CENTRE FOR INTEGRATED COMPUTER SYSTEMS RESEARCH • C • I • C • S • R •

THE UNIVERSITY OF BRITISH COLUMBIA

FOCUS

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TO MARKET

A look at the process of moving UBC research through the commercialization process.

Moving a technology from inception through to commercialization is an arduous task with lots of hurdles along the way. But for Ian Yellowley of the UBC Department of Mechanical Engineering, years of hard work is starting to pay off. He and his colleagues spent more than six years developing a patented process control system architecture that meets the demands of today's manufacturers for greater speed, flexibility and control over the end product.

The system is now being marketed and further developed through a West Vancouver company called Cimprovisor Hightech Industries Inc. The company recently

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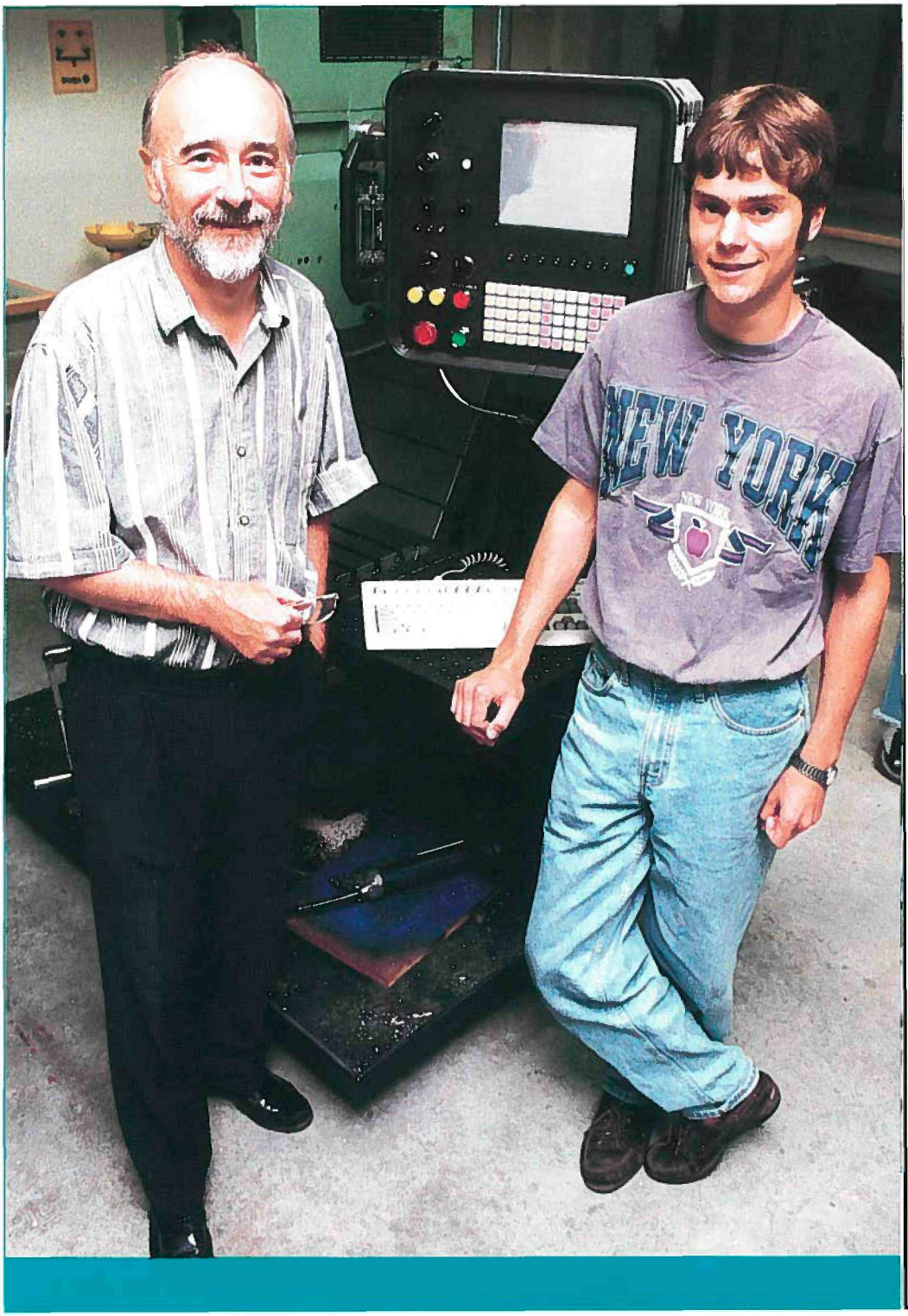


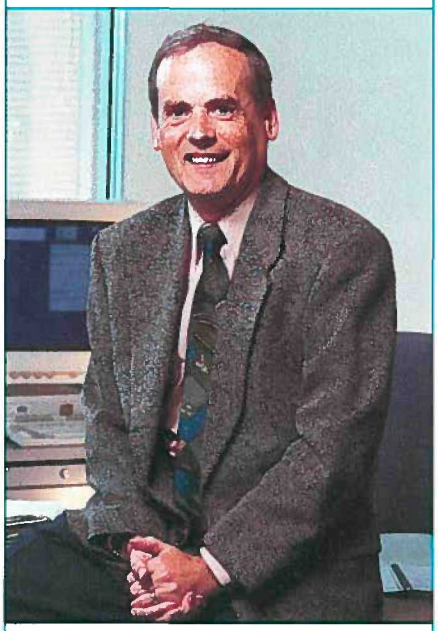
Cimprovisor was started on the basis of research by CICSR's Ian Yellowley (left). Rudi Seethaler (right), a UBC student working with Yellowley, is also acting as a consultant to Cimprovisor.

IN THIS ISSUE

DIRECTOR'S STATEMENT

As you can see from this newsletter, there are new developments in CICSR. The combination of ASI, industry and NSERC funding is resulting in several innovative research projects involving CICSR faculty and graduate students. We highlight some of these in this issue.

Our cover story features the work of Ian Yellowley whose patented control system architecture is being successfully commercialized by a West Vancouver company. We also interviewed Sam Chanson, a CICSR member who has been in charge of



founding a computer engineering group at the Hong Kong University of Science and Technology. We also cover several interesting research projects happening right here on campus, from linking wireless networks on the Internet to research into electric power systems.

I would also like to call your attention to the UBC Open House October 13-15. The entire campus will be open to the public from 10:00 am to 5:00 pm each of those days, and in particular, CICSR labs will have displays and demos running, with faculty and students available to discuss their research projects. Please take advantage of this opportunity to meet us, and learn more about our work.

Dr. James Varah, CICSR Director

Taking research to market

Ian Yellowley describes how he moved his control system architecture from the lab to commercialization.

To Market... continued from cover

installed its first system, adding its revolutionary control system to a high-speed router for a company in the business of fabricating kitchen and bathroom cabinets and counter tops. Yellowley sees this as just the beginning. "I see the company developing a whole range of machine tools based on our architecture."

In the millworking business, the system allows its users to more easily program complex contours. The control system can automatically slow the router down to get around tight corners. The modular object-oriented architecture is readily adaptable to a huge range of problems and complexities faced in today's manufacturing environment. "The controller can compensate for a lot of shortcomings of the machine it is controlling, and can make improvements in performance and accuracy that are quite dramatic," said Yellowley.

The emergence of global competition is forcing manufacturers to automate more processes as the market demands increase. Manufacturers of the next century will have to be able to deliver zero defects, flexible part design, high quality at a low cost, and they will have to be able to work with a wide range of materials, and deliver in a very timely manner. Only automation, and flexible systems such as the one Yellowley and his team have developed, will enable manufacturers to meet these demands.

When Yellowley started the research six years ago, he didn't set out to invent a new type of architecture, but to combine process control with geometric control on existing modern control systems. This proved to be so difficult and frustrating, the research team instead developed a new way of doing things. Yellowley and his colleagues feel that the key to more effective control revolves around the issues of adaptive control and integration of extensive sensory feedback . The result of this belief, the Cimprovisor system, is a platform for providing capabilities far beyond those available with more traditional architectures. Cimprovisor modularity guarantees a predictable rapid response to sensor input at each axis while maintaining axis coordination.

There is little question that the system is an improvement over existing, traditional technology. But that doesn't make commercial success a given. Yellowley believes that the development of a working prototype in the lab is just the start. Even the first corporate sale by Cimprovisor is a small victory compared to the full-scale commercialization he has in mind. He says it would be easy to sell lots of systems if the technology were licensed to a large multinational manufacturer of control systems, but he doesn't want to see that happen. He is committed to seeing the invention commercialized in B.C., so that the jobs and the fruits of the knowledge he and his team have gained stays here.

Selling next-generation control systems is a tough job for a small company from B.C., but Cimprovisor has a lot of things going in its favour. The company is well financed, has experienced management, an excellent product with large market potential, and the continuing research support of Yellowley and his team. 'It's not your typical cash-starved, two-people-in-a-basement type of start-up," said Yellowley.

However, time is of the essence for the company. "The whole area of open control systems is very competitive. We were one of the first, but we need to get a lot of systems out there to establish a solid presence in the market."

However, Yellowley does not concern himself much with the day-to-day operations of the company. He is busy heading an aggressive research project aimed at making improvements to the system, and adapting it for other uses, notable for secondary wood manufacturing. His research is funded by Cimprovisor, NSERC and the B.C. Advanced Systems Institute.

Ultimately, his goal is to see the knowledge he and other researchers in the province have gained directly benefit B.C. In the case of Cimprovisor, he'd like the company to grow and succeed so that it can be a place where students educated at UBC can go to work, and feel both challenged and at home. On a larger scale, he'd like to see B.C.-developed technology used as a means for residents of the province to control our economic destiny by keeping the jobs, and the wealth-generation potential of both our wood products, and our advanced technology, right here in the place from which it originated.

Linking Wireless Networks on 'the Net'

Victor Leung is part of a research team that is looking at ways to solve the complex problems that arise in the process of linking wireless data networks to the Internet.

The use of internet is booming, both in terms of a dramatically-increasing user base, and a proliferation of services available through the 'net'. Now, a group of researchers, led by Victor Leung of the UBC Department of Electrical Engineering, is looking at ways to solve the problems around linking wireless data networks to the Internet.

The project, which officially started this summer, involves two universities and one company. From UBC, Leung, plus two Computer Science Department members, Norm Hutchinson and Son Vuong, are involved. Steve Hardy from the SFU School of Engineering Science is involved, and Motorola's Advanced Radiodata Research Centre (ARRC) provides input, facilities and funding. This three-year, collaborative research project is also funded by NSERC.

According to Leung, the bulk of the work will be done at UBC in both the Communications and Distributed Systems Labs. Initially, the project team will focus on the development and demonstration of an internetworking environment consisting of a test-bed interconnecting local area and wide area wireless networks to the current Internet, using the TCP/IP protocol suite. As the Internet evolves to accommodate multiple protocols, broadband multimedia services and personal communications services, the team plans to expand its horizons to develop solutions to support the Internet of the future.

Leung said there are two main issues that the project will focus on initially. The first is to work on ways for the networks to locate users of wireless services once they've travelled away from their home base. Currently, users can sign up for wireless service, and have TCP/IP connection, but they are given specific addresses associated with the particular wireless network they've signed on to. When they move to a new location and onto a new network area, it's difficult for messages to find them.

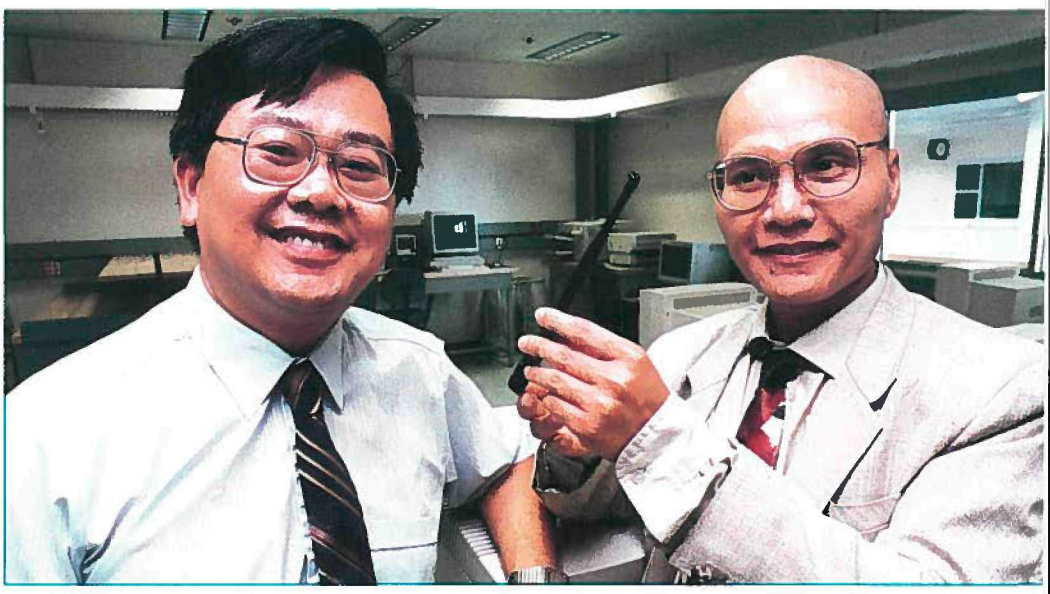
"This is being remedied by augmenting the IP protocol. Development is already ongoing," said Leung. "We want to monitor the development and see where we can make improvements." The idea is to allow users the freedom to move while retaining their home base address. When they sign onto a foreign network , the goal is to have the system detect this and automatically forward messages from home base to the foreign network without the user doing anything. There is a lot of complexity involved in this process, especially when the process involves users on the move from network to network.

The second issue the project team is tackling is a problem with the TCP protocol when used with wireless networks. The transport layer provides for end-to-end data integrity, and has a built-in flow control function that allows it to react to congestion on the Internet. When the transport layer loses a packet of data, it assumes there is congestion, and will hold back the transmission rate. However, for wireless networks, which are inherently less reliable than current wide area networks, the TCP protocol's response is often not the right one. It's not always congestion, but could be signal fading, interference or other problems that cause a packet to be lost.

Both wireless networks and TCP have built-in error recovery systems, said Leung. "The two do not interact in a predictable manner." With the bandwidth limitations of wireless networks, it's important that they operate at peak efficiency, which means there is a real need for a solution to the problem Leung and his team are tackling.

The impetus for the project came last summer when Motorola invited Leung to submit a proposal for their R&D funding program. Motorola encourages research into the development of applications of wireless data networks, because without applications, they would not have a market for their wireless data communications products. "Motorola has products for wireless data networking, but people don't have a lot of applications for it yet. It's beneficial for the company to encourage applications in this area," said Leung.

His background is well-suited for this kind of work. His research interests cover many areas that combine telecommunications and computer networking, including design, evaluation and analysis of network architectures, protocols, network management, control and internetworking strategies for reliable, efficient and cost effective communications. The thrust of his research is to contribute to the development of the emerging global network that will allow ubiquitous multimedia communications between people and machines, regardless of where they are in the world, and even when they're on the move.

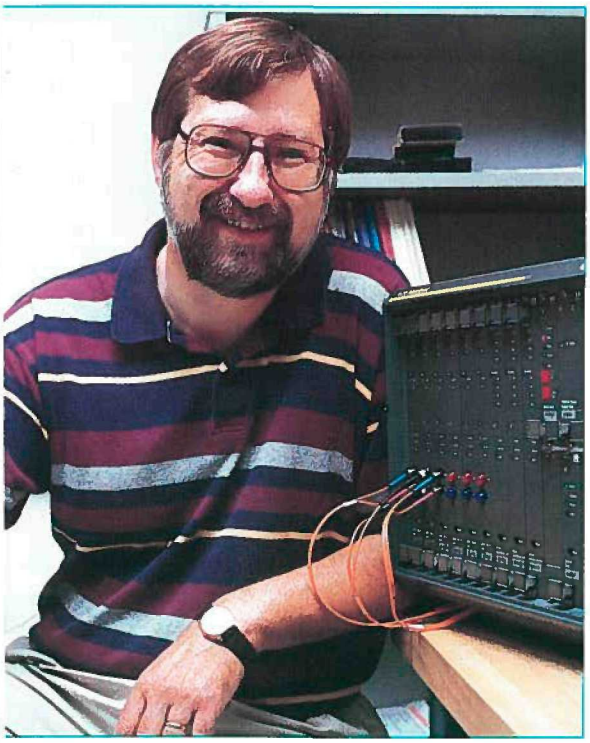


Victor Leung of Electrical Engineering is collaborating with Son Vuong of Computer Science on linking wireless data networks.

Facilitating Communications of the Future

Gerald Neufeld is developing tools that will enable the communications applications of the future, such as video-on-demand and broadband multimedia communications.

Many of the communications technologies of the future that are developed in Canada will owe a debt to the Canadian Institute for Telecommunications Research (CITR), a federal Network of Centres of Excellence dedicated to advanced communications research. One CICSR member, Gerald Neufeld of the Department of Computer Science, is working on one of the pieces that will allow applications to run on the networks of the future.



Gerald Neufeld

"We're not interested in the applications themselves, but are developing the infrastructure that makes them possible. We're the plumbers."

- Gerald Neufeld

CITR is divided into five main research areas: design and management of broadband networks, broadband services, photonic devices and systems, mobile and personal communications, and broadband indoor wireless communications. Neufeld, who is one of several CICSR members involved in CITR, is responsible for a project within the broadband services area. He is developing a continuous-media file server, which will make applications such as video on demand and multimedia communications possible.

"We're not interested in the applications themselves, but are developing the infrastructure that makes them possible," said Neufeld. "We're the plumbers."

In his continuous media file server project, Neufeld chose an application that would make the greatest demands on the underlying system. He chose news on demand because it's the kind of application where people request lots of short clips, and interact quite actively with the system. Video on demand is less taxing on the system because people usually request a movie and let it play for an hour or two with few interruptions.

Neufeld noted that the development of high-speed broadband networks is complex, but that it is relatively easy to achieve high bandwidth. How you deal with all that capacity is the real problem. ATM (asynchronous transfer mode) switching was developed to handle switching for these new, powerful networks. But another problem is how to enable computers hooked into high-speed networks to handle the volume of a network capable of throughput of 622 Megabits per second (Mbps) or more. Computers are designed to handle just a fraction of that volume, so developing techniques to enable the system to process and organize huge volumes of data is a real challenge.

Neufeld is working with Mabo Ito of Electrical Engineering on the problem. They chose a multiprocessor host because a single processor is not fast enough for what they are demanding of the system. In the development of a circuit board and host interface, they chose to put the board directly on the memory bus, rather than the usual placement on the I/O bus to further speed the processing. And they have enabled processors to access the ATM card in parallel rather than dedicating one processor totally to one card. The result is the kind of processing horsepower that can be used as a continuous media file server.

The project will be complete in about a year, but already the team has demonstrated a working prototype. The broadband services project within CITR involves four related pieces of technology including Neufeld's development of a continuous media file server, quality of service negotiation, scalable video encoding, and application development. The pieces are being put together at the University of Waterloo, and the results to date were demonstrated at the CITR national meeting in Vancouver this summer.

Another related area that Neufeld is working on concerns protocols that support some form of real-time communication. The basic problem is that given a variable, continuous bit-rate stream, such as you would find in the transmission of video, how do you allocate system resources across the switches in the most efficient manner? Neufeld notes that if the network is purely an ATM network, then ATM itself will provide some of this allocation. But the reality is that networks are not now, and are not likely to develop into seamless, homogeneous systems. The server on a system may be ATM, but it could well be connected to ethernet, token ring, or even another form of ATM.

"The physical network is always changing," said Neufeld. "There are different forms of ATM, and there may be other, completely different ideas implemented in the future. The TCP/IP protocol allows for the continuum of many different networks on the Internet, and Neufeld believes that the mix of different networks is a reality that's here to stay. He's planning to spend more time on the problem of network management issues in high speed networking this fall. In general his goal is to examine the latest technologies in distributed operating systems and computer networks and protocols, compare their capabilities with the applications the world wants implemented on these systems, and play a part in bridging the gap and making it actually work.

Chanson in Hong Kong

Sam Chanson has spent the past two years in the country he was born in, helping to found the Computer Engineering Group at Hong Kong University of Science and Technology.

CICSR member Sam Chanson has been noticeably scarce around the UBC campus over the past two years. He has been spending his time helping to found a world-class Computer Science Department at the Hong Kong University of Science and Technology (HKUST).

The University was created in the late 1980s by the Hong Kong government with the view that it was to become the premier research institution in the Far East. An important mission of the university is to service the region's industry and commerce. The University took in its first batch of students in 1991.

According to Chanson, HKUST is different from the other six universities in Hong Kong in that it focuses only on science and technology, and it follows the U.S. style of operation instead of British. In fact, more than 90% of its faculty members graduated from universities in North America. Its emphasis on research is reflected in the fact that the ratio of graduate to undergraduate students is about 25%, more than double that of the other universities in Hong Kong.

Chanson landed his position at HKUST as a result of a visit to Hong Kong in September 1990 to attend an IEEE conference. At the conference he met Professor Vincent Shen, the Department Head of Computer Science at HKUST. He had known Shen at Purdue University sixteen years ago when they were both faculty members there. Shen told Chanson of the vision of the university and took him to see the construction site at Clear Water Bay. "I became very interested in the possibility of helping to start a department from scratch to service the region where I was born," said Chanson.

In January 1993, he joined HKUST. He was given the task of recruiting faculty members in Computer Engineering (CE), devising a curriculum for the CE program, setting up a CE Laboratory and formulating a research focus and projects for the CE Group. In addition, since he had experience looking after the computing facilities for the UBC Computer Science Department, he was put in charge of overseeing the development of computing facilities in the Computer Science Department at HKUST, and was asked to be the Associate Head of the Department in July 1993.

Chanson said his job was made easy because of the generous financial support from the Hong Kong government and industries. "We were able to set up computing facilities which would be considered first rate by any standard." The CE group now consists of 10 faculty members with expertise in computer networks, distributed and parallel systems, real time systems, performance analysis, and theory of distributed computing.

Sam Chanson with research assistants Alexis Berthillier (r) and Danny Chan.

The lab has two 16-port ATM switches, 12 SPARC stations (mainly SPARC-20s with multimedia kit), four high-end Pentiums, FDDI, Ethernet and ATM networks, a laser printer and access to a 140-node Intel Paragon multiprocessor machine. The Computer Engineering program started to take in the first batch of students last year, and the program attracted some of the best students in Hong Kong, said Chanson.

Under his direction, the projects started in the Department include: ATM congestion control, multiparty video conferencing system, video server research, parallel algorithms and applications, parallel programming environment and parallel compilers, load balancing over heterogeneous networks and workstations, real time kernel, protocol testing and verification, and VLSI optimization.

Chanson is the principal researcher in several of these areas. He has received more than HK$10,000,000 (about Can. $1.7 Million) in research grants from the Hong Kong government and some local companies for work on the CE projects. In the last two and a half years that he has been in Hong Kong, he has published 6 journals and 21 conference papers. Some of the work was actually done at UBC, said Chanson, who continues to visit the campus on a regular basis to interact with his students and colleagues.

"I applied much of my UBC experience to the HKUST environment. The most important factor that makes a department great is people - both faculty and students. We are doing our best to recruit the best people and help them to attain their full potential."

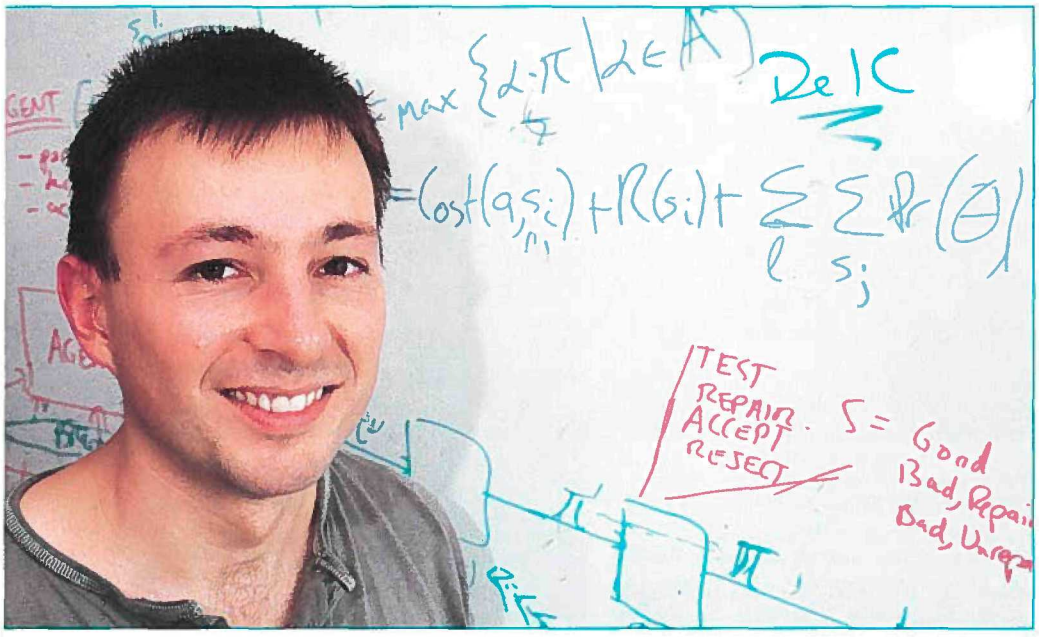
- Sam Chanson

He said he has learned a lot from his experience building a program, a research lab and a research group almost from scratch. "Perhaps some of the important things I have learned are management skills, interaction with government and industry, and the need for compromise."

He said the example set by the UBC Department of Computer Science is an excellent one. "I applied much of my UBC experience to the HKUST environment. The most important factor that makes a department great is people - both faculty and students. We are doing our best to recruit the best people and help them to attain their full potential."

Enabling Computers to Make Decisions

Craig Boutilier is working on ways to enable computers to make useful decisions, even when there is no perfect answer, and when they are many complex considerations.



Craig Boutilier is developing ways for computers to solve complex problems.

Computer systems have become fairly adept at making decisions where the information needed is factual, and the decision required is black or white, with no gray areas. But introduce uncertainties, multi-stage problems, or a decision in which immediate consequences must be weighed against long-term consequences, and the smartest computer system is stymied.

Computer Science Department member Craig Boutilier specializes in developing ways to help computers solve just such problems, but he recognizes the extreme difficulty of this task. "Multi-stage or long-term problems are computationally intractable," said Boutilier. "My work focuses on cases where I can come up with useful solutions in reasonable time frames."

One way to approach this is to simplify the problem to the point that a system endowed with artificial intelligence, such as a robot, can 'think' its way through all of the ramifications of a decision and arrive at a solution in a reasonable amount of time.

Boutilier uses the example of a robot that can roam and has the job of personal assistant. One of the first tasks of the day for the robot is to get Boutilier some coffee from the Barn (the coffee shop across the street from the CICSR/CS building). A number of factors affect the robot's decision, including its location, the weather, what other tasks must be done, their relative importance to fetching coffee, and whether or not Boutilier has coffee already.

"The robot has to determine what to do in every possible situation, and the number of possibilities grows exponentially with each additional factor that must be considered in the decision-making process," said Boutilier. "To help simplify the decision, we try to enable the program to identify, at any given time, factors that are relevant, and to ignore all irrelevant details. We also try to have the robot approximate an optimal solution, and not waste time trying to come up with the very best possible answer. If it has to deliberate for hours before finally deciding it should get coffee, and the morning passes before it makes a decision, that's not a useful solution."

Boutilier is currently looking at applying his work on testing and repair processes in manufacturing with researchers at Rockwell International in Palo Alto. The problems involved are complex. In the process of putting together a device with thousands of components, the resulting product doesn't always work. Testing at each step of the way costs money and is also fallible. In coming up with an optimal testing strategy, Boutilier has to balance the cost of testing and repair with the cost associated with a faulty product reaching the customer. In doing so, considerations include the number of times to test a faulty component, whether or not to repair it, how many times the test and repair cycle should be repeated before a component is rejected, and numerous other questions along these lines. The goal is to consider the process as a whole, and devise solutions that reduce overall costs.

"Algorithms can barely solve the one-component case, let alone tackle problems involving thousands of components," said Boutilier. "Practically, an intelligent system cannot give the optimal solution, but if it can reduce overall costs, it has achieved its goal. Approximation is the key."

Another research area that Boutilier is working on is the development of languages to allow people to customize decision-making programs. One application is a software program that acts as an administrative assistant, updating the user's calendar, picking up and sorting through e-mail, and sending information requested by others. There is no way to develop a standard program that would meet every user's needs.

"You can't build the program once and for all. It has to be interactive, and take into account the user's preferences," said Boutilier. One issue is that people don't tend to talk in terms of probabilities and percentages, or other concrete numerical terms a computer can understand. So Boutilier is interested in adapting a program to the looser, more qualitative language of everyday speech.

Generally, in the field of artificial intelligence, researchers are examining larger and larger problems, but current computer systems are only able to tackle small, unrealistic problems. As the problems start to approach the complexity of the real world, researchers can't make the algorithms work in any practical way.

Now, AI researchers like Boutilier are exploring the concept of 'bounded rationality' as a means to bridge the gap between what is practical in the real world, and possible with today's computer systems. Boutilier provides this example to explain: an intelligent robot is in the middle of the road, trying to decide whether it's best to go right or left. A truck is heading straight for it. If the robot does not make up its mind within seconds, its decision will become irrelevant. Any move is better than no move at all. Says Boutilier, "Good solutions are only good if they're timely. Ultimately that's the way things are going to go."

A Position of Power

Hermann Dommel is awarded a chair in electric power systems.

CICSR member Hermann Dommel was recently awarded a new chair to support electric power systems engineering research at UBC. The chair is for five years' duration, and is funded by NSERC, B.C. Hydro and their research subsidiary, Powertech Labs.

According to Dommel, B.C. Hydro made the move to establish the chair to strengthen electric power engineering education and research at UBC.

Power system analysis using computers has been the focus of Dommel's research for many years. "The electric power industry has been a heavy user of computers from the beginning," said Dommel. That's because power transmission systems are interconnected into very large, complex systems that have to work together. For example, the power system in B.C. is linked along the west coast of North America all the way to Mexico. If there's a short circuit in a substation in California, we feel the effect in B.C.

The sheer size of the system puts strain on it. Dommel uses the analogy of a drive shaft in a mechanical engine — if the rods are too long, they are put under increasing strain, and eventually, they twist or break. He says that today's power systems have similar stability issues, and that the strain on the system is increasing.

One of the reasons is that the nature of power systems is changing with the advent of independent power producers, whereby anyone can be a power supplier by building a plant and putting their power onto the transmission grid. While this is a way to tap many potential new sources of power, it also complicates the grid and causes a lot of technical problems for maintaining frequency, stability and power quality, according to Dommel.

Dommel's research focuses on a specific problem that can occur in complex power systems: fast electromagnetic transient phenomena. In any transmission line, there are breakers at both ends. When connecting the line, one of the breakers closes first and sets a wave in motion that can lead to overvoltages. When a transformer fails, it is often due to such overvoltages.
He and Jose Marti, also a member of the UBC Department of Electrical Engineering, have developed a computer program to analyze the causes of transients and to help prevent it from happening. The program is currently being used at B.C. Hydro, and many power corporations across Canada and around the world. There are actually three different software packages currently on the market that were designed for this purpose, and Dommel and Marti have had their hand in all three at different times.

The version Dommel has most recently worked on is sold through Microtran, a UBC spin-off company. There is also a larger version developed commercially with industry collaboration, and another program developed by the Bonneville Power Administration (BPA). Dommel worked at BPA for eight years before coming to UBC in 1973, and worked on the software while he was there.

In connection with his new research chair, Dommel plans to do a lot more work on stability in large power systems. Stability is a pressing problem because utilities are not permitted to build transmission lines or new power plants as readily as they were able to in the past. "The system is being operated closer to the limits of what it can handle compared to the past," said Dommel.

He and his research group are studying new control techniques that will depend heavily on computer controls to run power systems as efficiently as possible.

As the power grid moves closer and closer to its operating limitations, the danger of problems such as blackouts increases. In B.C., we have become accustomed to a very reliable power system. Dommel and his research team are working on ways to ensure things stay that way. ■

Hermann Dommel (seated) surrounded by his research team and students of electric power engineering.

UBC Open House

CICSR and the Department of Computer Science will have many exciting lab demonstrations during the campus-wide UBC Open House. Events listed below take place in the CICSR/CS Building, 2366 Main Mall, 10 am to 5 pm, October 13, 14 and 15.

Computational Geometry: Test your wits against math puzzles. *(Room 262)*

Database Laboratory: Try Data Mining to discover patterns hidden in data in a database. *(Room 003)*

Distributed Systems Group: Live broadcasting of events through the Internet. *(Room 348)*

E-GEMS: Try out the latest and greatest educational games. *(Room 045)*

Graphics (Imager): Fish tank virtual reality, 3-D modelling and animation, and more! *(Rooms 153 & 146)*

Image Processing: See how to improve television picture performance and see digital mammography. *(Room 188)*

Integrated Systems: Come and play with our trains. *(Room 342)*

Lab for Computational Intelligence: See robots track objects, and watch robot cars play soccer. *(Room 144, 108)*

Parallel and Distributed Computing: Are two heads better than one? Can computer collaborate? *(Room 308)*

Reading Room: Learn how to use the UBC library on-line system. *(Room 262)*

Computation and Visualization: Get caught in the Web *(Room 162)*

Communications Lab: Hands-on demo of communications over mobile radio. *(Room 388)*

Explore the Internet, Electronic Guest Book, Quick Stops and more! ■

C·A·L·E·N·D·A·R

Distinguished Lecture Series 1995-96
Real-Time Embedded Systems

Six academic and industrial leaders address the future of systems development.

September 14, 1995
Standards for Real-Time Systems: Ada vs POSIX
Dr. T. P. Baker
The Florida State University

October 12, 1995
Real-Time Systems: A Practitioner's Perspective
Dr. C. Douglass Locke
Loral Federal Systems

November 9, 1995
What do car parking, space robots and air traffic control have in common?
Dr. Shankar Sastry
University of California at Berkeley

January 11, 1996
Fundamentals of Real-Time Scheduling
Dr. C. L. Liu
University of Illinois at Urbana-Champaign

February 8, 1996
Methods and Tools for Validating Real-Time Constraints
Dr. Jane Liu
University of Illinois at Urbana-Champaign

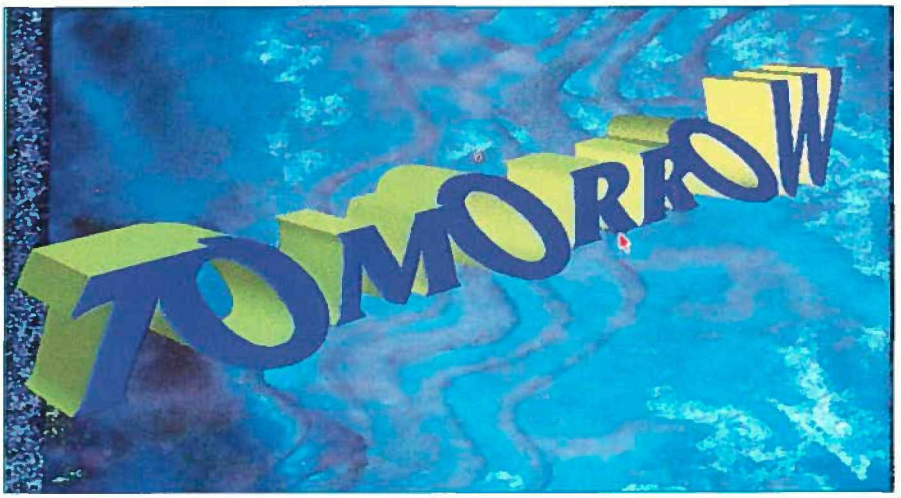
March 14, 1996
Autonomous Calibration in Telerobotics and Virtual Reality
Dr. John Hollerbach
The University of Utah

Join us for a Glimpse of the Future of Real-Time Embedded Systems

Lectures are from 4:00 pm to 5:30 pm, in the new CICSR/CS Building, room 208, 2366 Main Mall, UBC.

March 12, 1996
The ASI Exchange (formerly Graduate Students Presentation Day)

The 5th annual ASI Exchange will highlight graduate student research in the form of posters and displays. Representatives from high tech companies, government, funding agencies and venture capital companies will be invited to attend.
Place: Robson Square Conference Centre
Contact: Jack Snoeyink via e-mail at snoeyink@cs.ubc.ca



Multimedia figures prominently in MAGIC's future. Graphic by Peter Cahoon of MAGIC.

CICSR Faculty Forum 1995-96

In this third annual Faculty Forum, six CICSR members present and discuss their ground-breaking research in integrated computer systems.

September 21, 1995
Built-in Self-Testing of VLSI Circuits
Dr. André Ivanov

October 19, 1995
Automated Database Design
Dr. Robert Goldstein

November 16, 1995
Broadband Ultrasound Localized Waves for Medical Imaging
Dr. Matthew Palmer

January 18, 1996
Learning to Recognize 3-D Objects
Dr. David Lowe

February 15, 1996
Computing Between the Lines
Dr. Jack Snoeyink

March 21, 1996
Transferring Automation Technology to BC's Fishing Industry: A Progress Report
Dr. Elizabeth Croft

CICSR Faculty Forum For 1995-96
The CICSR Faculty Forum was created to provide local researchers and industry with an opportunity to find out more about the world-class research being performed at the University of B.C. by CICSR Faculty.

Join Us For a Closer Look at UBC's Integrated Systems Research Projects.

Talks will be held from 4:00 to 5:30 pm in the new CICSR/CS Building, Room 208, 2366 Main Mall, UBC. Lectures are complimentary.

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The UBC Centre for Integrated Computer Systems Research (CICSR) is an interdepartmental research organization made up of computer-related research faculty members in the Departments of Computer Science, Electrical Engineering and Mechanical Engineering. Currently there are more than 60 CICSR researchers which direct over 200 graduate students and collaborate with dozens of industrial firms in areas such as robotics, artificial intelligence, communications, VLSI design and industrial automation.

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