals; microprocessors; B/W and colour graphics CRT display systems - low resolution and high resolution.

Dataplotting Services Ltd.

160 Duncan Mill Road
Don Mills, Ontario, Canada
M3B 1Z5
Tel: (416) 447-8518
Chief Executive Officer and Senior Marketing Executive: Wilfred Parker, President

Activities: As a plotting service bureau, provide computer processing of geophysical data, flatbed plotting systems, and contouring packages; provide computerized plotting services for map production, demographic and sales profiles, graph production, and engineering design plotting; provide both hardware and software; design, furnish and install complete production-line systems tailored to customer needs; provide consulting services; conduct research and development.

Davis, Eryou & Associates Ltd.

1755 Woodward Drive
Ottawa, Ontario, Canada
K2C 0P9
Tel: (613) 226-2015
Contact: W. R. Davis or N. D. Eryou, Principals

Activities: Design products and/or systems; provide consulting services; conduct research and development; analyze and design rotating machinery; design vehicle body test structures; analyze vibration and acoustics problems; carry out computer modelling of complex mechanical systems; design data acquisition and process control systems.

Digital Equipment of Canada Limited

100 Herzberg Road
P.O. Box 11500
Ottawa, Ontario, Canada
K2H 8K8
Tel: (613) 592-5111
Chief Executive Officer: D. J. Doyle, President
Senior Marketing Executive: J. Richardson, Marketing Manager

Activities: Configure major computer systems; develop the supervisory software; and design, specify and manufacture custom interface equipment.

The basic building block in computer-aided design and computer-aided machinery is the mini-computer. Canada's leading supplier is Digital Equipment of Canada, a wholly-owned subsidiary of Digital Equipment Corporation of Maynard, Mass. Digital maintains a large manufacturing and sales operation in Kanata, near Ottawa.

Founded in Canada in 1963, Digital Equipment of Canada produces about 90 per cent of the wired logic panels sold worldwide by the corporation, and assembles and tests the PDP-11 series of mini-computers. Increasingly, the company is taking on the responsibility to integrate peripheral devices with the central processor for system testing prior to shipment to the customer premises, and will translate customer specifications into a system with the special interfaces and controls to do the task. Off-the-shelf company equipment is modified to meet the requirement, new hardware is designed to handle unusual applications, and small production runs of special sub-systems are made as needed.

A recent major project is the supply of 22 mechanical control systems for the major Montreal area postal plant. This advanced postal facility will be a highly automated operation for the speedy sorting and distribution of

mail. Under this $6.1 million project, Digital will provide the computer hardware, a substantial quantity of special assemblies, and will modify operating software.

Digital has also devised pipeline control systems, power monitoring and control systems, has designed and manufactured remote terminals for on-line data collection, and has developed "smart remote" interface devices capable of executing a number of functions independent of the supervising mini-computer.

In addition to the products manufactured and tested at the Kanata plant, Digital Equipment of Canada markets component products including logic modules, disk drives and magnetic tape systems, interactive printers and scope terminals, input/output devices, and communications interfaces. Sales offices are located across Canada.

Digital Graphics Limited

90 Don Park Road
Markham, Ontario, Canada
L3R 1C4
Tel: (416) 493-9622
Telex: 06-23761
Chief Executive Officer: E. Herzig, President
Senior Marketing Executives: F. Long, General Manager, F. Durigon, Sales Manager

Activities: Design products and/or systems; manufacture products; provide consulting services; sell products and/or systems - precision tooling, film artwork, documentation and numerical control drill tapes or production of electronic printed circuit boards, schematic drafting, mechanical drafting and cartography.

Established in 1973, this firm specializes in the provision of computer-generated artwork for printed circuit boards. It was the first Canadian company to offer this service to electronics manufacturers, and was one of the first North American service bureaus to use interactive computer systems for this purpose. The company has enlarged the scope of its operations to the point where it can now provide everything from printed circuit board design layouts to finished circuit board prototypes. Along with the artwork that enables customers to produce their own circuit boards, the company will supply numerical control drill tapes, control tapes for automatic component insertion machines, and component parts list documentation if required.

Working from a simple form of gridded layout supplied by the customer or prepared from the customer's schematic, Digital Graphics operators digitize all conductor routing, showing track widths and separation, pad positions and sizes. This information is fed into a computer memory to form the data base. From this computer data, extremely accurate tooling films, with tolerances better than 0.001 inches, are produced by photoplotters, along with solder resist masks and screen print marking films.

Since the artwork is, in fact, output from a computer stored data base, changes are relatively simple to make at either the digitizing stage or after tooling films have been completed. Different circuit layouts need only have their uncommon parts processed - the common features remain in the computer memory to be recalled at will.

As opposed to the laborious task of preparing artwork manually, the turnaround time from creation of the original schematic to production of a prototype PCB is greatly reduced through the use of Digital Graphics' computer generated artwork. Violations due to incorrect positioning of tracks and pads are also eliminated thus greatly reducing required inspection time on both the artwork and the PC boards.

From the rough sketches supplied by customers, Digital Graphics can also supply finished schematic and logic drawings, processed with the aid of a completely separate data base symbol library. These drawings can be scaled to any size for standard filing or microfilm processing.

With its computer-generated artwork operations already working on a three-shift basis, the company is now developing procedures for the provision of schematic drafting services on a production basis. It is also engaged in the production of the very precise films from which are printed the bar codes used in the Universal Product Code system to identify uniquely tens of thousands of different products on supermarket shelves.

Digital Methods Ltd. (DML)

1736 Courtwood Crescent
Ottawa, Ontario, Canada
K2C 2B5
Tel: (613) 225-1171
Telex: 053-3661
Chief Executive Officer: B. F. Chown, President
Senior Marketing Executive: R. E. Hicks, Marketing Director

DML (cont'd)

Activities: Design of real-time systems utilizing mini-computers. A strong emphasis is placed on human factors engineering. Digital Methods Ltd. performs system design and implementation only; does not manufacture any hardware; but will design and specify assemblies, and will specify and procure equipment.

The assignment that set DML on the course it has followed over the past few years was a study contract undertaken in 1967 for the Ministry of Transport to investigate the automation of air traffic control. This resulted in JETS (Joint Enroute Terminal System), the most advanced automated air traffic control system in the world, which is now being installed across Canada.

The company has also been intimately involved in the development of a training simulator for air traffic controllers. A large computer simulates aircraft movements and interaction on ATC positions.

A data acquisition system designed by DML has been used extensively to analyze the performance of STOL aircraft in the Ottawa-Montreal commuter experiment. The system is also being used by De Havilland to support engineering flight test of its latest entry into the market, the DHC-7.

The company has worked on a variety of other projects such as the development of computer animation with the National Research Council. Another example is a computerized tester for automatically testing both finished digital wristwatches and the LSI chips used in the watches, with up to three completely different sets of parameters.

The linear accelerator in Atomic Energy of Canada Limited's Therac 6 Neptune radiotherapy unit is under the failure-proof control of a computer system. DML supported AECL in the design and implementation of the computer system. Other projects include a Laboratory Data Management System that keeps records on the wide variety of tests on samples of foodstuffs, animal feeds and fertilizers tested by Canada's Department of Agriculture; a Water Quality Laboratory Instrument Testing System that both conducts the tests and keeps records; and a Taxi Dispatch System.

A large current project is the creation of a telex-switching system that will use as many as 256 mini-computers. Canadian Marconi Company, Montreal, is the prime contractor for the system for Teleglobe Canada. DML is responsible for system software.

The work of Digital Methods Ltd. has tended to focus on applying computers to solve sophisticated scientific, operational and business problems. DML does not manufacture any hardware. The company draws on the standard product lines of all computer suppliers, and will work with electronic designers to create special assemblies as required.

B. Elliott (Canada) Limited

478 Evans Avenue
Toronto, Ontario, Canada
M8W 2T9
Tel: (416) 252-5252
Telex: 06-967558
Chief Executive Officer: R. Erwin Fischer, President
Senior Marketing Executive: R. A. L. Christie, Manager, NC Department

Activities: Provide numerically-controlled lathes; programmable controllers; represent the following companies in field of computer numerical control - Droop & Rein, Behrens, Union, Mecof, Sculfort.

H. G. Engineering Ltd.

260 Lesmill Road
Don Mills, Ontario, Canada
M3B 2T5
Tel: (416) 447-5535
Telex: 069-66710
Chief Executive Officer: P. H. Griggs, President
CAD Contact: A. Firmin, Vice-President

Activities: Provide software for CAD systems; structural analysis for a wide range of products including pressure vessels, public vehicle seats and rail cars; vibration analysis; consulting services; design and assemble software systems; represent ASAS. MARC, and Whessoe's PSA-5 systems.

Epic Data Industries Ltd.

Division of Ebco Industries Ltd.
785 Alderbridge Way
Richmond, British Columbia, Canada
V6X 2A4
Tel: (604) 278-5578
Telex: 043-55619
Chief Executive Officer: Helmut Eppich, President
Senior Marketing Executive: T. McCrystal, Director of Marketing

Activities: Provide computerized data collection system for job costing, material control, department costing, portable inventory records.

Ex-Cell-O Corporation of Canada Ltd.

120 Weston Street
London, Ontario, Canada
N6C 1R4
Tel: (519) 438-2133
Telex: 064-5859
Chief Executive Officer: R. H. Strickland, Canadian Vice-President
Senior Marketing Executive: P. J. Ryall, General Manager

Activities: Provide computer numerical control machine tools; design, furnish and install complete production-line systems tailored to customer needs; manufacture products; provide consulting services.

Ferro Technique Ltd.

695 Montée de Liesse
Montreal, Quebec, Canada
H4T IP9
Tel: (514) 341-3450
Telex: 05-827531
Chief Executive Officer and Senior Marketing Executive: George Miechowsky, President

Activities: Provide computer numerical control machine tools; numerical control computer-assisted programming systems.

Genrad Limited

307 Evans Avenue
Toronto, Ontario, Canada
M8Z 1K2
Tel: (416) 252-3395
Chief Executive Officer and Senior Marketing Executive: R. J. Provan, President

Activities: Provide logic circuit analyzers; automatic testers.

Geophysical Service Incorporated

Subsidiary of Texas Instruments, Inc.
Digital Systems Division
280 Centre Street East
Richmond Hill, Ontario, Canada
L4C 1B1
Tel: (416) 889-7373
Telex: 06-217814
Chief Executive Officer and Senior Marketing Executive: Barry Armstrong, General Manager

Activities: Provide printed circuit board testing systems.

George J. House Associates Inc.

1 Duke Street
Suite 106
Hamilton, Ontario, Canada
L8P 1W9
Tel: (416) 522-0235
Chief Executive Officer: George J. House, President

Activities: Provide consulting services in process planning; programming languages; sculptured surfaces; economics of CAM systems; geometric modelling; automation of manufacturing processes; bounded geometry numerical control processing; integrated management systems; computer-directed production systems; and group technology with applications in manufacturing processes.

Graham F. Crate Limited

350 Sparks Street, #808
Ottawa, Ontario, Canada
K1R 7S8
Tel: (613) 236-3905
Chief Executive Officer: Graham F. Crate, President

Activities: Design products and/or systems; provide consulting services; conduct research and development; carry out computer simulation of discrete processes involving material handling systems or automatic traffic systems such as discrete part manufacturing lines and mass transit systems.

Gross Machinery (Canada) Ltd.

18 Jarvis Street
Toronto, Ontario, Canada
M5E 1N1
Tel: (416) 364-7161
Telex: 065-25106
Chief Executive Officer: Harold Gross, President
Senior Marketing Executive: Michael Gross, Executive Vice-President

Activities: Provide computer numerical control machine tools; represent Fujitsu, Hitachi-Seiki, Kotobuki Industry, Makino Milling Machine, Mitsubishi Heavy Industries, Mitsui-Seiki, Mori-Seiki, OKK, OKuma, Pratt & Whitney, Toshiba, Yoshida, Voest, Acme International, Homma Metal Works, Roku-Roku Fangyo Ltd.

Gunnar A. Jacobson Associates

785 Plymouth Avenue
Montreal, Quebec, Canada
H4P 1B3
Tel: (514) 731-1156
Chief Executive Officer and Senior Marketing Executive: Gunnar A. Jacobson

Activities: Design, furnish and install complete production-line systems tailored to customer needs; design products and/or systems; provide consulting services; conduct research and development; product design - building components.

Hawker Siddeley Canada Limited

Data Processing and Graphics Division
Mississauga, Ontario, Canada
L4T 3W2
Tel: (416) 677-4840
Telex: 06-968817
Chief Executive Officer: W. Bates, General Manager
Senior Marketing Executive: S. Manchuk, Sales Manager

Activities: Design, furnish and install complete computerized production-line systems tailored to customer needs; provide materials requirement planning systems based on Honeywell IMS 2000 system parts inventory control system (Statistical Tabulating Corporation, Chicago); provide NC machine tool post processor.

Hewlett Packard (Canada) Limited

6877 Goreway Drive
Mississauga, Ontario, Canada
L4V 1M8
Tel: (416) 678-9430
TWX: 610-492-4246
Chief Executive Officer: C. Williams, President
Senior Marketing Executive: M. Naggiar, National Sales Manager, Computer Systems

Activities: Provide programmable automatic test systems for electronic circuits.

Hypro Machine Controls

Division of Hinterland Handcrafts Limited
P.O. Box 370
Bancroft, Ontario, Canada
K0L 1C0
Tel: (613) 332-1124
Chief Executive Officer and Senior Marketing Executive: Carl Pitts, President

Activities: The new division of this company is developing an economical computer numerical control system.

Hypro Machine Controls is a recently established division of Hinterland Handcrafts Limited, a 15-year-old company concerned primarily with the production of leather goods and employing about 70 people.

Under the direction of Terry Pitts, formerly with Computing Devices of Canada Ltd., the development of the microprocessor-based computer NC is being assisted by funding under the federal Program for the Advancement of Industrial Technology (PAIT), and the first system is expected to be available by mid-1977.

Incorporating 16-bit microprocessors, the Hypro CNC system will be applicable to a wide variety of machines, and will provide 3-axis control for two machines simultaneously thus significantly reducing the cost of controls for each machine.

Unlike existing controllers that require separate input terminals such as teletypewriters, and which have no provision for simple editing to correct errors or incorporating changes, the Hypro system will have its own software generation capability. Magnetic tape in cassette form will be provided in addition to the conventional paper tape. A compiler will be included for the processor language which is itself more sophisticated than that used in competitively priced controllers. This language will enable operations like pocket milling to be performed automatically, as well as programming for tool offsets and backlash.

In spite of its sophisticated capabilities, the basic Hypro system can act as a most economical 2-axis point-to-point controller, due to its modular design. Software modules in ROM form, and hardware modules, can be added as required to extend the capabilities of the basic system.

In view of the economies and flexibility of its system, Hypro envisages a considerable market in the woodworking industry as well as in metalworking. While the more sophisticated language actually simplifies programming, a self-testing feature will further simplify operation for anyone with minimum experience of NC programming.

The Bancroft company will adapt customer machines so that they can use its control system. It will undertake to retrofit new machines and also sell adapter kits to fit a number of standard machines. These kits will enable users to modify their own machines so that they can obtain the benefits of the Hypro NC system.

IBM Canada Limited

1150 Eglinton Avenue East
Don Mills, Ontario, Canada
M3C 1H7
Tel: (416) 443-2111
Telex: 06-966574
Chief Executive Officer: L. K. Lodge, President
Manager, Manufacturing Systems: Brian Roffey

Activities: Design products and/or systems; manufacture products; provide consulting services; sell products and/or systems; conduct research and development; provide numerical control programming systems, production and inventory control systems, numerical control programming for drafting systems, ASTAP program - ac, dc, transient, statistical and circuit-failure analyses.

Instronics Limited

143 Neil Avenue
Stittsville, Ontario, Canada
K0A 3G0
Tel: (613) 836-4411
Telex: 053-4115
Chief Executive Officer: Harry Godfrey, President
Senior Marketing Executive: Lou Robert, International Marketing Manager

Activities: Design and manufacture products that convert analog information into digital format for further processing. A graphic editing system is also available as a support service.

Instronics Limited was established 20 years ago as a manufacturers' sales representative organization. As the company grew, profits were plowed back into engineering design and manufacturing of specialized electronic instruments not generally available on the market such as the Gradicon.

The Gradicon has been, and continues to be, a highly successful product. It uses servos and position encoders to provide precise digital readouts of X-Y co-ordinates from graphic representations. Simple in concept, the Gradicon consists of a free-moving cursor whose cross hair is positioned over co-ordinate points on two-dimensional graphical material. Execution of the concept, however, has demanded the most precise magnetic and servo engineering. The cursor is magnetically linked to a slave unit under the table's top surface. This slave relays co-ordinate information to within 0.004 in. over a 36 in. x 48 in. area.

The Gradicon was originally designed to digitize cartographic data. Users have found many other applications for the digitizer, including printed circuit board design, weather prediction studies, water level and streamflow data analyses, and highway planning.

A direct outgrowth of the Gradicon is an analytical stereoplotter. Instronics developed this instrument in concert with Canada's National Research Council, and delivered the first unit to NRC in late 1976. The stereoplotter system consists of an optical viewer, controller interface electronics, a general purpose (PDP-11/45) computer and a precision plotting table.

The instrument has been designed for photogrammetrists, incorporating precision optics and mechanics. It can accept input from a number of sources and can perform automatic least-squares adjustment procedures for interior, relative and absolute orientations. It also corrects systematic errors such as film distortions, asymmetric lens distortions, atmospheric refraction and earth curvature. Outputs consist of off-line contours or cross sections, or plots in model co-ordinates or ground co-ordinates.

Another significant product developed by the company is its TSD (touch sensitive digitizer), under licence from the National Research Council. The TSD is a direct interface between man and a computer or other digital system. With the touch of the glass digitizing area by a finger, felt-tip pen, or any other passive probe, the exact position is automatically identified and converted into binary or BCD format for transmission directly to a digital display or computer. The TSD screen can overlay interactive graphic CRT screens, rear projection systems, maps or documents, to become an active component in a system.

In support of these digitizing devices is a computer-based interactive graphic editing system, INTERMAP, that permits cartographers, engineers and designers to display, manipulate and modify data-based maps, drawings and other graphic material. The system accepts information from a digital source and displays the information on a high resolution interactive storage CRT. The display can be easily modified, including inserting lines, instructing the system to automatically connect or complete lines, removing lines, and inserting or removing alphanumeric information.

Instronics maintains production and design facilities in Stittsville, Ontario; sales and service offices in Vancouver, British Columbia, and Arlington, Virginia; and a manufacturing plant in Ogdensburg, New York. The company merchandises its own products only, although it will build any processor into its equipment to meet customer preferences.

Interautomation (1974) Limited

2630 Royal Windsor Drive
Mississauga, Ontario, Canada
L5J 1K7
Tel: (416) 823-3600
Chief Executive Officer: J. Hiltemann, President
Principal Operating Executive: G. S. Bagosy, General Manager
Senior Marketing Executive: D. A. Secord, Process Systems Sales Manager

Activities: Design, furnish and install complete digital control systems for production-line applications including, but not limited to: bulk weighing and conveyor systems, transfer machines, industrial furnaces and heat treating, combustion processes, production monitoring and piece counting, and continuous process control; design computer control system elements and/or systems configured to client requirements; design, furnish and install computer systems for energy conservation and management (e.g. facilities monitoring and demand levelling systems for industrial plants); computer automation for automotive engine exhaust emission testing, test stands and torque measurement; and computer systems for maintenance scheduling.

The company does not act as a resale agency for computer manufacturers. Products and devices procured for system integration are selected on the basis of functional requirements and availability of support services.

Intercomp Resource Development and Engineering Limited

603 7th Avenue South West
Calgary, Alberta, Canada
P2P 2T5
Tel: (403) 264-7205
Telex: 03-824857
Chief Executive Officer: R. C. McCulloch, President
Senior Marketing Executive: S. B. Beveridge, Vice-President, Operations

Activities: Provide computer simulation of oil and gas reservoirs and gas and liquid pipeline networks; design and sell software packages; provide consulting services.

Interdata of Canada Limited

6486 Viscount Road
Mississauga, Ontario, Canada
L4V 1H3
Tel: (416) 677-8990
TWX: 610-492-9372
Chief Executive Officer: Joseph Molina, General Manager
Senior Marketing Executive: H. Stewart, National Marketing Manager

Activities: Design products and/or systems; manufacture products; provide direct numerical control, and flexible machining systems, machining and workpiece handling, and materials handling storage/retrieval systems.

James W. Stevenson & Company Limited

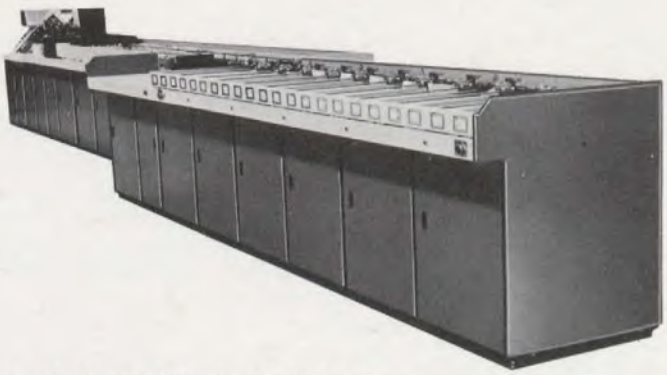
2000 Ellesmere Road
Unit #8
Scarborough, Ontario, Canada
M1H 2W4
Tel: (416) 438-6967
Chief Executive Officer and Senior Marketing Executive: James W. Stevenson, President

Activities: Provide automatic precision drafting installations; digimeter mensuration appliances; and co-ordinate measuring equipment.

Kom Lynn & Associates Ltd.

1401 West Broadway Avenue
Vancouver, British Columbia, Canada
V6H 1H6
Tel: (604) 733-1323
Telex: 04-507661
Chief Executive Officer and Senior Marketing Executive: D. Lynn, President

Activities: Design systems; provide consulting services in the planning and design of raw material warehousing, handling, retrieval and delivery systems; order picking systems and warehouse picking systems.



Leigh Instruments Limited

Industrial Products Division
350 Weber Street North
Waterloo, Ontario, Canada
N2J 4E3
Tel: (519) 884-4510
Telex: 069-5440
Chief Executive Officer: J. R. B. Steacie
Senior Marketing Executive: R. A. Manina, General Manager, Industrial Products Division

Activities: Provide design, consulting and production services in the field of optical character reading and automatic coding systems.

This company has developed an optical character reading and automatic coding system in co-operation with the Canadian Post Office. The unit, NAS K1, uses a special-purpose computer in support of the optical character recognition function and driving the coding and sorting elements of the machine. The company is not actively seeking CAD/CAM projects, but will consider major developments such as the NAS K1. Efforts are being oriented to further developing and marketing of the present product line.

MacDonald, Dettwiler & Associates Ltd.

Nootka Building
10280 Shellbridge Way
Richmond, British Columbia, Canada
V6X 2Z9
Tel: (604) 278-3411
Telex: 04-355599
Chief Executive Officer and Senior Marketing Executive: J. S. MacDonald, President

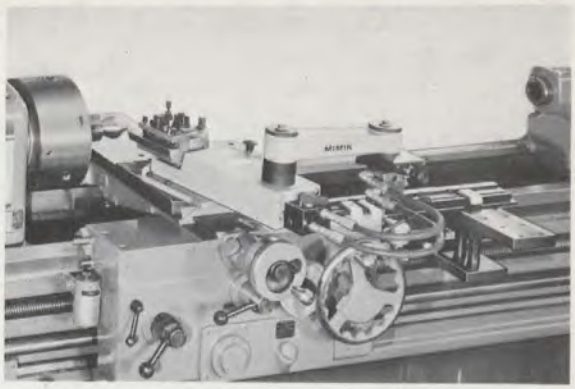
Activities: Provide CAD software, computer-controlled conveyor systems, and consulting services; design systems.

Manufacturing Data Systems International Canada Ltd.

P.O. Box 5657, Station A
Toronto, Ontario, Canada
M5W 1N8
Tel: (416) 923-8261
Chief Executive Officer: Ken Stephenz, President
Senior Marketing Executive: Tom Ward, Sales Manager

Activities: Provide software for tape production for users of numerical control equipment, supported through access to a time-sharing system; software for the operation of on-line graphic display, flat-bed plotting, drum-type plotting, and CRT display equipment; a computer-aided manufacturing service system (CODE) for inventory control of part blueprints; and an on-line graphics display system combined with CODE for use as a design tool for a wide variety of manufactured products in many different fields; design and sell systems; provide consulting services; conduct research and development.

Mimik Limited



P.O. Box 670
Galt Avenue
Cambridge, Ontario, Canada
N1R 5W6
Tel: (519) 621-8010
Owner: L. S. Magor, President
Chief Executive Officer: M. Schipprack, General Manager
Senior Marketing Executive: R. Isaac, General Sales Manager

Activities: Design products and/or systems; manufacture products; sell products and/or systems; conduct research and development; provide computer-controlled industrial actuators, computers for metalworking applications, computer-machine tool interface systems, and direct computer-control machine tools.

In business for more than two decades, Mimik Limited is known internationally for its hydraulically operated tracer units. Attached to lathes, vertical mills or boring machines, these units enable the machine to follow the contours of a master template without operator guidance. Mimik originated the Universal Tracer (UT), and claims there are more Mimik UTs in use today than any other universal tracer on the market. The UT series is designed for maximum versatility of application and variety of work pieces, involving anything from simple stepped shafts to complex internal contours, with fully pivoting slide, swivelling valve arms and 40-position toolholders. Many complex and delicate parts used in aerospace have been machined using Mimik UT tracers. Tracer controls are based on the company's skills in hydraulics technology that enable it to maintain accuracies close to .0001 in.

The company's most recent development is Datadrive - a radically new form of NC drive designed for use in both new and older machines. It is a digital, closed loop, linear hydraulic actuator that can be retrofitted to older machines or supplied already fitted to the preferred Hardinge HC. Datadrive has the advantage that the control logic is not in the loop with the machine, and is therefore not affected by it. The drive and the machine are, however, in a loop together, so that failure to respond to an initial command results in a force buildup until the command is satisfied, unlike conventional open loop NC that cannot reliably respond to widely varying loads.

In the Datadrive, the digital control logic is converted into linear motion of the spool of a hydraulic servo valve by means of an electric stepping motor, reduction gearing, and a toothed drive that engages a calibrated rod. One control pulse results in a discrete movement, typically .0001 in., of the spool. This in turn causes the cylinder, which is slaved to it, to move the same amount in the desired direction. Any open loop tape control, as provided by a variety of manufacturers, can be used with the Datadrive, using point-to-point, straight line or continuous path according to requirements. The digital nature of the drives also enables them to be connected directly into a computer that can run several machines simultaneously while providing the benefits of on-site programming, editing and modifying.

As an alternative to conventional paper tape control, Mimik is also working on a hard wired or dedicated computer control system that permits the lathe operator to program operations by means of pushbuttons or keyboards. The various steps are displayed in terms familiar to the operator, who can modify them at any time. An "interrupt" can also be applied at any moment, allowing the operator to carry out any manual adjustments he may desire, after which the machine will be able to continue from precisely where it left off.

Moog Hydra-Point Canada Ltd.

5572 Ambler Drive
Mississauga, Ontario, Canada
L4W 2K9
Tel: (416) 624-1452
Chief Executive Officer and Senior Marketing Executive: A. E. Rodway, General Manager

Activities: Provide sales and service centres for DNC and CNC-compatible numerically-controlled machining centres manufactured by Hydra-Point Division of Moog Inc., East Aurora, N.Y.

Moore Brothers Machinery Co. Ltd.

8455 Decarie Boulevard
Montreal, Quebec, Canada
H4P 2J3
Tel: (514) 342-2940
Telex: 055-60993
Chief Executive Officer: C. E. Moore, President
Senior Marketing Executive: E. C. Moore, Vice-President

Activities: Provide computer numerical control machine tools and machining centres; computer numerical control profiling equipment; computer numerical control production milling machines; provide consulting services; Canadian representative for Boston-Digital Corp. and Sheldon Machine Co. in the United States.

Multiple Access Limited

405 Ogilvy Avenue
Montreal, Quebec, Canada
H3N 1M4
Tel: (514) 273-6311
Chief Executive Officer: J. O. McCutcheon, President
Senior Marketing Executive: R. Crossan, National Sales Manager

Activities: Provide consulting services, CAD computer services, structural and mechanical design; piping systems design and interactive graphics systems.

Multiple Access Limited orginated in 1969 as a scientific/engineering computer service firm, based on a Control Data computing facility in Don Mills, Ontario. It has subsequently acquired AGT Data Systems Ltd., as well as broadcasting interests in Toronto and Montreal. The corporate head office is now in Montreal.

The Multiple Access Computer Group has developed into one of the largest Canadian-owned computer services companies. It offers a unique blend of people expertise, user-oriented programs and super-scale scientific and commercial computing facilities (including a Control Data 6600 and CYBER 73), all available through the company's own continent-wide computer communications network.

Technical Services Division

Centred in Don Mills, with branch offices across Canada, this division includes the Engineering Services Group whose support personnel have practical industry and computer experience in civil, structural and mechanical engineering.

For CAD, the division offers a wide variety of programs. As examples of finite element structural design systems, ANSYS has been used by Ontario Hydro for nuclear reactor design, while Howden Parsons Ltd., Toronto, has used NASTRAN for turbine design, and Spar Aerospace Products Ltd., and RCA have used STARDYNE in the structural design of satellites. A large number of programs, including AMECO for automatic building design in metals and concrete, are available in the structural engineering field, while programs for structural analysis of piping systems and pressure vessel design are among those available to mechanical engineers.

Also available are COMPAID for design, material control, and automated isometric drawings for piping systems in the petrochemical industry, PMCS and PROPLAN for project management control, and FIPAC for financial planning and control and economic feasibility studies.

Ruscom Logics Division

Providing custom-engineered hardware and software systems, this division has delivered many time and cost-saving systems to major Canadian manufacturers and other organizations. Typical of these is a press monitoring system for the Toronto Star, displaying vital information in real time on CRT screens for foremen and press operators. Another system at the Star controls the routing of newspaper bundles at rates up to 320 per minute to the correct truck loading bays. CN/CP Telecommunications uses a Ruscom Logics designed computer system, incorporating six mini-computers and CRT displays, as a multi-terminal message editor for its telegram service.

Real-time production control systems, ranging from the scheduling of truck and excavator loads in an open-pit mine to control of painting operations for a major automobile manufacturer, are among other projects handled by Ruscom Logics. These examples illustrate the division's multi-industry experience which enables it to design efficient hardware and software systems for almost any specified application.

Ruscom's current activities include several mini-computer based material control systems for the Canadian Post Office.

Norpak Limited

Pakenham, Ontario, Canada
K0A 2X0
Tel: (613) 624-5336
Chief Executive Officer and Senior Marketing Executive: Mark Norton, President

Activities: Provide graphic display processors, interactive computer graphics, and image processing systems.

This young company has made remarkable strides since its incorporation in 1972. One of its first products, developed in conjunction with the Communications Research Centre of the federal Department of Communications, was a family of raster graphics display processors for use in both interactive computer graphics and computer image processing applications.

The Norpak Raster Graphics Processor (RGP) family meets computer display requirements in a particularly cost-effective manner. Users requiring fast-access interactive graphics need not pay for the high resolution or multi-colour capabilities required in some imagery applications. Should subsequent applications require additional features, these options and memory expansion can be simply obtained with additional circuit boards.

While the RGP family offers a modest 512 x 512 resolution for putting digital information on a standard raster colour television screen, the latest Norpak product line is a high-performance, high resolution (up to 4,000 x 4,000) Incremental Graphics Processor (IGP) for monochrome displays. The IGP drives either an electromagnetic or an electrostatic or a colour penetration tube, and is a random point as opposed to a raster scan plotting system.

Another important Norpak innovation is a highly sophisticated image data processing system known as a Research Development System. The RDS has high colour resolution and a graphics processing capability allowing the use of graphics overlays and graphical manipulation in addition to more conventional image transfer. The RDS is expected to have wide military, industrial and medical applications, while both the RDS and the IGP lend themselves to computer-aided design functions. The complexities of multilayer printed circuit boards or three-dimensional design shapes can be greatly simplified with the aid of Norpak processing systems.

Over the next year, Norpac plans to introduce a variety of turnkey systems the first of which will be an integrated and printed circuit design system.

Omicron Data Systems Ltd.

4480 Cote de Liesse Road
Montreal, Quebec, Canada
H4N 2R1
Tel: (514) 733-7166
Chief Executive Officer and Senior Marketing Officer: C. R. Ahooja, President

Activities: Develop computer time-sharing systems as applied to communications circuit control such as telephone traffic concentrators, message store and forward systems, and on-line data storage and retrieval systems. Maintains an electronic manufacturing facility capable of delivering complete turnkey systems.

Established in 1966, Omicron Data Systems was instrumental in advising on early systems which are now well-established. The company helped set up the main computer at the Department of Supply and Services to handle the supply requirements of the Government of Canada. It also did a major technical and marketing study of computer time-sharing on behalf of Canadian Pacific-Canadian National Telecommunications.

Omicron later undertook a study into ways to increase the capacity of the "Bellboy" paging service marketed by Bell System telephone companies. A computer-controlled system was recommended that is now used in all major cities and towns in Canada, in parts of the United States and in some European locations. Now known as Selective Wide Area Paging (SWAP), the Omicron system is designed around digital computers and each is capable of serving up to 10,000 subscribers.

About the time of the development of the paging system, Omicron initiated work on the automation of the traffic usage recording systems then being employed by telephone companies for gathering data on the operation of their networks. By applying the computer to an essentially communications problem, the company succeeded in producing an on-line telephone network traffic surveillance system called CATS (Central Automatic Traffic System). CATS is capable of concentrating data from hundreds of thousands of points, and remotely controlling some of these points.

Omicron can build customized versions of CATS using unique modular software and hardware designs. The hub of the system is the network management and administrative centre which provides maximum versatility in data retrieval, manipulation and display of alarm status indicators. CRT terminals ensure instantaneous availability of network management data.

The company maintains a computer system to support the planning, design and development of systems. The resident computer system can be connected to larger systems if required. Omicron also maintains a modern electronic assembly manufacturing facility with a high level of quality control standards. Omicron not only produces assemblies for in-house needs, but can also provide competitive testing and assembly services to others.

Orchard Instruments Ltd.

44 Orchard Crescent
Toronto, Ontario, Canada
M8Z 3E3
Tel: (416) 231-3854
Chief Executive Officer and Senior Marketing Executive: D. Reid, President

Activities: Provide multi-terminal, multi-function computer graphics systems; intelligent data base systems; systems for mapping, numerical control machining, PCB design, document scanning and digitizing, and interactive graphics display.

Pratt & Whitney Aircraft of Canada Limited

1000 Marie Victorin Boulevard
Longueuil, Quebec, Canada
J4K 4X9
Tel: (514) 677-9411
Telex: 05-267509
TWX: 610-4223-3872
Chief Executive Officer: D. C. Lowe, President
Senior Marketing Executive: K. H. Sullivan, Vice-President, Marketing

Activities: Design products and/or systems; manufacture products; conduct research and development; provide numerical control systems; gas turbine engine component design; finite element analysis; interactive graphics; automated drafting; and engineering records information systems; provide consulting services.

Procom Systems & Computations Limited

Suite 401
1010 Ste. Catherine Street West
Montreal, Quebec, Canada
H3B 1G2
Tel: (514) 866-3150
Telex: 05-268812
Chief Executive Officer: J. Gordon German, President
Senior Marketing and Engineering Executive: D. M. Craig, Vice-President and General Manager

Activities: Design products and/or systems; provide consulting services; conduct research and development; ship design and construction.

Providing engineering computation services for marine industries, Procom Systems & Computations Limited is a wholly-owned subsidiary of German+Milne, one of Canada's leading firms of naval architects. The parent company, formed in 1920, has been responsible for the design of such well-known vessels as the Canadian Coast Guard icebreakers Louis St. Laurent and John A. Macdonald.

Using computer programs which it has developed specifically for these purposes, Procom performs engineering calculations for consulting naval architects, shipowners and shipbuilders. These can range all the way from the design of hull form and shell plates with three-dimensional curvature to the distribution of cargo in a ship for maximum safety at sea.

Formed in 1967, Procom actively solicits business in the general area of engineering design calculations, but particularly in the marine field where it has well-proven technical competence. The firm has most recently been engaged in computations for the R-class icebreakers being built by Burrard Dry Dock Co. Ltd. in North Vancouver, and also played a significant role in design calculations for the ferry "Princess of Acadia." The group was involved in environmental data calculations in connection with the voyage of the Humble Oil tanker Manhattan through the Arctic Ocean, and is willing to undertake any projects that it considers to be within its technical competence involving computer-aided design calculations.

Promac Controls Inc.

30 Progress Avenue
Scarborough, Ontario, Canada
M1P 2Y4
Tel: (416) 292-1444
Chief Executive Officer and Senior Marketing Executive: J. A. C. Whiteside, President

Activities: Provide computerized equipment and process control systems.

Rousseau Controls Ltd.

271 Labrosse Avenue
Pointe Claire, Quebec, Canada
H9L 1A3
Tel: (514) 695-1240
Telex: 05-821535
Chief Executive Officer: D. Casgrain, President and General Manager
Senior Marketing Executive: R. D. Playfair, Director of Marketing

Activities: Design and manufacture custom-designed industrial hydraulic power units and installations, baggage belt loaders; and mobile pneumatic and hydraulic test stands with computer-control capability.

Screw Machine Services Limited

31 Beverly Hills Drive
Downsview, Ontario, Canada
M3L 1A2
Tel: (416) 249-7985
Telex: 06-965549
Chief Executive Officer: H. I. Collison, President
Senior Marketing Executive: D. Collison, General Manager

Activities: Provide direct numerical control and computer numerical control machining systems.

Sentrol Systems Ltd.

4401 Steeles Avenue West
Downsview, Ontario, Canada
M3N 2S6
Tel: (416) 661-7000
Telex: 06-965672
Chief Executive Officer and Senior Marketing Executive: R. Lindsay, President

Activities: Design, furnish and install complete production-line systems tailored to customer needs; conduct research and development; provide batch processing control systems for different types of production lines (e.g. fine papers).

SMT-Pullmax (Canada) Limited

505 Iroquois Shore Road
Unit #9
Oakville, Ontario, Canada
L6H 2R3
Tel: (416) 845-3151
Chief Executive Officer: C. Bandi, President
Senior Marketing Executive: J. Torrens, Technical Sales Director

Activities: Provide computer numerical controlled machine tools.

Standard Modern Tool Company Limited

69 Montcalm Avenue
Toronto, Ontario, Canada
M6E 4N9
Tel: (416) 787-2494
Telex: 065-24450
Chief Executive Officer: W. Hibbins, General Manager
Senior Marketing Executive: T. Essex, Marketing Manager

Activities: Design, furnish and install complete production-line systems tailored to customer needs; design products and/or systems; manufacture products; provide consulting services; provide precision machined components and assemblies, nuclear power station components and assemblies, engine lathes and machine tools.

Systemhouse Ltd.

560 Rochester Street
Ottawa, Ontario, Canada
K1S 4M2
Tel: (613) 236-9734
Telex: 053-4517
Chief Executive Officer: J. R. Davies, President
Senior Marketing Executive: R. Hamer, Director of Marketing
CAD/CAM Contact: Brian Giles, Manager, Special Projects

Activities: Provide computerized cartographic and interactive graphics systems; design, furnish and install complete production-line systems tailored to customer needs; provide consulting services; conduct research and development.

Systems Approach Limited

Computer Products Division
1719 St. Laurent Boulevard
Ottawa, Ontario, Canada
K1G 3V4
Tel: (613) 523-1700
Chief Executive Officer: T. Ortt, President
Senior Marketing Executive: D. M. Williams, Vice-President

Systems Approach Limited manufactures and markets a low-cost mini-computer based graphics system which supports GRAPPLE. GRAPPLE was originally developed to run on an IBM 370 by Bell Northern Research for use internally by engineers. To provide a faster and less-expensive alternative to the 1370, without sacrificing capability, the GRAPPLE language was implemented on a mini-computer.

The GRAPPLE language is now available on an IM/70 mini-computer from Systems Approach Limited and is considered the fastest mini-computer based system with general purpose graphics capabilities. GRAPPLE can perform any role in which it is important to describe objects in visual terms, rather than doing long calculations. It is especially valuable in interactive design, using the computer's rapid manipulation of data to accelerate the realization of the designer's ideas. Thus a designer can sit down at the graphics terminal and generate a picture of a street plan, a building, a bridge or a ship. To all intents and purposes, response is instantaneous. Pictures are drawn at a rate of 200 lines per second. Regardless of the complexity of the operation, it is rare for the user to have to wait for more than two seconds for the machine to respond.

GRAPPLE is both a very concise picture description language and also a means of manipulating those pictures. Thus, besides the storage and re-creation of shapes, GRAPPLE allows the user to modify shapes that are already stored.

For instance, someone who designs floor plans may want to take down walls and put them up again in different places, shuffle tables and chairs around the room, add a door in one place or draw an electrical cable. Using another feature of the program, he can zoom in on one corner until it fills the screen, and then work with it in an enlarged scale.

The way that the picture is described in GRAPPLE allows other information to be stored and extracted from it without setting up a separate data base. For example, the dimensions of the room and of its windows, doors, etc., can be extracted directly from the stored description of the floor plan by calling up a program to do so. A bill of materials for constructing such a room can be created by another program. The information can be stored in various "layers" of associated data (e.g. the floor plan, the furniture to go in it, the carpeted areas, the telephone

cabling to be installed.) The user can display as many as 100 of these layers starting with one or two, and then superimposing as many as he wishes (e.g. the room with its furniture and telephone cabling, etc.).

There are currently three applications that have been developed to run under GRAPPLE which allows the system to be used as a tool by non-EDP personnel. These include:

DRAW1 - A highly advanced interactive drafting package for draftsmen.

ORG CHART - A program that provides extensive capabilities in laying out and manipulating organization charts.

GENGRAPH - General purpose data graphing system. Creates scaled and shaded bar graphs, pie graphs and line graphs.

Teklogix Ltd.

1260 Fewster Drive
Mississauga, Ontario, Canada
L4W 1A5
Tel: (416) 625-5673
Chief Executive Officer: J. R. Coutts, President

Activities: Provide computerized material handling systems, sorting systems, conveyor systems, and distribution systems; provide data processing systems for inventory control, order entry, and customer processing; provide configuration inventory control systems for materials and stocks for purchasing and production-line optimization; design, furnish and install complete production-line systems tailored to customer needs; provide consulting services; conduct research and development.

Tektronix Canada Limited

900 Selkirk Street
Pointe Claire, Quebec, Canada
H9R 3S3
Tel: (514) 697-5340
Telex: 05-821570
Chief Executive Officer and Senior Marketing Executive: Warren Clark, General Manager

Activities: Supply interactive graphics display systems.

G. A. Thompson & Associates Limited

105 Leacock Drive
Pointe Claire, Quebec, Canada
H9R 1H2
Tel: (514) 695-1821
Chief Executive Officer: A. Thompson, President
Senior Marketing Executive: R. Skowronski, Vice-President

Activities: Install complete production line systems tailored to customer needs; provide consulting services; provide technical repair services for electronic, hydraulic and mechanical sections of DNC, SNC and NC machines.

Transocean Machine Co. Inc.

5500 Royalmount Avenue
Montreal, Quebec, Canada
H4P 1H9
Tel: (514) 739-2241
Telex: 05-267655
Chief Executive Officer: D. Stinnes, President
Senior Marketing Executive: G. H. Hauffe, General Manager

Activities: Represent 10 companies supplying NC equipment, four of them providing computer numerical control systems: S.O.C. Gratziano; NAHO Werkzeugmaschinenbau Babel & Co; Eugen Weisser; Gebr. Heinemann.

Unified Technologies Incorporated

4800 Dundas Street
Islington, Ontario, Canada
M9A 1B1
Tel: (416) 236-1159
Chief Executive Officer and Senior Marketing Executive: Bob Sandness

Activities: Provide microprocessor systems, hardware and software; Fortran compilers; communications interface systems.

Upton, Bradeen & James Ltd.

30 Railside Road
Don Mills, Ontario, Canada
M3A 1A5
Tel: (416) 445-7660
Telex: 06-96660
Chief Executive Officer: T. A. Breckles, President
Senior Marketing Executive: Robert Hendry, General Sales Manager

Activities: Provide computer numerical control machine tools; design, furnish and install complete production-line systems tailored to customer needs; provide consulting services; represent the following international machine tool manufacturers in the field of computer numerical control equipment: Autonumerics, Boerhringer, Cincinnati Gilbert Machine Tool, Cincinnati Inc, Farrell, G. A. Gray, Hillyer, Index-Verkaufs, New England Machine & Tool, Paul Ferd. Peddinghaus, Tiefbohr-Tecknik, Wohlenberg.

Varian Associates of Canada Ltd.

45 River Road
Georgetown, Ontario, Canada
L7G 2J4
Tel: (416) 457-4130
Telex: 069-7502
TWX: 610-492-2641
Chief Executive Officer: R. G. Webster, President
Senior Marketing Executive: Ken Oag, Sales Manager

Activities: Provide electrostatic printer-plotters; mini-computers; data-handling systems.

Wave Electronics Limited

29-1445 Rothesay
Winnipeg, Manitoba, Canada
R2G 1V3
Tel: (204) 668-9826
Chief Executive Officer: R. J. Ward, President
Senior Marketing Executive: J. Wallace, Vice-President

Activities: Design, furnish and install complete production-line systems tailored to customer needs; manufacture products; provide consulting services; conduct research and development; provide programmable controllers.

Westinghouse Canada Limited

Electronic Systems Division
175 Longwood Road
P.O. Box 510
Hamilton, Ontario, Canada
L8N 3K2
Tel: (416) 528-8811
Telex: 061-8655
Chief Executive Officer: E. M. Hepburn, Division Manager
Senior Marketing Executives: J. C. Wilder, Product Manager, Information Displays; F. R. Aitken, Product Manager, Linatrol

Activities: Provide CRT displays, Linatrol optical line tracers.

A. C. Wickman Ltd.

1425 The Queensway
Toronto, Ontario, Canada
M8Z 1T4
Tel: (416) 259-2311
Telex: 06-217897
Chief Executive Officer: L. D. Manning, President
Senior Marketing Executive: W. B. Bone, Sales Manager

Activities: Represent the Automation and Measurement Division of The Bendix Corporation in Canada; supply computer-controlled inspection gauges and instruments; co-ordinate measuring machines; positioning systems; surface finish and texture inspection instruments; automatic gauging and assembly machines; in-process gauges and controls; X-ray thickness gauges; layout and inspection machines; multiple-form grinders.

The A. R. Williams Machinery Company Limited

(Machinery Division)
69 Montcalm Avenue
Toronto, Ontario, Canada
M6E 4P1
Tel: (416) 787-2497
Telex: 06524450
Chief Executive Officer: R. Amerie, President
Senior Marketing Executive: T. Essex, Marketing Manager

Activities: Represent various machine tool manufacturers; provide computer numerical control machines - Standard Modern, Jones & Lamson, Drummond Division of Stavely Machine Tools Ltd; direct computer control machines; programmable logic control injection molding machines for use with in-house computer controls - National Automatic Tool Co; TN/C inspection centres; computer-controlled parts inspection systems; design, furnish and install complete production-line systems tailored to customer needs; design products and/or systems; manufacture products; provide consulting services, and financing, leasing, designs for equipment and facilities for a complete range of numerical control, computer numerical control, and direct computer control equipment for manufacturing processes.

Williams & Wilson Limited

71 Front Street East
Toronto, Ontario, Canada
M5E 1B9
Tel: (416) 363-8731
Telex: 06-217734
Chief Executive Officer: I. T. Wilson, President
Senior Marketing Executive: G. Bush, Manager, Machine Tools

Activities: Provide computer numerical control equipment; sell products and systems; conduct research and development; represent several manufacturers of machine tools and computer-controlled machining centres - Allen Bradley, Fujitsu-Fanuc, General Electric, Warner & Swasey, Kearney & Treaker, Andrews Engineering.

Research Organizations

British Columbia Research Council

3650 Wesbrook Mall
Vancouver, British Columbia, Canada
V6S 2L2
Tel: (604) 224-4331
Telex: 04-507748
Chief Executive Officer: Dr. P. C. Trussell, Director
Contact: P. A. Stricker, Systems Engineer, Division of Engineering Physics

Activities: Stress analysis, design of space-frame structures; analysis of submerged cables, buoy systems, and towed bodies in water, both surface and submerged; motion-compensating cranes; simulation of mechanical/hydraulic control systems; problem analysis and feasibility studies; engineering, including mechanical, hydraulic, electric, electronic, and optical systems; herring sex sorting systems; leak-rate detectors; manufacturing and material testing; model testing of ocean systems - ships, submersibles; highway scanners and photologging systems.

In 1970, the British Columbia Research Council established a development company, Techwest Enterprises Ltd. to provide a means of moving research products from B.C. Research into the marketplace, and for undertaking design and manufacture of novel sophisticated equipment.

A number of successful developments have been completed, including heave compensating cranes and constant-tension winches, highway route scanners and subsea pumps.

Canadian Institute of Metalworking (CIM)

McMaster University, T.B. 13
Hamilton, Ontario, Canada
L8S 4K1
Tel: (416) 525-9140
Contact: J. E. Crozier, Director

The CIM is a unique, self-sustaining Canadian resource facility affiliated with McMaster University. It was established in 1971, through financial assistance from the federal Department of Industry, Trade and Commerce to provide a service to the Canadian metalworking community in the application of numerically controlled (NC) machine tools and computer-aided manufacturing (CAM) equipment. CIM promotes these technologies by carrying out development work in machining and software. Services are offered in the areas of programming and consulting to evaluate, justify and orient plant facilities and personnel in NC/CAM.

CIM undertakes training of industry personnel to provide maximum utilization of plant NC/CAM equipment. Interactive group workshops lasting from one to five days are regularly scheduled, and special individual company programs held either at CIM or on company premises, can be tailored to suit individual requirements.

Studies of plant manufacturing techniques, analysis of equipment processes and procedures, and recommendations to industry concerning updating to new equipment and methods can be provided on request. When specific gains in productivity are envisioned in the theoretical analysis, the selected components may actually be manufactured using CIM's own machine tools to verify the results obtained in the theoretical process.

Because investment in new capital equipment must be the foundation for future profitability in a company, CIM offers assistance in analyzing machine requirements and establishing specifications for the equipment. Upon receipt of vendor proposals, CIM will assist in comparing responses to the specifications. The Institute will also help in the evaluation of the proposed NC personnel and suggest methods to overcome any problems with co-ordination and operation of new machines.

As a demonstration centre for industry, CIM has its own well-equipped NC machine shop where machining problems may be investigated and solved. Programming facilities include use of the university's computers and support equipment, while CIM has its own special edit terminal and plotting equipment to complement the programming service. It also has a generalized post processor that is easily adapted to various combinations of control systems and machine tools. Programmers from industry, with previous training in the use of APT or SPLIT, are encouraged to use the resource facilities at CIM for batch programming when instant turnaround is not required.

CIM's tape preparation system is oriented toward producing machine control tapes supported by complete documentation that provides a capability for machining a good part on the first run. A control tape produced by CIM is the end product of an engineered planned process and, in addition to the tape, the customer receives a tool layout sheet, input and output APT listing, a geometric-plotted output, and a typewritten NC manuscript.

Centre de Recherche Industrielle de Québec

333 Franquet Street
Ste. Foy, Quebec, Canada
Tel: (418) 659-1550
Chief Executive Officer: Claude Descoteaux, President and General Manager

Activities: Design products; manufacture of prototypes; provide consulting services; conduct research and development; design printed circuit boards, CRT terminals, power supplies, process control equipment, microprocessors.

Communications Research Centre

Department of Communications
Directorate of Communications Techniques and Equipment Research
Shirley Bay
P.O. Box 11490, Station "H"
Ottawa, Ontario, Canada
K2H 8S2
Tel: (613) 596-9436
Contact: H. G. Brown, Program Manager, Image Communication

Activities: Conduct research in interactive computer graphics applications in electronic design; integrated and printed circuit board layout; new communications systems; general consulting and evaluation; demonstrations of existing systems; computer graphics language support.

Department of Public Works

Computer-Aided Design Development Division
Technological Research and Development
Sir Charles Tupper Building, Confederation Heights
Ottawa, Ontario, Canada
K1A 0M2
Tel: (613) 998-9513
Contact: Robert Bycraft, Chief

Activities: Develop new systems for architectural design using Bell-Northern Research's GRAPPLE, and other systems such as the Merriweather System. Systems are available to industry and consultants (DPW buildings are usually designed by outside consultants); CAD development division has been set up on a five-year program, with two years nearly completed by the fall of 1976.

National Research Council

Manufacturing Technology Centre
Building M4
Montreal Road
Ottawa, Ontario, Canada
K1A 0R6
Tel: (613) 993-2331, 993-9208, 993-2188, 993-2471
Contact: E. S. Moore, General Manager

Activities: Apply numerical control machines to metalworking industries; provide guidance, assistance and advice to Canadian metalworking industries trying to increase productivity through the use of numerical control.

National Research Council

Division of Electrical Engineering - Model Shop
Building M50
Montreal Road
Ottawa, Ontario, Canada
K1A 0R8
Tel: (613) 993-2565
Contact: W. J. Johnson, Head, Model Shops

Activities: Implementation and operation of a numerical-controlled milling machine, using a microprocessor-based controller for Model Shop use. An extension to APT parts programming support is being investigated through the application of graphic aids for part and cutter path verification using a graphics terminal. This activity is designed to interact with small companies by demonstrating the technology that can help them make more effective use of machine-shop resources and enhance their capability.

National Research Council

Division of Mechanical Engineering
Control Systems and Mechanical Engineering Laboratory
Building M-3
Montreal Road
Ottawa, Ontario, Canada
K1A 0R6
Tel: (613) 993-9208
Contact: Dr. J. A. Tanner, Head

Activities: Use PDP 1145 and peripherals, including graphic display, for developing manufacturing operations scheduling techniques; interactive models for plant and production scheduling, materials handling systems and energy consumption studies; interested in working with outside consultants to share NRC expertise in this field.

National Research Council

Division of Mechanical Engineering
Analysis Laboratory
Building M2
Montreal Road
Ottawa, Ontario, Canada
K1A 0R6
Tel: (613) 993-2834
Contact: Dr. R. E. Gagne, Head

Activities: The application of computer modelling and simulation techniques to the design of mechanical devices and systems; computer modelling and simulation expertise; hybrid computer programming expertise; drawing on design experience in aerosystems, turbomachinery systems, plant controller design, plant scheduling studies, transportation system design and operations.

New Brunswick Research and Productivity Council

Engineering Department
P.O. Box 6000
College Hill Road
Fredericton, New Brunswick, Canada
E3B 5H1
Tel: (506) 455-8994
Telex: 014-46115
Contact: Dan Clarke, Electrical Engineer

Activities: Computer-controlled machining capability; consulting service on suitability of different machines and systems.

Ontario Research Foundation

Engineering Department
Sheridan Park Research Community
Mississauga, Ontario, Canada
L5K 1B3
Tel: (416) 822-4111
Contact: E. E. Remedios, Principal Engineer

The Ontario Research Foundations (ORF) is a joint venture of industry and government, providing Canadian companies with a broad range of industrial technologies through non-profit, contact research. Founded in 1928, it now has a staff of more than 300 scientists, engineers, technologists and administrators.

As a contract research organization, ORF provides comprehensive technological capabilities to those small and medium-sized companies that are not large enough to have their own R and D facilities, and technological specialization to larger companies to complement their own in-house resources. It also offers a variety of testing and analytical services to assist in problem-solving.

In the design of structures or machine components, mathematical tools such as algebraic formulae do not always provide the complete picture, and ORF's design engineers have developed various structural analysis computer programs to meet these needs. Professional analytical personnel assist users in the effective application of these programs, and expert advice is offered on modelling techniques, data input and interpretation of results.

Through development of specialized software dealing with the applications of the finite element method in engineering branches, ORF can now cover the following analyses:

1. Beams, rectangular and triangular elements, cover deflections, internal reactions, stress, thermal stress and prescribed displacements.
2. Isoparametric hexahedron and pentahedron elements, cover deflections, internal reactions, stress and prescribed displacements for solid structures.
3. Axi-symmetrical shell elements to solve for deflections, thermal stress and prescribed displacements of shells of revolution.
4. Axi-symmetrical solid elements for solution at stresses and displacements of solids of revolution.
5. Frequency and nodal shapes, and the resulting vibratory stresses.
6. Thermal stresses of all modes of heat transfer.
7. Isoparametric solid element. Plate and beam elements. Analysis at cyclical symmetric structures.
8. Large deflection and stability analysis of structures.

In addition to these specialized programs, ORF has access to general-purpose commercial computer programs such as NASTRAN, ANSYS, STARDYNE and NONSAP.

In summary, ORF provides the following CAD services and support:

1. Detailed design checks in the design stage.
2. Modifications of existing designs.
3. Analytical aids to engineering testing.
4. Technical support for ORF programs.
5. Technical support for commercial computer programs.
6. Conducting training and technical seminars.

Systems Analysis, Control and Design Activity (SACDA)

University of Western Ontario
Faculty of Engineering Science
London, Ontario, Canada
N6A 5B9
Tel: (519) 679-6570
Contact: J. R. Dickinson, Director

Activities: Computing support; process systems analysis; data reconciliation; scheduling of multiproduct processes; dynamic simulation; computer graphics.

Educational Institutions

Carleton University

Faculty of Engineering
Ottawa, Ontario, Canada
K1S 5B6
Tel: (613) 231-3619
Contact: John Knight, Associate Professor

Activities: Computer-aided design of microwave circuits, digital circuits, optimization, and structural design; technical advice and consulting.

Concordia University

Centre for Building Studies
1455 de Maisonneuve Boulevard West
Montreal, Quebec, Canada
H3G 1M8
Tel: (514) 879-8530
Contact: Dr. P. Fazco, Director, J. Carswell, Assistant to the Director

Activities: Research into the use of computer graphics and computer-aided design in the field of building design with support of the "Grapple" graphics system; provide consulting services.

Concordia University

Electrical Engineering Department
1455 de Maisonneuve West
Montreal, Quebec, Canada
H3G 1M8
Tel: (514) 879-7236
Contact: Serge Gracovetsky, Associate Professor

Activities: Instrumentation for surface roughness analysis of paper (on line); micro-computer engineering application laboratory; design, construction and delivery of instruments; design and limited production of special purpose microprocessor systems for industrial applications. (software, coding of ROM, hardware, complete and documentation).

Concordia University

Mechanical Engineering (Fluid Control Centre)
1455 de Maisonneuve Boulevard
Montreal, Quebec, Canada
H3G 1M8
Tel: (514) 879-8418
Contact: Dr. R. Cheng, Associate Professor

Activities: Computer-aided wood cutting system; digital, analog and mini-computer facilities; research and development to improve manufacturing and quality control processes; research and development of efficient scanning and data collecting units and integration with computer systems to form overall design or manufacturing process control.

The George Brown College of Applied Arts & Technology

Computer Services/Engineering Technology Department
500 MacPherson Avenue
Toronto, Ontario, Canada
M5T 2T9
Tel: (416) 967-1212
Contact: George Danac, Teaching Master

Activities: Tool design and production, supported by on-line terminals connected to central time-sharing computer; teaching programs and part-time courses in the application of computers to numerical control machines.

McGill University

Electrical Engineering Department
P.O. Box 6070, Station "A"
Montreal, Quebec, Canada
H3C 3G1
Tel: (514) 392-5397
Contact: Professor P. Silvester, Chairman

Activities: Research on the application of numerical methods to the analysis of large electrical networks; development of these analysis programs into CAD packages for networks and systems, not necessarily restricted to electrical; finite element program packages for electromagnetic field analysis; development of specialized CAD programs; man-machine communication problems in CAD; consulting on the use of existing general purpose programs, including the modelling of discrete or disturbed systems, network components, and electromagnetic fields; development and consultation on problem-oriented languages and man-machine communication in CAD.

McGill University

Mechanical Engineering Department
P.O. Box 6070, Station A
Montreal, Quebec, Canada
H3G 3G1
Tel: (514) 392-4549
Contact: Roy Hoffman, Professor

Activities: Teaching of courses and research projects in computer-aided design, computer graphics, computer-aided programming of numerically-controlled machine tools; numerical control programming using the APT language; writing of postprocessors for NC machines; prototype machining of parts via an NC lathe or 3-axis NC machining centre, plotting of tool motions to verify NC types; development of specialized programs for computer-aided design, computer-aided manufacture, computer graphics, etc. to customer specifications.

McMaster University

Departments of Mechanical and Electrical Engineering
Hamilton, Ontario, Canada
L8S 4L7
Tel: (416) 525-9140
Telex: 061-8347
Contacts: Professors J. N. Siddall, Dr. J. L. Tlusty, W. R. Newcombe, H. A. Elmaraghy, J. W. Bandler, J. E. Crozier

While the departments of Mechanical and Electrical Engineering at McMaster University are both involved with the use of computers to solve engineering problems, there are two groups concerned with research directly affecting computer-aided design and computer-aided manufacturing. In the Department of Mechanical Engineering, a Metalworking Research Group headed by Prof. J. N. Siddal has its own metalworking laboratory facilities which include numerical control systems. The Department is also involved in the study of computer-aided design of structures, machine elements and linkages; reliability; optimization, vibration and noise problems; interactive plant layout routines; development of interactive design packages using computer-aided design and graphics. Faculty members act as consultants to industry on many of these problems, and a list of reports prepared on these subjects is available from the Department.

The second group, covering simulation, optimization and control (G-SOC) is interdisciplinary. Group co-ordinator is Dr. J. W. Bandler, Professor of Electrical Engineering whose particular interests include circuit and system modelling and design. The G-SOC also has expertise in optimal design centring, tolerancing and tuning; optimization software; interactive design; and microwave circuits, and provides advice on the formulation and solution of problems within these areas. A free catalogue of more than 100 of the Group's reports, including abstracts, descriptions of contents and indication of related work, is available on request to Dr. Bandler.

Extensive facilities for research are available including the university's CDC 6400 computer as well as dedicated computers and computer terminals. Mention should be made, in particular, of a PDP 11/45 with sophisticated graphics capability and a dual processor shared disc Supernova-Nova, both with real-time disc operating systems, as well as two Nova 1200 and one Nova digital computers which are dedicated to the research projects of G-SOC members.

A description of the services offered by The Canadian Institute of Metalworking, which is also associated with McMaster University, can be found in the section on "Research Organizations."

Southern Alberta Institute of Technology

Metals Department - Numerical Control Division
1301-16th Avenue Northwest
Calgary, Alberta, Canada
T2M 0L4
Tel: (403) 284-8407
Contact: Barry Wilson, Senior Instructor

Activities: 3-axis, computer-controlled milling machine; courses in numerical control programming and operation.

University of Calgary

Mechanical Engineering Department
Calgary, Alberta, Canada
T2N 1N4
Tel: (403) 284-5732
Contact: E. W. Johnson, Associate Dean

Activities: Computer-aided production of tapes for numerically-controlled machines for manufacture of non-analytical surfaces, such as artificial limbs; advice, consultation, and training in programming for numerical-controlled machines.

University of British Columbia

Mechanical Engineering Department
Wesbrook Crescent
Vancouver, British Columbia, Canada
V6T 1W5
Tel: (604) 278-2781
Contact: Dr. J. P. Duncan, Professor and Head

Activities: Developers and appliers of the POLYHEDRAL NC computer-aided machining system. The system can accept surface definitions in several forms varying from models to drawings and polygraphs of sculptured surfaces and can prepare instructions for their automatic machining in numerically-controlled equipment. A POLYHEDRAL NC documentation is available for public distribution; the Department can offer consulting services in applications of POLYHEDRAL NC to the reproduction of very complex surfaces as encountered in industrial die making or in medical prosthetics. Applications in boat building, aircraft and automotive panels, moulds for shoes, forging and casting dies are examples.

University of New Brunswick

Department of Mechanical Engineering
Manufacturing and Production Engineering Program
P.O. Box 4400, Head Hall
Fredericton, New Brunswick, Canada
E3B 5A3
Tel: (506) 453-4513
Contact: Dr. David J. Bonham, Assistant Professor

Activities: Computer support facilities; computer numerical control for TOS Kirum mill; development of adaptive control systems and graphic modelling design; consulting; APT programming.

University of Ottawa

Department of Computer Science
Ottawa, Ontario, Canada
K1N 6N5
Tel: (613) 231-5420
Contact: L. G. Birta, Chairman

Activities: Development of interactive computer graphics software packages to meet specific needs.

University of Saskatchewan

Electrical Engineering Department
Graphic Systems Design and Application Group
Saskatoon, Saskatchewan, Canada
S7N 0W0
Tel: (306) 343-2673
Telex: 074-2659
Contact: Dr. A. R. Boyle, Professor

Activities: Mini-computer-controlled interactive graphics for automated cartography and geographic information systems; updating large amounts of textual data associated with locations; operational management information systems.

University of Toronto

Department of Mechanical Engineering
5 Old Kings College Road
University of Toronto
Toronto, Ontario, Canada
M5S 1A4
Tel: (416) 978-3040

Contact: Professors I. W. Smith, R. Fenton

Activities: Provide design and production courses involving CAD; one undergraduate course on CAD, which emphasizes optimization.

University of Waterloo

Electrical Engineering Department
University Avenue
Waterloo, Ontario, Canada
N2L 3G1
Tel: (519) 885-1211
Telex: 069-5259
Contact: Jiri Vlach, Professor, W. D. Little, R. J. Pick, K. G. Adams, E. L. Holmes

Activities: Analysis and design of electric networks, linear and non-linear transistor networks, active networks, micro and mini-computer hardware and software for machine control; design and analysis of pressure vessels and structures, making use of the finite element technique and interactive computer graphics; design and analysis with respect to the ASME pressure vessel code; computer numerical control of industrial machining systems; computer-controlled sewing systems for the apparel industry; fundamental research in machining and its relationship to numerical control; contract research; consulting in all of the above areas.

Associations and Societies

Canadian Institute of Steel Construction

300-201 Consumers Road
Willowdale, Ontario, Canada
M2J 4G8
Tel: (416) 491-4552
Contact: M. I. Gilmor, Assistant Director of Engineering

Activities: Develop and promote computer programs for the design of steel structures using the appropriate Canadian specifications. These programs, generally used by structural engineers, select the steel members to be used in the structure. Provide computer-user seminars and user manuals.

Canadian Shipbuilding and Ship Repairing Association

701-100 Sparks Street
Ottawa, Ontario, Canada
K1P 5B7
Tel: (613) 232-7127
Contact: H. M. Walsh, President

Activities: Support its members' efforts to improve efficiency through the introduction of more automated procedures and equipment.

Canadian Society for Civil Engineering*

Computer Applications Division
700-2050 Mansfield Street
Montreal, Quebec, Canada
H3A 1Y9
Tel: (514) 842-8121
Contact: Whitman Wright, Chairman, Computer Applications Division

Activities: Provide a range of services to members - newsletter, technical sessions and conferences, papers on the state of the art and the availability of computer programs.
*A Constituent Society of the Engineering Institute of Canada

Canadian Tooling Manufacturers' Association

P.O. Box 384
London, Ontario, Canada
Tel: (519) 434-1235
Contact: R. S. Eberhard, Executive Secretary

Activities: Advance the general interests of the tool and die industry; represent a group of firms involved in the manufacture of tools, dies, jigs, fixtures, gauges, molds, special and standard machinery cutting tools and general jobbing machine shop products.

Computer Aided Manufacturing - International, Inc.

1107-611 Ryan Plaza Drive
Arlington, Tex, 76011
Tel: (817) 265-5328
CAM Contact: Dr. R. N. Claytor, Project Co-ordinator

Activities: A not-for-profit research and development corporation dedicated to the advancement of the application of the computer to manufacturing problems; advanced technical planning for computer applications; support industry standardization; develop user-specified and tested software for manufacturing industries through co-operative projects; distribute a free News Alert 10 times a year; hold two major meetings and several specialized workshops and seminars each year.

Numerical Control Society

1201 Waukegan Road
Glenview, IL 60025
Tel: (312) 724-7700
Contact: C. A. Wangman, Executive Director

Activities: There are two Canadian chapters, in Central Ontario and Montreal; a technical organization contributing to the application and advancement of numerical control technology in all industry; provide a central information source and information exchange; serve as a focal point for the exploration of new ideas in the profitable and productive use of numerical control; each year conduct an annual meeting and technical conference; national conferences, regional seminars, chapter meetings, and co-operative programs with secondary schools and colleges; NCS correspondence courses are also offered, including basic NC part programming, APT part programming, and NC co-ordinator courses; special seminars; speakers registry; conduct technical surveys such as the Post-processor Survey and Industrial Survey on numerical control input (preparation and verification methods); monthly society newsletter devoted exclusively to numerical control; Who's Who in Numerical Control, directory of NCS members; edited bound volume of the AMTC Conference Proceedings, including more than 50 papers on numerical control; guide to publications available on NC technology; list of informative audio visual presentations. In addition, membership in NCS allows members preferential fees and other benefits with the following organizations:

AIIE - American Institute of Industrial Engineers
GAMI - French Numerical Control Society
SANCS - South African Numerical Control Society
SME - Society of Manufacturing Engineers
IMMS - International Material Management Society

For further information please contact:

Ontario Chapter
c/o George Goossen
Uniroyal Ltd.
149 Strange Street
Kitchener, Ontario, Canada
N2G 4J4
Tel: (519) 744-7171

Quebec Chapter
c/o John Nassr
Canadian Advanced Production Consultants
15 Greenview
Dollard des Ormeaux, Quebec, Canada
H9A 2E3

Activities: Information, various publications and an annual technical conference.

Portland Cement Association

116 Albert Street
Ottawa, Ontario, Canada
K1P 5C3
Tel: (513) 236-9471
Chief Executive Officer: L. C. DeCory, Vice-President, Canadian Operations

Activities: Develop computer programs for the design of reinforced concrete structures and provide them to consultants and service bureaus.

Special Interest Group on Design Automation

ACM Headquarters
1133 Avenue of the Americas
New York, NY 10036
Tel: (See contacts below)
Contacts: SIGDA Chairman - C. W. Rose
Computing and Information Science
Case Western Reserve University
Cleveland, OH 44106
Tel: (216) 368-2800

SIGDA Newsletter Editor, R. J. Smith II
Lawrence Livermore Laboratory
L-156
P.O. Box 808
Livermore, CA 84550
Tel: (415) 447-1100, Ext. 8088

Activities: Formal and informal technical meetings; co-sponsor of annual Design Automation Workshop; publish quarterly newsletter; panel and technical sessions at national meetings.

Bibliography

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1 RETURN
2 DISPLAY
3 SAVE VIEW
4 DEFINE WORKING STRUCTURE
5 BOUNDARY DISPLAY OF MESH
6 PLANARITY CHECK
7 NORMAL CHECK
8 AUTO NORMAL ORIENTATION
9 REVERSE NORMAL
PICK FROM MENU
=

Government of Canada
Gouvernement du Canada
Industry, Trade and Commerce
Industrie et Commerce