INVESTMENT OPPORTUNITIES IN CANDIAN RESEARCH

Profiles of Canadian Artificial Intelligence Research Groups With Advanced Expertise, Technologies and Products Seeking Exchanges, Collaborations and Investment

INVESTMENT CANADA
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INVESTMENT OPPORTUNITIES IN CANDIAN RESEARCH

**Profiles of Canadian Artificial Intelligence Research Groups
With Advanced Expertise, Technologies and Products
Seeking Exchanges, Collaborations and Investment**

Sponsored By

**Investment Canada,
the Natural Sciences and Engineering Research Council, and
the Information Technology Association of Canada**

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INVESTMENT OPPORTUNITIES IN CANADIAN RESEARCH

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RESEARCH GROUP PROFILES

Artificial Intelligence Group, University of New Brunswick 6

Applied and Theoretical areas of AI emphasizing computer vision, expert systems and machine learning.

Artificial Intelligence Research Group, Centre de recherche informatique de Montréal 9

Research and applications development related to expert systems, knowledge engineering and very large knowledge bases.

Communications Protocols Research Group, Université de Montréal 12

Research on new communication protocol standards for OSI and ISDN, and the use of formal description techniques for protocol design.

Computer Supported Cooperative Work Research Group, University of Toronto 15

Development of a video-enhanced computer communications set-up designed to improve collaboration on complex, detailed work projects.

Dynamic Graphics Group, University of Toronto 18

Advanced 3D computer graphics research and work in program visualization and human-computer interface design.

Nial Research Group, Queen's University 21

Implementation of a powerful, high level, array-based programming language.

Object-Oriented Programming Research Unit, Carleton University 24

Research in object-oriented programming languages, systems and applications.

Parallel Programming Group, Centre de recherche informatique de Montréal 28

Development of software tools for the parallel decomposition, portability, and scalability of array-based computation.

Pattern Analysis and Machine Intelligence Group, University of Waterloo 31

Pattern analysis and machine intelligence (including parallel forms) with a special focus on computer vision, knowledge-based systems, and their applications to computer-based manufacturing.

Software Engineering Group, Centre de recherche informatique de Montréal 34

Research in the areas of software development modelling, re-use (design and code), metrics and reverse engineering.

Taxis Project Group, University of Toronto 37

Object-oriented data bases and CASE environments, involving the design language "Taxis" and the modelling language "Telos".

Turing Research Group, University of Toronto 40

Research involving the "Turing" general purpose programming language.

User Interface Group, University of New Brunswick 44

User interface design including human factors, rapid prototyping, user interface management systems, computer graphics, visualization, and novel input devices such as a six dimensional mouse.

Other research groups for whom profiles will soon be available include those at the

University of British Columbia,
University of Victoria,
Simon Fraser University,
the Advanced Systems Institute, and
the Information Technology Research Centre.

WHAT EXPERTISE, TECHNOLOGIES AND PRODUCTS WILL YOU FIND IN THIS BOOKLET?

You will find research capabilities within the general areas of

- **Large Knowledge Based Systems,**
- **Software Engineering, and**
- **AI-Based Software.**

Examples of the range of expertise, technologies and products that are available through the research groups profiled in this booklet include:

- **visual programming environments,**
- **computer vision systems,**
- **vision-based robotics systems,**
- **language recognition systems,**
- **NIAL (a successor to LISP and Pascal),**
- **3D spatial interaction and shape detection,**
- **communication protocols,**
- **automatic/assisted software system designs,**
- **and more.**

WHAT RANGE OF INVESTMENT OPPORTUNITIES ARE THERE?

A wide range of opportunities exist, including

- **research personnel exchanges,**
- **collaborative research,**
- **contract research,**
- **research consortium membership,**
- **licensing agreements,**
- **distribution agreements,**
- **joint agreements, and**
- **strategic alliances.**

WHAT RESEARCH GROUPS WILL YOU BE INTRODUCED TO?

You will be introduced to 13 highly networked, well-established, advanced research groups, involving more than 200 researchers, 20 universities, and working with , or representing, 80 firms.

WHO SHOULD YOU CONTACT IF YOU WANT TO KNOW MORE?

Mr. Peter Standeven
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FAX: 416 971-9529

WHAT DOES CANADA OFFER IN TERMS OF RESEARCH SUPPORT?

. **Government Funding:** Canadian researchers, universities, and businesses are eligible to apply to the Department of External Affairs and International Trade for up to 2/3 funding of joint science and technology initiatives with European partners. The activities must be aimed at exploring, establishing, or continuing joint projects in technological research and development (R&D).

. **The Tax System:** The Canadian corporate income tax system provides a number of significant R&D tax incentives for firms. Currently, it allows for a 100% deduction for current R&D expenditures, as well as for capital expenditures made on R&D machinery and equipment. Canada also allows an investment tax credit on qualifying R&D expenses incurred in Canada. The rate of the credit is 20% of R&D expenditures. Both current expenditures and expenses on machinery and equipment qualify for the credit.

Recent international studies have concluded that "relative to other countries [i.e. the U.S., France, Germany, Italy, Sweden, the U.K., Japan, and Korea] Canada's tax treatment of R&D remains the most favourable because it offers the taxpayer a variety of broadly-based tax benefits at both the federal and provincial levels."

. **University-Industry Collaborative Programs:** Canada offers a diverse range of university-industry collaborative research programs. These feature flexibility and shared responsibility. Non-Canadian firms can be considered as possible collaborators in these programs if significant benefits to Canada can be foreseen.

The Natural Sciences and Engineerings Research Council of Canada (NSERC) offers a wide range of such programs including:

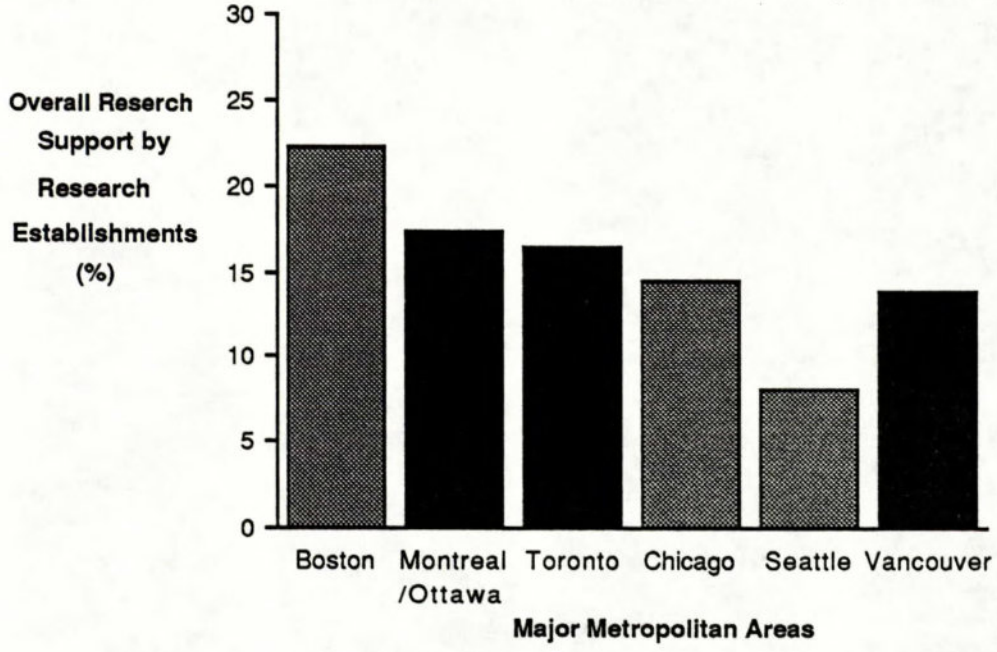
- Cooperative R&D Programs (research grants & shared equipment);
- Industry Research Chairs;
- Industrial Research Fellowships;
- Research Personnel Exchanges; and
- University-Industry Affiliations (helping you to open liaison offices on campus, provide space to you on campus, circulate R&D bulletins, offer consulting services, etc.)

. **A Competitive Research Environment:** Financial support for research, coupled with the availability of a full range of research professionals, are critical and necessary factors for the successful creation, development and distribution of new technologies. Recent studies by Industry, Science and Technology Canada (ISTC) and the OECD have shown that Canada's major metropolitan areas are highly competitive with similar U.S. centres in terms of these two important factors [see Figure 1].

Figure 1

Relative Intensity of Research Capabilities*

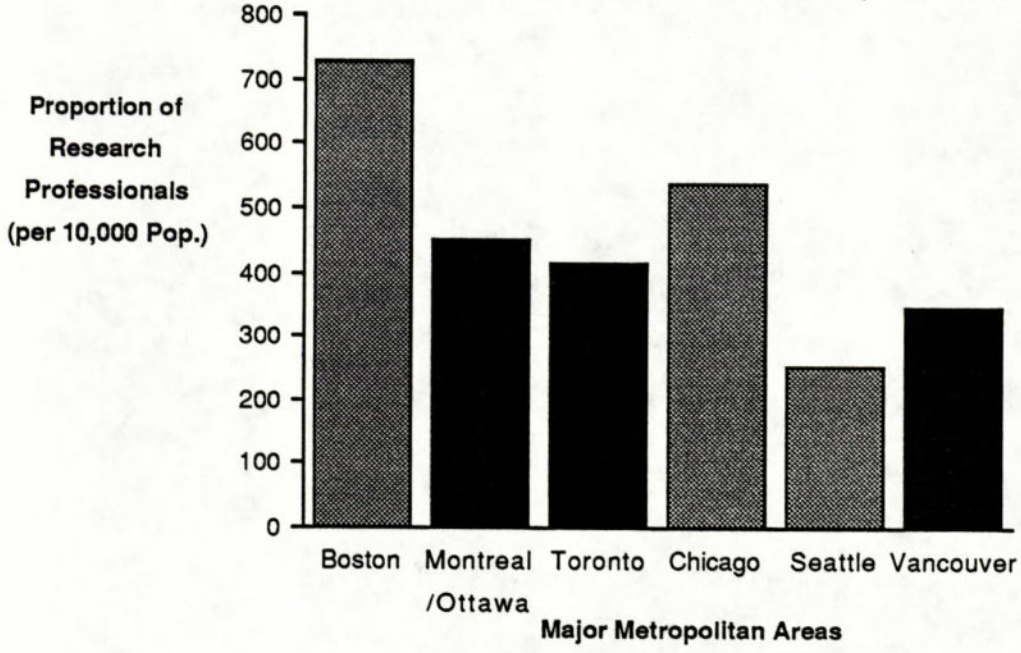
Selected Canadian and American Metropolitan Areas, 1989



Source: Science, Technology and Economic Analysis Division (ISTC)/OECD
* Does not include government research establishments.

Relative Intensity of Research Capabilities*

Selected Canadian and American Metropolitan Areas, 1989



Source: Science, Technology and Economic Analysis Division (ISTC)/OECD
* Does not include government research establishments.

HOW DOES CANADA PROVIDE YOU WITH PRIVILEGED ACCESS TO THE NORTH AMERICAN MARKETPLACE?

By coming to Canada, you will gain direct access to a North American marketplace of 285 million consumers.

. Canada's Free Trade Agreement (FTA) with the United States provides for free flow of research personnel, professionals, entrepreneurs, and business men and women between the two countries.

. The Canada/U.S. FTA provides for the duty-free distribution of many high technology goods and services between the two countries which would normally be subject to duty if they flowed directly from Europe or Asia.

. Canadian cities, such as Halifax, Montreal, Ottawa, Toronto, Calgary and Vancouver, offer you speedy and low cost transportation directly into the U.S. market. It is not uncommon to have lower transportation or distribution costs to U.S. cities from Canada than it is from from the U.S. itself.

CANADIAN RESEARCH CAPABILITIES OFFER YOU A REAL ADVANTAGE!

CANADIAN RESEARCH GROUP PROFILES

ARTIFICIAL INTELLIGENCE GROUP
UNIVERSITY OF NEW BRUNSWICK

KEY CONTACT:

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NATURE OF RESEARCH:

The Artificial Intelligence (AI) Group at the University of New Brunswick is involved with research in both applied and theoretical areas of AI, emphasizing computer vision, expert systems and machine learning.

MAJOR ACHIEVEMENTS:

The AI Group has successfully designed several expert systems for commercial clients in the lumber and power utility industries. In addition, the Group has hosted two "Applications of Artificial Intelligence" conferences in Fredericton, New Brunswick.

DESCRIPTION OF RESEARCH:

In addition to the industrial applications work described below, the AI Group's current research activities also offer potential industrial applications. These research activities are focused on:

- *Appropriate knowledge representation methods* for the knowledge contained in power plant operating manuals;
- *Combining formal temporal logic with real-time expert systems* (this research is being applied to a soot-blowing advisor for a coal fired generating station);
- Building *industrial active vision systems* for the lumber industry. Optimizing log sawing to ensure the highest lumber yield in a sawmill;
- Learning of *low-level features in machine-vision;*

- *3D shape detection* using a single view with ambient light;
- Investigation of *engineering design using expert systems*; and
- *Knowledge-based approaches for computer-assisted translation* of documents from English to French and French to English.

CURRENT INDUSTRIAL INVOLVEMENT:

The AI Group at the University of New Brunswick has had considerable involvement with industry, particularly wit companies in New Brunswick. Recent projects have included:

- The development of an expert system for diagnosing resistance temperature detectors at a nuclear power plant;
- Real-time detection and measurement of industrial objects using a cooperative computer vision approach, with application to lumber mills;
- Research into appropriate knowledge representation methods for the knowledge contained in power plant operating manuals;
- A study of expert systems as decision tools for nuclear regulatory tasks;
- An investigation of the application of expert systems to crisis management for utility power distribution test data for a nuclear power plant; and
- Research into automated generation of control program test data for a nuclear power plant.

INDUSTRIAL INVOLVEMENT SOUGHT:

The AI Group would be interested in discussing industrial research contract opportunities, particularly with companies in process-oriented industries (ie. pulp and paper, nuclear and coal-fired power generation, and chemical industries). Industrial funding or collaboration on academic research topics would also be welcomed, particularly from corporations actively involved with expert systems, real time control, or machine vision development projects.

RESEARCH GROUP PROFILE:

The Principal Researchers Are:

Prof. R.H. Cooper
Dr. E.F. Hill
Dr. L. Goldfarb
Dr. B.J. Kurtz
Dr. B.G. Nickerson
Dr. S.W. Rauch
Dr. W.D. Wasson

Number of Researchers: 9
Number of Post Graduate Students: 7

University/Institute Involvement:

- University of New Brunswick, Computer Science
- University of New Brunswick, Electrical Engineering

ARTIFICAL INTELLIGENCE RESEARCH GROUP
CENTRE DE RECHERCHE INFORMATIQUE DE MONTREAL (CRIM)

KEY CONTACT:

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Facsimile: (514) 848-8892

NATURE OF RESEARCH:

The Artificial Intelligence (AI) Group at CRIM is involved in research and applications development related to expert systems, knowledge engineering and very large knowledge bases.

MAJOR ACHIEVEMENTS:

The CRIM AI Group has successfully developed a number of expert and knowledge based systems for corporate clients in various industries.

DESCRIPTION OF RESEARCH:

While implementing a number of different applications, the CRIM AI Group has also continued to pursue fundamental AI research in several areas including:

- The development and study of knowledge acquisition techniques and models;
- The automation of the knowledge engineering process;
- The incorporation of deep knowledge in expert systems;
- The automatic testing and validation of expert systems; and
- The use of very large knowledge bases and complicated causal networks;

Within these areas of research the CRIM AI Group has made advances in:

- Blackboard systems;
- The integration of statistical, heuristic, model-based, and case-based reasoning strategies;
- The development of intelligent user interfaces;
- Qualitative reasoning techniques for time-varying systems;
- The integration of qualitative reasoning and numerical optimization; and
- Constraint satisfaction algorithms for qualitative reasoning.

CURRENT INDUSTRIAL INVOLVEMENT:

CRIM is a non-profit corporation composed of seven university members, 35 industrial members, and 60 employees. CRIM's mission is to act as a link between universities and industry, and to facilitate collaborative research. The AI Group at CRIM has been heavily involved with industry. Recent projects have included:

- An intelligent controller/diagnostic system for an aluminum electrolysis tank (Client - ALCAN Aluminum);
- A knowledge based system to assist engineers in designing and testing aerodynamic models for flight simulators (Client - CAE Electronics);
- A diagnostic system for dealing with pitch deposits in pulp and paper mills, incorporating deep knowledge of the kraft process (Client - PAPRICAN);
- An expert diagnostic system for monitoring the state of hydroelectric dams (Client - Hydro-Quebec); and
- An expert advisory system to assist meteorologists in the production of airport weather forecasts (Client - Meteoglobe Canada).

INDUSTRIAL INVOLVEMENT SOUGHT:

The AI Group at CRIM is interested in pursuing a number of different types of industrial involvement:

. Support for CRIM itself through membership or the contribution of appropriately qualified personnel or research funding;

. Applications development work on a contract basis, taking advantage of the Group's considerable expert systems development expertise (major Fortune 100 type industrial corporations similar to those noted as clients together with financial corporations may have an interest in working with CRIM on applications); and

. Funding for pre-competitive research relating to its research activities. Industrial sponsorship of such projects can be structured to include a corresponding ownership interest.

RESEARCH GROUP PROFILE:

<u>The Principal Researchers Are:</u>

Jacques Quellet
Renato De Mori
Michel C. Desmarais

Number of Researchers: 8
Number of Post Graduate Students: 6
Visiting Industrial Researchers: 2

<u>University/Institute Involvement:</u>

. Concordia University, Computer Science
. Ecole Polytechnique, Genie electrique
. McGill University, School of Computer Science
. Universite de Montreal, Informatique et recherche operationnelle
. Universite de Sherbrooke
. Universite du Quebec a Montreal
. Universite Laval
. Centre canadien de recherche sur l'informatisation du travail (CCRIT)
. Centre de recherche industrielle du Quebec (CRIQ)
. Institut de recherche d'Hydro-Quebec (IREQ)
. Pulp and Paper Institute of Canada (PAPRICAN)

COMMUNICATION PROTOCOLS RESEARCH GROUP
UNIVERSITE DE MONTREAL

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NATURE OF RESEARCH:

The Communication Protocols Research Group is involved in research on new communication protocol standards for OSI and ISDN, and the use of formal description technique for protocol design, implementation, and testing. The Group is also interested in distributed systems and their communications protocols, the problems of compatibility between heterogeneous systems and their interconnection, and error and crash recovery in distributed systems.

MAJOR ACHIEVEMENTS:

Dr. Gregor V. Bochmann is widely respected for his expertise in the area of communications protocols. The Communications Research Protocols Group is funded by several organizations and is part of the Network of Centres of Excellence program with the Canadian Institute for Telecommunications Research. The Group has also had considerable involvement with industry and has developed several software packages which are in commercial use.

DESCRIPTION OF RESEARCH:

The Communication Protocols Research Group is involved with research relating to new communications protocol standards. Some of the research projects that are currently underway include:

- *Rule-based descriptions of communications protocols* - investigation of the use of the Prolog language as a formal specification and implementation tool for standardized protocols, such as the Manufacturing Message Services within MAP (Research Partner- IBM);

- *Object-oriented specifications* - the definition of an object-oriented specification language (MONDEL) for applications related to network management and object-oriented databases. Concepts of existing object-oriented languages and of standardized protocol specification languages are integrated in MONDEL (Research Partner - Bell-Northern Research);

- *Test suite development* - test suite are being defined for ISO protocols and ISDN systems. Theoretical work is also being done using the Lotos language for testing;

- *Test results analysis* -using a tool called TETRA, results of a test sequence are checked against a formal specification. Application of this tool in a real-time, interactive environment is being studied;

- *Distributed Lotos implementation* -using ISLA as a base, a Lotos interpreter developed at the University of Ottawa and implemented in Prolog, the project is aimed at developing a distributed execution environment for Lotos; and

- *Formal description techniques* - work relating to the Estelle, Lotos, and ASN.1 formal description techniques.

CURRENT INDUSTRIAL INVOLVEMENT:

Dr. Bochmann is the holder of the IDACOM-NSERC-CWARC industrial research chair on communication protocols. He and his research group have acted as consultants to and performed industrial research for a large number of government and corporate organizations including: the Department of Communications (Canada), SRI International, Hahn-Meitner-Institute, Siemens, Philips, Unisys, Digital Equipment Corporation, Bell-Northern Research, Mitusbishi, NTT and IBM.

INDUSTRIAL INVOLVEMENT SOUGHT:

The Communication Protocols Research Group is interested in:

. Industrial research contract opportunities with companies involved with telecommunications and data communications research; and

. Licensing software packages, relating principally to protocol implementation and testing, that the Group has developed.

RESEARCH GROUP PROFILE:

<u>The Principal Researchers Are:</u>

Gregor Bochmann
Pierre Mondain-Monval

Number of Researchers: 6
Number of Graduate Students: 15
Visiting Industrial Researchers: 1

<u>University/Institute Involvement</u>:

. Canadian Institute for Telecommunications Research
. Centre de recherche informatique de Montreal (CRIM)
. Groupe telematique inter-universites -

.Concordia University
.Ecole Polytechnique
.INRS Telecommunications
.McGill University
.UQAM
.Universite de Montreal
.Universite d'Ottawa

COMPUTER SUPPORTED CO-OPERATIVE WORK (CSCW) RESEARCH GROUP
UNIVERSITY OF TORONTO

KEY CONTACTS:

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NATURE OF RESEARCH:

The Computer Supported Co-operative Work (CSCW) Research Group's research involves the development of a video enhanced computer communications setup designed to improve collaboration on complex and detailed work projects. The researchers will not only be developing the necessary software and hardware needed but will also be looking at the psychological and sociological aspects of the communications and work patterns of users of the developed system.

MAJOR ACHIEVEMENTS:

The CSCW Group forms part of the highly respected Dynamic Graphics Project at the University of Toronto. Members of the CSCW Group have considerable experience with computer supported collaborative work environments having been involved with the Capture Lab, a Computer Supported Meeting Environment for the Centre for Machine Intelligence, EDS and with projects underway at Rank Xerox EuroPARC.

DESCRIPTION OF RESEARCH:

The CSCW Group is in the process of developing a combined hardware and software technology for communicating over distances that will allow the communication to support work as effectively as close-at-hand communication. The technology under development will incorporate the use of user defined and controlled audio and video and the design of a video-enhanced collaborative workstation.

The CSCW researchers are addressing three major issues with their work. These issues are:

. *The sense of presence of the fellow collaborator.* This will be achieved using a combination of audio, visual, and electronic mediums, controllable by the collaborator;

. *The allocation of control between users, both of the video and electronic links.* This work is designed to simulate control of personal physical space usage; and

. *The management of the information display.* This includes research on how the results of actions by multiple parties, both synchronous and asynchronous are encoded and displayed. Screen allocation and collaboration control will also be addressed.

CURRENT INDUSTRIAL RESEARCH:

The CSCW Group is supported in part by funding and equipment from several commercial organizations including Apple Computer. In addition, Professor Buxton is currently working with EuroPARC performing research on their video-enhanced computer communications project.

INDUSTRIAL INVOLVEMENT SOUGHT:

The CSCW Group is interested in financial support and technical collaboration form corporations interested in computer-supported cooperative work. In addition, the Group believes that the technology under development has commercial market potential and hence are interested in having discussions with computer, software, communications or similar firms who might license or otherwise bring the technology to market.

RESEARCH GROUP PROFILE:

<u>Principal Researchers</u>:

. Marilyn Mantei
. Ron Baecker
. William Buxton
. Barry Wellman

Number of Researchers: 5
Number of Post Graduate Students: 10
Number of Scholarships and Fellowships 8

University/Institute Involvement:

- University of Toronto, Department of Computer Science
- University of Toronto, Department of Sociology
- University of Toronto, Faculty of Management
- Computer Systems Research Institute (CSRI)
- Information Technology Research Centre (ITRC)

DYNAMIC GRAPHICS GROUP
UNIVERSITY OF TORONTO

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NATURE OF RESEARCH:

The Dynamic Graphics Research Group is part of the Dynamic Graphics Project within the Computer Science Department at the University of Toronto. The Group is involved in many research activities relating to advanced 3D computer graphics topics, program visualization and human-computer interfaces.

MAJOR ACHIEVEMENTS:

The Dynamics Graphics Project is recognized as one of the leading computer graphics labs in the world and is well known for its work in rendering and computer animation. The Lab has had research agreements with many of the largest computer vendors including Digital Equipment Corporation, Apple Computer, Xerox and Commodore.

DESCRIPTION OF RESEARCH:

The Dynamic Graphics Group is involved with research relating to mathematical modelling, global illumination, rendering, object-oriented systems, and physically-based modelling. A current research thrust involves the development of a very sophisticated and capable rendering system. This research will develop:

- More complete local illumination models, including models for ansiotropic reflection;
- A more general global illumination model, where as many as possible of the interactions of light with matter will be accounted for;
- Controlled approaches to the use of dynamics in modelling. A kinematic approach for the modelling of human gaits is also being researched;

. Rendering that is more strongly related to the devices used for display. This work includes formalization of the rendering process and characterization of the display devices; and

. Further study of filtering algorithms, an object-based animation system, and physically-based animation.

Members of the Group are also involved with other research relating to human-computer interaction. This research includes:

. The development of novel methods of information display to facilitate user comprehension of the behaviour and structure of complex systems such as large computer programs. These methods include program animation (eventually exploring the use of colour and sound effects) and 3D representations in program visualization and visual programming; and

. The development of tools for the design and production of multi-media documents (i.e. documents incorporating text, graphics, animation, video, and sound).

CURRENT INDUSTRIAL RESEARCH:

The Dynamic Graphics Lab has considerable experience working with industry and at the present time has research agreements with Digital Equipment Corporation and Apple Computer. In addition, Professor Buxton is consulting with Xerox PARC and Commodore.

INDUSTRIAL INVOLVEMENT SOUGHT:

The Dynamic Graphics Group is interested in financial support for and technical collaboration with the Dynamic Graphics Lab. In addition, the Group is interested in talking with companies who might license and market some of the software that they have developed. At present, the Group has (at various stages of completion) the following applications which might be licensed:

. An advanced 3D rendering system with strong filtering and texture mapping features, and with a good interface;

. Some physically-based animation software; and

. A physically-based illumination model.

RESEARCH GROUP PROFILE:

Principal Researchers:
Eugene Fiume
Ronald Baecker
William Buxton
Marilyn Mantei
Alain Fournier (University of British Colombia)

Number of Researchers: 5
Number of Post Graduate Students: 15
Number of Scholarships and Fellowships: 10

University/Institute Involvement:

- University of Toronto, Department of Computer Science
- University of Toronto, Department of Electrical Engineering
- University of Toronto, Management
- Computer Systems Research Institute (CSRI)
- Information Technology Research Centre (ITRC)

NIAL RESEARCH GROUP
QUEEN'S UNIVERSITY

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NATURE OF RESEARCH:

The Nial Research Group has designed and implemented a very powerful array-based programming language that builds on concepts from APL, Lisp, FP and procedural languages like Pascal.

MAJOR ACHIEVEMENTS:

The Nial Research Group has received over $1,500,000 in funding over its history and has developed a commercial quality language interpreter. The Nial portable interpreter, known as Q'Nial, has been marketed successfully to develop a number of prototype applications, and is now in use at a large number of sites.

DESCRIPTION OF RESEARCH:

The Nial Research Group has designed and implemented an array-based language that builds on concepts from APL, LISP, FP and procedural languages like Pascal. The data structures of the languages are based on a mathematical theory of nested arrays which are combined using operations that obey many universal laws. Nial is a very high level language that uses data-driven techniques to achieve rapid prototyping of systems that involve considerable data manipulation.

The first implementation of Nial is a portable interpreter written in C called Q'Nial. Q'Nial

implements the full language and is intended as a rapid prototyping tool for problems in information systems, mathematical computations, and knowledge-based applications. Q'Nial has been used to develop a number of prototype applications that require both database technology and an inference mechanism to manipulate knowledge about the data. The language can be thought of as a successor to LISP and APL.

The recent focus of the Nial Research Group has been on the design of a typing system that permits the flexible typing of the objects in the language. The revised language, called T'Nial, has been designed and a prototype compiler has been implemented to demonstrate the concepts. The long term goal is to develop an integrated programming environment in which programs developed during a rapid prototyping phase can be evolved into production level software by introducing type information and using compilation techniques.

CURRENT INDUSTRIAL INVOLVEMENT:

The Nial Project has had a long history of involvement with industry and owes some of its origins to the development of an array theory by Dr. Trenchard More at the IBM Cambridge Scientific Center. The IBM Center and Queen's University jointly developed the first versions of Nial. Subsequently, the Nial Project has had contracts with several companies including IBM, Bell Canada, and Spectrum Engineering. In addition, a company called Nial Systems Limited has been established to commercially market Q'Nial. Nial Systems sells versions of Q'Nial for a wide variety of computer platforms. Q'Nial has several additional features including a window package, direct access files, an in-workspace editor, improved logic programming primitives, and the ability to link C programs to Q'Nial. Nial Systems also offers an AI Toolkit for Nial which consists of a collection of programs and techniques for use in prototyping expert system. Q'Nial has been used in a number of commercial applications such as an intelligent underwriting assistant for a major Canadian insurance company, a depreciation analysis system, and diagnostic capability for complex engineering systems.

INDUSTRIAL INVOLVEMENT SOUGHT:

The Nial Research Group is interested in additional funding (development contracts or research grants) for further development of the Nial language, its implementation (including the typed variant T'Nial), and applications. In return for such support, the group would provide privileged access to the applications developed.

Nial Systems Limited is interested in investment funding or strategic partnerships with computer or software companies that would facilitate an expanded development and marketing effort for Q'Nial. Nial Systems believes that there is generally a lack of good software tools in the marketplace for the rapid construction of prototype systems, particularly for systems that mix artificial intelligence concepts with the manipulation of very large amounts of data. Q'Nial has been used with existing database systems and will allow a knowledge based application to be designed very quickly. Thus, Nial Systems believes that there is a significant market opportunity available for Q'Nial if sufficient financial and marketing support is available.

RESEARCH GROUP PROFILE:

<u>The Principal Researchers Are</u>:

Dr. Michael A. Jenkins
Dr. Janice I. Glasgow
Dr. Patrick T. Martin

Number of Researchers: 3
Number of Post Graduate Students: 10
Number of Post Doctoral Fellows: 1
Number of Scholarships and Fellowships: 6

<u>University/Institute Involvement:</u>

- Queen's University, Department of Computer and Information Science
- Information Technology Research Centre (ITRC)
- Institute for Robotics and Intelligent Systems (IRIS)
- Queen's University, Department of Chemistry
- Technical University of Denmark, Systems Science Group
- University of Alberta, Department of Computer Science

OBJECT-ORIENTED PROGRAMMING RESEARCH UNIT
CARLETON UNIVERSITY

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NATURE OF RESEARCH:

The Research Group in Object-Oriented Programming conducts research in object-oriented programming languages, systems and applications.

MAJOR ACHIEVEMENTS:

The Object-Oriented Programming Research Unit is recognized as one of the leading research units within this field in the world. The Unit's founder, David Thomas, has formed a significant company, Object Technology International (OTI). OTI technical staff have pioneered the development of the first multi-processor Smalltalk system, the first object-oriented C for a mainframe, the first embedded Smalltalk, the first object-oriented team programming environment and the first incremental persistent object garbage collector.

DESCRIPTION OF RESARCH

The Research Group in Object-Oriented Programming is currently investigating Smalltalk environments for industrial applications, object-oriented software engineering, persistent and distributed objects and visual programming. More specifically, work is underway on the following projects:

- *Actra* - a multi-tasking, multi-processing Smalltalk for embedded applications;

- *Animation* - tools and techniques for cartoon animation based on 3D representations that are sufficiently precise to be useful for realistic scene and object rendering. Cartoon rendering is then viewed as a alternative to realistic rendering. Another emphasis is the development of control techniques for manipulating motion;

- *Constraint Systems* - an advanced constraint satisfaction system based on hierarchies of constraints and events. The system is based on ThingLab (Borning), one of the most powerful constraint systems in existence. An object-oriented Prolog facility that executes in Smalltalk has been developed;

- *Visual Programming Environments* - improved tools for designing, programming, and debugging;

- *Team programming* - development of an approach for managing OOP projects which makes use of a team programming tool called Orwell. Also techniques for packaging and instantiating multiple applications which use different versions of a class library

- *Sticky - An Experiment in Object Persistence* - investigation of the mechanisms required to support a distributed persistent object system integrated with the Smalltalk programming environment. The application context for the project is a shared hypertext system for engineering design; and

- *Flexible User Interfaces* - development of an application framework which allows applications to be constructed in a manner which permits novel levels of menu and window customizing by end-users.

CURRENT INDUSTRIAL RESEARCH:

The Object-Oriented Programming Research Unit has had considerable involvement with both industry (Tektronix, Dy-4 Systems, Western Digital) and government (Defense Research Establishment Organization, Canadian Department of National Defense).

Object Technology International Inc. (OTI) provides technology, tools, and training which enable the development, delivery, and support of object-oriented systems and products. Customers included Fortune 500 companies in major industries and both U.S. and Canadian government agencies.

OTI technical staff are organized into three teams: The Embedded Systems Product Development Group, the Turnkey Applications Group and an Education Unit. Embedded applications, built using object-oriented technology range from dedicated special purpose controllers to multi-processor VME and FDDI based distributed systems. The Turnkey Group provides complete custom solutions built to customer requirements. The Education Unit provides training courses and assistance in developing in-house training programs.

INDUSTRIAL INVOLVEMENT SOUGHT:

The Object-Oriented Programming Research Unit would be interested in research funding or contract research from corporations interested in supporting the Unit's research efforts.

Object Technology International Inc. would be interested in discussions regarding strategic partnering or development contracts with corporations interested in OTI's object-oriented expertise.

RESEARCH GROUP PROFILE:

The Principal Researchers Are:

D. A. Thomas
W. Lalonde
J. Pugh
R. Dillon
J. Tombaugh

Number of Researchers: 5
Number of Post Graduate Students: 20

University/Institute Involvement:

. Carleton University, School of Computer Science
. Carleton University, Department of Psychology
. Ottawa University, Department of Computer Science
. Telecommunications Institute of Ontario (TRIO)

PARALLEL PROGRAMMING GROUP
CENTRE DE RECHERCHE INFORMATIQUE DE MONTREAL (CRIM)

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NATURE OF RESEARCH:

The Parallel Programing Group at CRIM is involved in the development of software tools for the parallel decomposition, portability, and scalability of array based computation. The Group is working towards the development of a completely integrated systems for parallel programming including a program library in the style of LINPACK or EISPACK.

DESCRIPTION OF RESEARCH:

The Parallel Programming Group project is involved with the development of a parallel programming system that will allow programmers to make full use of the speed advantages of multi-processor architecture computers. With the proposed system, a programmer will be able to create flexible and efficient programs, using a functional language (which is declarative) in a very parallel compiled form. The research draws upon Dr. Lenore Mullin's previous research on the Mathematics of Arrays, and will result in the functional programs being portable, verifiable, and independent of their execution mode with the capability of having their behaviour analyzed. Programs will be transformed and compiled automatically or semi-automatically in programs more adapted to parallel processing.

Original elements of the Group's approach include the integration of algorithmic programming techniques, program transformations and dataflow techniques. The algorithmic programming includes explicit definition of communicating processes and the re-use of sub-programs included in a library. The transformation and mapping modules will be structured as knowledge-based software, and therefore will be evolutive. Knowledge can then be coded in logic rules and/or algorithms. The dataflow techniques encompass a hierarchical structured functional language, oriented graphs for program representation and a mixed or dataflow execution mode.

The project will result in the development of a functional language including efficient array operations based on the Mathematics of Arrays; an algorithm library which will initially include matrix inversion that can be executed on a wide class of architectures and run more efficiently than existing libraries like LINPACK; an experimental compiler which will compile to an intermediate language such as C or FORTRAN; and a methodology for the creation of a completely portable parallel programming system. The proposed programming system will be an aid to optimally use MIMD machines with or without vector registers and SIMD machines, such as mesh or dataflow architectures.

CURRENT INDUSTRIAL INVOLVEMENT:

The Parallel Programming Group has only recently been assembled. At the present time the Group is holding discussion with two major computer manufacturers in the United States, as well as a Canadian manufacturer of parallel machines, regarding support for its project.

INDUSTRIAL INVOLVEMENT SOUGHT:

The Parallel Programming Group is interested in arranging researcher exchanges and collaborative research efforts with computer or communications companies involved with parallel processor architectures. Funding relationships that might ultimately lead to the commercialization and licensing of the programming system would also be considered.

RESEARCH GROUP PROFILE:

The Principal Researchers Are:

Dr. Lenore Mullin
Dr. Guang Gao
Dr. Gaetan Hains
Dr. Nazim Madhavji
Dr. Ettore Merlo
Dr. Lixin Tao
Dr. Gary Lapalme

Number of Researchers: 7
Number of Post Graduate Students 6
Number of Scholarships and Fellowships: 2
Number of Visiting University Research: 1
Number of Visiting Industrial Researchers: 3

University/Institute Involvement:

- Centre de recherche informatique de Montreal (CRIM)
- Concordia University, Computer Science
- Ecole Polytechnique, Genie electrique
- McGill University, Computer Science
- Universite de montreal, Informatique et recherche operationnelle

PATTERN ANALYSIS AND MACHINE INTELLIGENCE (PAMI) GROUP
UNIVERSITY OF WATERLOO

KEY CONTACT:

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NATURE OF RESEARCH:

The PAMI Group is active in the areas of pattern analysis and machine intelligence (including parallel forms) with special focus on computer vision, robotics, knowledge based systems and their application in computer integrated manufacturing.

MAJOR ACHIEVEMENTS:

The PAMI Group has a very strong record of producing research results that are put to commercial application by industry. Over $5,000,000 in research funding from industrial contracts and government funding has been received by the PAMI Group since 1981.

DESCRIPTION OF RESEARCH:

The PAMI Group is involved with research on pattern analysis and knowledge based systems, computer vision and image analysis, and robotics. Research on pattern analysis and knowledge based systems includes: pattern analysis and synthesis of mixed mode data; knowledge organization and inductive learning and inferences; and structural pattern recognition based on random graphs. In addition, emphasis is now being placed on parallel pattern analysis and machine intelligence systems, including parallel search heuristics, parallel graph morphism algorithms, and parallel architectures for knowledge directed searching.

Computer vision and image analysis research involves: computer vision for 3D scene analysis using a variety of approaches - constellation matching algorithms, graph and hypergraph morphism algorithms, knowledge directed searches based on a hypothesis refinement process, synthesis of rule networks, and perspective projections of 3D configurations of point features and Kalman filters. Basic theory and methodology are being designed and developed for texture analysis, since texture plays an important role in image segmentation and classification. Research on pattern recognition includes clustering techniques and applications in image coding and management of data resources.

Robotics research includes the development of a complete vision and knowledge based robotics system that plans, guides, controls, and monitors robot efforts in a workcell. Other robotics projects include the PAMI Autonomous Roving Platform project which uses a multi-sensor system (i.e. sonar, laser, and visual band CCD camera) and the PAMI Multi-Agent Intelligence Robotic System which involves methods for planning the optimal local and global path generation of robot manipulators in a computer vision environment.

CURRENT INDUSTRIAL INVOLVEMENT:

The PAMI Group is heavily involved with industry. Current clients include SPAR Aerospace, IBM Canada Ltd., LeatherCam, and Syncrude Canada. Past clients have included General Motors, Hughes, Alberta Research Council and Northern Telecom.

INDUSTRIAL INVOLVEMENT SOUGHT:

The PAMI Group would be interested in research contracts from manufacturing organizations wishing to take advantage of the Group's expertise. In addition, the Group has developed a large number of software programs that could have commercial potential.

These programs include: a pattern recognition package; pattern analysis packages on descrete-valued and mixed-mode data; inductive learning packages for both time-dependent and independent data; image processing package; graph morphism package, random graph synthesis algorithm; path and trajectory planning for roving interactive robotic control package; integrated knowledge based systems package; office automation simulation package; and a computer graphic package. The PAMI Group is interested in working with corporate partners to commercially exploit the market potential for these programs.

RESEARCH GROUP PROFILE:

The Principal Researchers Are:

Andrew Wong
Mohamed Kamel
Helen Shen
Glenn Heppler
T. Unny

Number of Researchers: 5
Number of Graduate Students: 4
Number of Post Doctoral Fellows: 2
Visiting Industrial Researchers: 3

University/Institute Involvement:

- University of Guelph
- University of Hull (U.K.)
- University of Waterloo, Systems Design Engineering
- University of Waterloo, Mechanical Engineering
- Information Technology Research Centre (ITRC)
- Manufacturing Research Corporation of Ontario (MRCO)

SOFTWARE ENGINEERING GROUP
CENTRE DE RECHERCHE INFORMATIQUE DE MONTREAL (CRIM)

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NATURE OF RESEARCH:

The CRIM Software Engineering Group is involved in a major software engineering and artificial intelligence project, with research in the areas of software development modelling, re-use (design and code), metrics, and reverse engineering.

MAJOR ACHIEVEMENTS:

The CRIM Group is involved in a major multi-million dollar development effort as part of a consortium made up of several Montreal area universities and Quebec-based computer and industrial companies, and with collaboration from foreign research laboratories in the United States and Europe.

DESCRIPTION OF RESEARCH:

The Software Engineering Group is involved with research relating to software systems design, software development process modelling, design and components re-use, reverse engineering and software metrics. Specific projects include the following:

. *Automatic or assisted software systems design,* including distributed systems. The assistance is to support decision making, decision recording, and the reasoning behind the decision in an explicit manner;

- *Software development process modelling.* Dynamic adaptation of the software process to context and environment is sought. The model includes a wide spectrum process description language which supports imperative, descriptive and intelligent approaches and is enactable;

- *Design and components re-use.* Study and definition of syntactic and semantic classification methods for design re-use. Re-use of design yields a handle in locating components for code re-use;

- *Reverse engineering* attempts to recover design structure from source programs and integration of this process in the standard forward software development process. The construction of design structure is a knowledge intensive activity that has to be supported and assisted; and

- *Software metrics.* Development of objective metrics to monitor software engineering activities. Productivity, complexity, reliability and quality are attributes to be measured which have an impact on the software development process.

CURRENT INDUSTRIAL INVOLVEMENT:

The Software Engineering Group's current research activities form part of a large scale project which involves a consortium of fourteen companies and public sector organizations in the areas of manufacturing and distribution, financial services, public services, government services, and consulting services.

INDUSTRIAL INVOLVEMENT SOUGHT:

The Software Engineering Group is interested in talking with large computer or software companies involved in software engineering projects who might have an interest in licensing some of the Group's software. In addition, the Group would be interested in financial support and collaborative research with large end-user type organizations who have large internal software development requirements.

RESEARCH GROUP PROFILE:

Principal Researchers:

Renato De Mori
Ettore Merlo
Lenore Mullin
Jean Vaucher
Pierre Robillard
Fereidoon Sadri
Gregor Bochmann
Nazim Madhavji

Number of Researchers: 9
Number of Post Doctoral Fellows: 1

University/Institute Involvement:

. Centre de recherche informatique de Montreal (CRIM)
. Concordia University, Computer Science
. Ecole Polytechnique, Genie electrique
. McGill University, Computer Science
. Universite de Montreal , Informatique et recherche operationnnelle

TAXIS PROJECT GROUP
UNIVERSITY OF TORONTO

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NATURE OF RESEARCH:

The Taxis project Group is involved with the application of knowledge representation techniques to databases and software engineering. The Group's research is centered on a design language known as Taxis, and requirements modelling language called Telos. Taxis and Telos were developed by the Group over the past several years.

MAJOR ACHIEVEMENTS:

The Taxis language research is highly regarded and is recognized as having produced one of the most advanced semantic data models available. The Taxis Group is well respected for its work with object-oriented databases and CASE environments. The Group's research results form the basis for the DAIDA project, funded by the European Commission under the ESPRIT program. Four European software manufacturers are participating in this project, along with three European academic research groups.

DESCRIPTION OF RESEARCH:

The Taxis language was developed to provide a framework for information system design. The language offers a notation that supports its underlying principles, providing a natural way of encoding knowledge about the application domain. Taxis is intermediate between a non-procedural conceptual requirements specification language and an ordinary application language plus database management system as used today. Its features include multiple inheritance of attributes, isA hierarchies of transactions, meta-classes, typed attributes, a procedural exception-handling mechanism, an iteration construct based on the abstraction mechanisms supported, semantic integrity constraints, including time-dependent ones, and communication Petri net-like processes (called scripts).

A compiler has been developed that translates Taxis programs and generates code for a Pascal-like target language augmented with relational database management facilities. The generated code includes: a relational database schema for storing data objects, operations for the manipulation of the database, as well as application programs. The Taxis implementation has many of the features of object-oriented databases.

Telos is a knowledge representation language designed for requirements modelling and analysis of information systems. Telos is built on the same organizational principles as Taxis, and adopts an object-oriented representational framework based on semantic networks that emphasize the organization of the requirements model. The requirements model is viewed as an account of a history of events and activities, and thus includes the use of time in the description. In addition, assertions can be part of a specification.

The Taxis Group believes that software development involves several distinct steps: an abstraction process, in which the real world is modelled, a design process, during which an abstract system model is developed consistently with the world model, and an implementation effort that gradually transforms a design into working programs. The Group's work with Telos is geared towards the abstraction process while Taxis is aimed at design modelling. The current research thrust of the Group is to develop an integrated CASE environment involving Taxis and Telos. More specifically the problem of software reusability will be addressed. The environment will help a designer develop a requirements model for his intended information system, and will also offer a Telos knowledge base of existing software components which is structured according to software component function and design history.

CURRENT INDUSTRIAL INVOLVEMENT:

Professor Mylopoulos of the Taxis Project Group has received research support from a number of commercial organizations including Ontario Hydro, IBM, and Digital Equipment Corporation. In addition, the Taxis research results are being used within two European ESPRIT projects, which involve industrial partners.

INDUSTRIAL INVOLVEMENT SOUGHT:

The Taxis project Group is interested in collaborating with companies to further the development of the Group's language research efforts. The collaboration might take the form of contract research or consulting arrangements. In addition, the Group is interested in having discussions with software or computer companies about commercial development of the Group's software programming environment.

RESEARCH GROUP PROFILE:

Principal Researchers:

John Mylopoulos
Alex Borgida

Number of Researchers: 4
Number of Post Graduate Students: 8
Number of Post Doctoral Fellows: 1
Number of Scholarships and Fellowships 5

University/Institute Involvement:

- University of Toronto, Department of Computer Science
- Canadian Institute for Advanced Research (CIAR)
- Computer Systems Research Institute (CSRI)
- Information Technology Research Centre (ITRC)
- Institute for Robotics and Intelligent Systems (IRIS)
- University of Passau, West Germany
- University of Frankfurt, West Germany
- University of Crete, Greece

TURING RESEARCH GROUP
UNIVERSITY OF TORONTO

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NATURE OF RESEARCH:

The Turing Research Group is involved in research relating to programming language technology. Their research includes additions and extensions to the Turing general purpose programming language, developed by the Group over the past eight years.

MAJOR ACHIEVEMENTS:

The Turing programming language has in the last few years become widely used within Ontario high schools and universities, and in a number of academic institutions outside of the province of Ontario, as a teaching/learning oriented language. In 1988, Professor R. Holt, a co-founder of Turing, was awarded the Canadian Information Processing Society's Information Technology Innovation Award for his pioneering effort with the development of the language.

DESCRIPTION OF RESEARCH:

Turing is a computer programming language, designed in 1982, by Prof. R.C. Holt and Prof. J.R. Cordy of the University of Toronto's Computer System Research Institute (CSRI). Educational use of Turing has spread rapidly due to its support of structured programming (making it preferable to Basic for schools) and its ease of learning (so schools replace Pascal with Turing). The advantage of Turing and its extension, Turing Plus, over industrial languages like C is greatly improved productivity and reliability while maintaining full flexibility and performance.

Turing owes some of its history to a language known as Concurrent Euclid, also developed at CSRI, which was commissioned by the U.S. Department of Defense. Turing now exists as a marketable product and has had considerable commercial success within the high school and university markets. As a teaching/learning-oriented language, Turing replaces Basic and Pascal. It has the simplicity of Basic, with even greater approachability, and as well a far more organized structure. Turing also has the full-power programming capacity of Pascal. It includes Pascal features as well as modules, dynamic arrays, convenient strings, flexible I/O and safe variant records.

Turing Plus is a compatible extension of Turing, meaning that any Turing program is also a Turing Plus program. Turing Plus can be thought of as an alternative to C, Modula 2, and Ada. The features that are added to Turing include separate compilation, concurrency, exception handling and a variety of features to provide the programmer with access to the underlying implementation.

Current research on Turing and its derivatives is taking place at the University of Toronto and Queen's University. The University of Toronto's work focuses on Turing Plus and ways of making concurrent programming more accessible to users. This work is intended to lead to programming environments that allow programmers to easily take advantage of shared memory concurrency. Aspects of the research include: language level concurrency; methods of program visualization that use graphical techniques to represent the static and dynamic characteristics of programs; debugging aids in a concurrent environment; and the development of a high speed compiler for Turing Plus.

At Queen's University, Prof. Cordy is researching programming environment tools related to Turing. A support tool called Turing-Tool, which acts as an "intelligent" program viewing system and editor, has been developed. The program uses knowledge-based techniques to support user created views of large programs in a sophisticated graphical user interface environment. The approach being used is also being extended to support a multi-language environment.

Other research underway involving Turing includes work on : Numerical Turing, a dialect of Turing that supports special computational facilities for numerical analysis research; Secure TUNIS, a portable UNIX-like secure operating system written in Turing; and basic research on an object-oriented Turing.

CURRENT INDUSTRIAL INVOLVEMENT:

Several commercial organizations have been involved with the development of Turing over the past few years. These companies include HCR Corporation, Apple Computer, Cognos Inc., and Bell-Northern Research. In addition at the present time, two companies, Newbridge Networks and Array Systems, are using Turing Plus within their development programs.

INDUSTRIAL INVOLVEMENT SOUGHT:

A company, Holt Software Associates Inc. (HSA) has been established to market the results of Professor Holt's research efforts. HSA is currently the exclusive distributor of the Turing language and is actively marketing this product which is available in IBM mainframe and PC, SUN M6800 UNIX, DEC VAX, Apple Macintosh, and UNISYS Icon versions. HSA is interested in obtaining investment capital and/or marketing partners to assist the company in expanding their Turing selling effort in the secondary school and university marketplaces.

The Turing Research Group would be interested in talking with large software end-users type organizations, CASE software developers and large software companies who might co-operate in ongoing Turing research or who would help to commercially exploit the potential offered by the Turing research. In addition, companies interested in using Turing Plus as a development tool within their product development efforts would also be of interest to the Group.

RESEARCH GROUP PROFILE:

The Principal Researchers Are:

Richard C. Holt
James R. Cordy
E.C.R. Hehner
T.E. Hull
D.A. Lamb

Number of Researchers: 8
Number of Graduate Students: 6
Number of Scholarships and Fellowships: 2

University/Institute Involvement:

- University of Toronto, Department of Computer Science
- University of Toronto, Department of Electrical Engineering
- University of Toronto, Computer Systems Research Institute
- Information Technology Research Centre (ITRC)
- Queen's University, Department of Computing and Information Science

USER INTERFACE RESEARCH GROUP
UNIVERSITY OF NEW BRUNSWICK

KEY CONTACT:

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University of New Brunswick
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Fredericton, New Brunswick
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NATURE OF RESEARCH:

The Group is interested in many areas of user interface design including human factors, rapid prototyping, user interface management systems, computer graphics, visualization, and novel input devices such as a six dimensional mouse.

MAJOR ACHIEVEMENTS:

The User Interface Group has made considerable progress in building an integrated programming environment consisting of several tools in the X windows environment and a six dimensional mouse for interacting with three dimensional "virtual environments".

DESCRIPTION OF RESEARCH:

For the last two years, Dr. Robson has been involved with the design and implementation of an integrated programming environment consisting of several tools in the X windows environment. These tools include an iconic data structure editor, an X window based language independent syntax-directed editor, a tree-structured editor, an icon specification language and an integrated library. Currently, Dr. Robson is investigating the use of hypertext for access to the integrated library and the design of a distributed programming environment.

Dr. Colin Ware's research interests include the development of visual user interfaces. His current research projects are as follows:

- *3D Spatial Interaction* - Investigating the potential of a 6D mouse which encodes both position and orientation for manipulating images of three dimensional scenes;

- *Use of Colour in Information Display* - designing an interactive colour geometry and the use of colour sequences for univariate maps;

- *Computer Animation* - developing techniques for Stimulus-Response animation where graphic objects are told how to behave and then left to animate themselves; and

- *Tools for Visualizing and Manipulating Spatial Data* - studying techniques for ocean mapping using high performance graphics.

CURRENT INDUSTRIAL INVOLVEMENT:

The User Interface Research Group has had limited industrial involvement to date but currently has an industrial contract to review the software testing procedure for critical real-time control software. In addition, the Group has developed an interactive graphical data editing system under contract for the Canadian Hdrographic Service.

INDUSTRIAL INVOLVEMENT SOUGHT:

The User interface Group is interested in developing contacts with software and computer companies or other research organizations that would allow the Group to further develop its programming environment tools, possibly to the point of commercial introduction. Such companies might include software compiler companies, X window application developers or computer workstation vendors. In addition, the Group is interested in contract research opportunities with companies who might be interested in exploiting the Group's expertise, particularly in the areas of user interfaces, data visualization, alternate input devices and computer graphics.

RESEARCH GROUP PROFILE:

<u>The Principal Researchers Are:</u>

Robert Robson
Colin Ware

Number of Researchers: 2
Number of Post Graduate Students: 3

<u>University/Institute Involvement:</u>

- University of New Brunswick, Computer Science