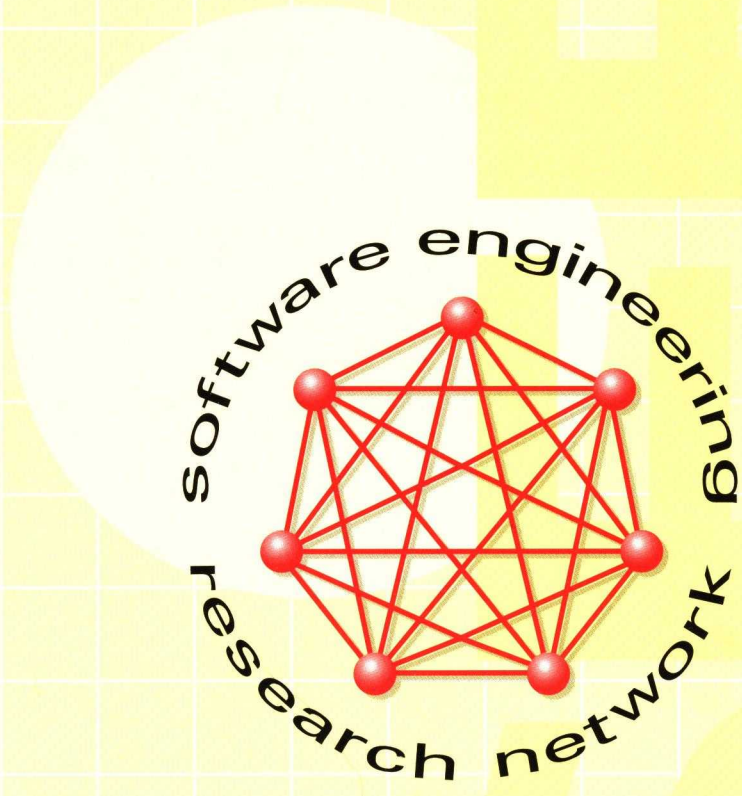


On the
edge and
leading
the way.

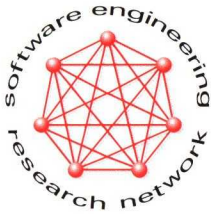


UNIVERSITY OF
CALGARY

INDUSTRIAL RESEARCH CHAIR IN SOFTWARE ENGINEERING



Software Engineering Research Network (SERN)

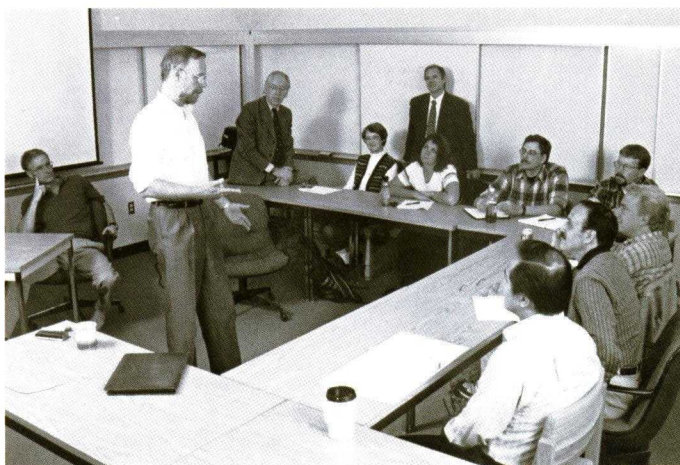


The Software Engineering Research Network (SERN) was established at the University of Calgary in 1996 to support the dissemination of good practice in software engineering and to promote university/industry collaboration in software engineering research. SERN is a joint venture of the Department of Computer Science and the Department of Electrical and Computer Engineering, and is administered by the Industrial Research Software Engineering Chair.

Initial sponsors of the program include Motorola Inc., Computing Devices Canada, ACTC Technologies Inc., Northern Telecom, the Government of Alberta and the University of Calgary.

The primary focus of SERN is to treat software development as a manufacturing discipline, and the objectives of SERN are:

- to establish research and graduate training activities at the University of Calgary that will develop highly qualified personnel in industrial software engineering
- to establish an organizational infrastructure at the University of Calgary supporting a long-term program of university/industry collaborative research on software engineering
- to undertake fundamental, real-world research in collaboration with industry



A student, Alan Goodbrand, giving a seminar on his research topic.

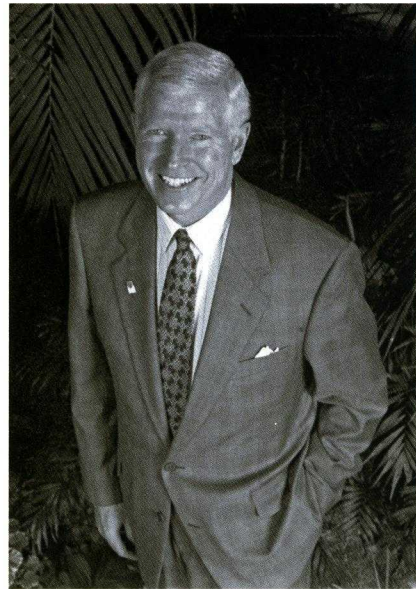
A NON-TRADITIONAL LEARNING ENVIRONMENT

The Software Engineering Research Network (SERN) M.Sc. Specialization in Software Engineering facilitates student learning through a program of mentoring and master classes rather than through conventional classroom teaching. Mentors from industry critique students' discussion of critical issues in software engineering and its industrial applications. University professors focus on developing the skills students will require to conduct principled research and link it to the current state of the art. The program encompasses the full spectrum of software engineering issues and advanced system development, and is funded through the Government of Alberta Access Program.

A MESSAGE FROM TERRY WHITE

President, University of Calgary

The University's strategic direction emphasizes both our research strengths and our support of the Calgary community. SERN is an outstanding example of the way in which collaboration between our university and industry benefits both our learners and our community by enabling research undertaken in industry to lead to a graduate degree at the university.



A MESSAGE FROM LEN BRUTON

Vice-President (Research), University of Calgary

The Government of Alberta has recognized the key importance of the information and communication technologies (ICT) sector in the development of the Alberta economy. ICT is the fastest growing economic sector, not only in Alberta, but throughout the world. The University of Calgary programs and expertise in this area are playing a major role in its development. SERN has been in the forefront of ICT research in Alberta, and the university/industry collaboration on which it is based is a fundamental component of the University of Calgary's ICT strategy.



A MESSAGE FROM BRIAN WESTCOTT

One of the Founders of the Industrial Research Chair in Software Engineering and President, E-Volve Inc.

Brian Westcott was the senior vice-president at one of the initial sponsors of the program, and led the movement to establish the Industrial Research Chair in Software Engineering.

His opinion, shared by many others in the industry, was that competition in the world's software markets emphasized the need for repeatable, defined, managed, and optimized software development processes in order to produce high-quality software. Although educational institutions were doing an excellent job of graduating students with a high level of technical knowledge and skills, very little was being done to give these same students a working knowledge and appreciation of software development processes. The Chair was created with three goals in mind:

- to perform fundamental research in software processes, with the laboratory for testing these processes being the companies sponsoring the Chair or the students
- to provide a process for the participating companies to obtain solutions to their real problems in the software process area
- to make the new software processes developed in the program publicly available to others in the software industry

In measuring the program's success, Mr. Westcott points to the increasing enrollment, growing recognition and reputation, and the positive reaction from companies involved. In addition, he views the co-operation between Engineering and Computer Science as indicative of the enthusiasm of the people involved.

A MESSAGE FROM GREG McAVOY

Chair of the Advisory Board of the Industrial Research Chair in Software Engineering, and Technical Manager in the Wireless Development Centre at Nortel Networks

Software engineering is fundamental to many companies' product development cycles and software now accounts for a growing component of most new products under development. Due to the rising demand for software and a significant lack of personnel, most software development projects are either late, over budget or have serious quality problems. By improving knowledge and skills in the software engineering area, we are better able to manage the complexities of software development and meet the demands of business.

Much of the research undertaken by SERN is collaborative with, and directly supported by, industry. The work of SERN is to help organizations evolve toward a culture of software engineering and management excellence by working to improve our people, processes and technology. Ultimately, SERN's goal is to help companies consistently develop software that fulfills user functional needs, that can be easily and completely traced throughout its life cycle, and that meets specified performance, cost and delivery criteria.

Nortel Networks has located major production and research activities in Calgary, which are critically dependent on access to highly qualified personnel and the continuous updating of our high-technology researchers. The collaboration with the University of Calgary in graduate programs and research involving both workplace- and university-based projects has been very successful and is a fundamental requirement for the growth



of our activities in Alberta. Several of our staff are completing graduate degrees in software engineering. Most of these students' thesis topics are based on issues arising from actual software development operations. Nortel has also engaged the faculty to undertake comprehensive training of our Calgary Wireless software organization in Requirements Engineering, Advanced Object Oriented Design, and Advanced Implementation Techniques. Nortel is currently funding three faculty members in a three-year research program to assist in the early life cycle stage of development.

The recently introduced undergraduate degree in software engineering has been eagerly awaited by many organizations that need new graduates who understand the software development process in great detail and who are immediately able to contribute to the process.

Expanding the SERN network, both provincially and internationally, is also underway and will contribute to the technology transfer potential and further establish the intellectual capital available in the province.



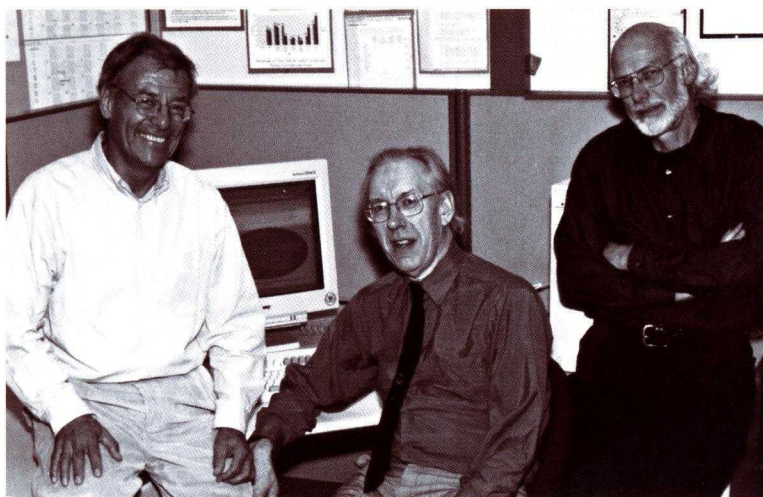
DR. MILDRED SHAW

Industrial Research Chair in Software Engineering

The University of Calgary established the Industrial Research Chair in Software Engineering to undertake research in software engineering/manufacturing aimed at strengthening the software manufacturing capabilities of Alberta and Canada. The holder of the Chair is Dr. Mildred L. G. Shaw, Professor of Computer Science, and Electrical and Computer Engineering. Dr. Shaw's research interests are mainly in the area of human and organizational aspects of knowledge and requirements engineering and their modeling and support through advanced information systems.

The software engineering thesis-based masters specialization was established in conjunction with the Chair at the University of Calgary to encourage students to undertake research projects as part of their full-time industrial employment. Since inception, SERN has added a course-based degree, expanded student enrollment, recruited a full complement of faculty and attracted two post-doctoral fellows. There are currently 48 students in the program. Nine students have graduated. A wide range of new graduate courses in software engineering has been developed and taught, and a number of significant industry- and university-based research projects have been initiated. SERN is also able to offer some courses in the form of distance education.

SERN is a major participant in the C4 computational collaboratory project to link university and industry research in Alberta and across Canada through the CANARIE CA*Net II high-speed network, and in the Learning Enhancement Envelope and Curriculum Redevelopment Fund initiative of Campus Alberta.



STRONG INDUSTRY AND ACADEMIC BACKGROUNDS

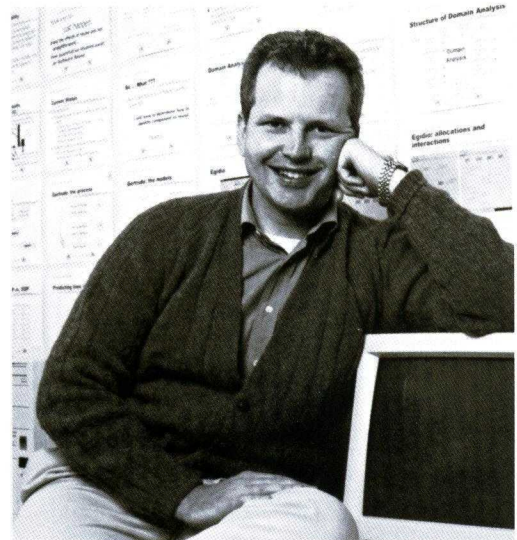
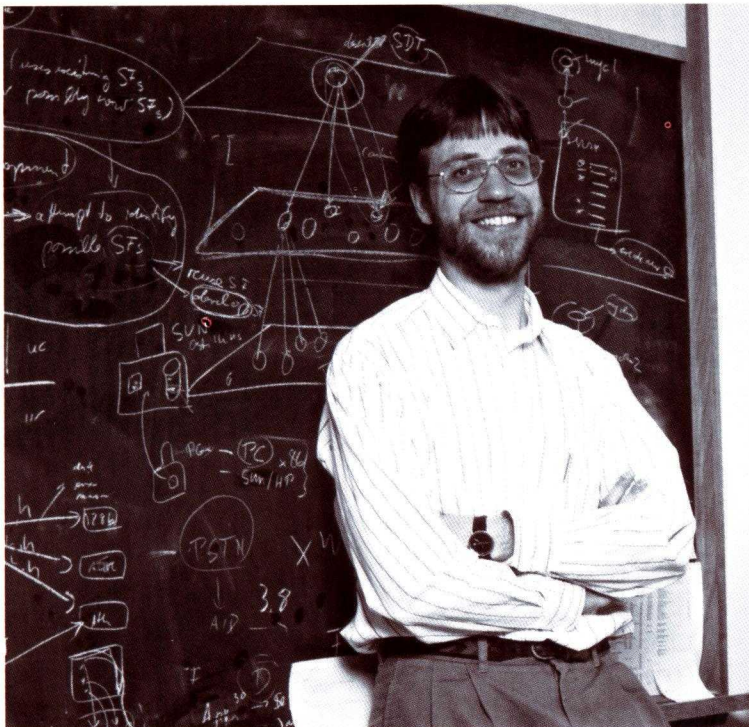
Many of the university professors involved in the SERN program have themselves had extensive industry experience. Dr. Brian Gaines (centre) has been technical director of a number of computer hardware and software companies. Dr. John Kendall (left), former Dean of Science, worked for five years with Nova Corporation, and previously in England at Lucas. Dr. Brian Unger (right) took a leave of absence from the university to develop a spin-off company arising from his simulation research, and is now President of iCORE, the Alberta government-funded research centre for ICT.

▼ **ARMIN EBERLEIN**

Assistant Professor, Department of Electrical and Computer Engineering

Dr. Eberlein's research focuses on the application of artificial intelligence and requirements engineering techniques to software engineering. He has investigated the use of well-defined software engineering processes to bring a clear structure into the software development life cycle as well as using formal methods to improve the correctness and preciseness of software.

Dr. Eberlein has also used object-oriented software engineering methods to implement computer-aided software engineering (CASE) tools for the design of large-scale software products. During his research, Dr. Eberlein has successfully brought together aspects from various domains in order to address problems experienced during software development. He has designed a telecommunications service development methodology, which covers the complete service development life cycle from initial requirements acquisition, through analysis, modeling, validation, verification, specification and implementation to testing, deployment and maintenance. The methodology is based on a novel, three-dimensional framework for requirements engineering, and provides, with the help of a specialized use-case design process, a smooth transition to currently existing development life cycles which employ formal methods. The methodology is currently being implemented in an expert system that actively assists the service designer during service development.



▲ **GIANCARLO SUCCI**

Associate Professor, Department of Electrical and Computer Engineering

Dr. Succi is interested in theoretical and applied research on the effects of integrating a reuse policy inside a software development process, in terms of process maturity, productivity, quality, long-term returns on investment, standards, effects on the market structure, relevant accounting techniques, and legal issues. In the field of software reuse, he has implemented a logic language compiler for a "generic" parallel architecture to achieve code reusability for parallel machines. In addition, he has developed a reusable software artifact library which has been validated in two software firms. Dr. Succi has also developed models to study the effects of reuse on quality and productivity and has validated these models using real data from industry.

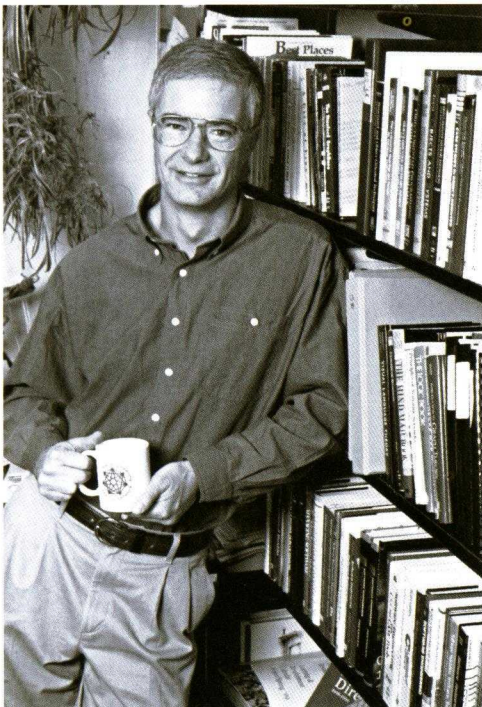
Dr. Succi is also interested in tools which support software engineering over the internet, in object orientation and in distributed systems.

In 1990, he developed, over the ftp protocol, a mechanism, named Slow File System, which allows mounting of remote file systems on local machines. He has studied the performance of Unix network environments, and in 1993, he designed a compiler and an abstract machine to allow the execution of a set-based logic language on remote machines using the http protocol.

▽ **ROB KREMER**

Assistant Professor, Department of Computer Science

Dr. Kremer's primary research interests include concept mapping languages, software design patterns, and intelligent agents. Concept maps constitute a large family of visual languages, or languages which allow programming using graphics, drawings, icons or animation. He developed a concept mapping meta-language called Constraint Graphs, which allows description of any concept mapping language using an annotated concept map as a specification language. Constraint Graphs can then emulate a custom graphical editor that understands the syntax of the target language. Furthermore, a Constraint Graphs editor's functionality can be easily extended at run time. Constraint Graphs can be used as an 'intelligent interface' to other programs, as a design tool for new visual languages, as an experimental tool for extensions to existing languages, and as a learning aid to students of visual languages.



△ **FRANK MAURER**

Associate Professor, Department of Computer Science

Dr. Maurer's research involves the increasing need for faster software development. This, in turn, requires larger, globally distributed development teams from which arise challenges in terms of coordination and management of schedules, personnel, information and tools.

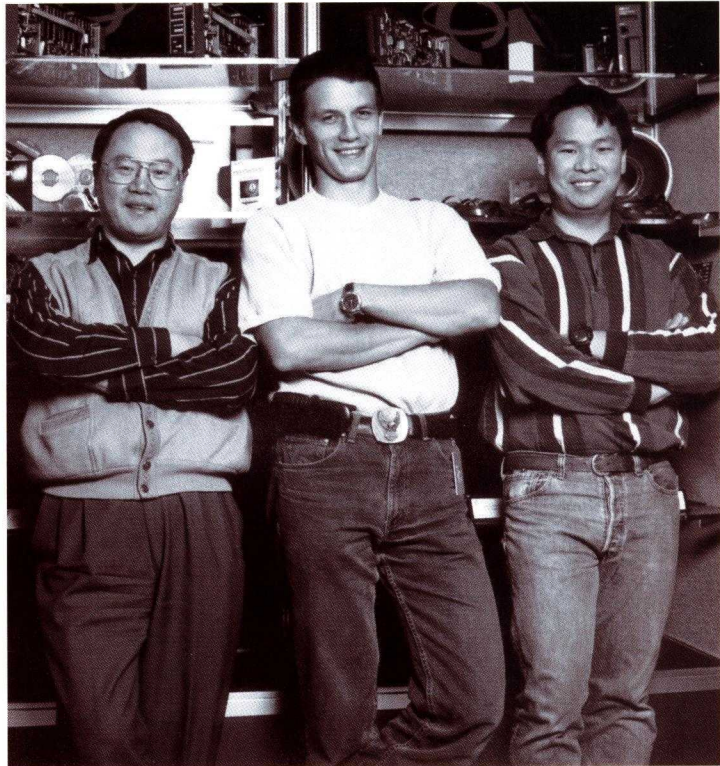
Dr. Maurer's research will provide insights into the requirements of globally distributed software processes as well as methods, techniques, and software tools to support them. The focus of the work will be on techniques

- to acquire causal dependencies between decisions made during software development (improving the traceability)
- to increase the flexibility of the software development processes
- to design and implement an internet-based process enactment engine

Dr. Maurer's research is based on the theoretical framework of software process modeling and software process improvement. Software process models describe the activities carried out in software development. The models are used as a basis for continuous improvement as well as the actual basis for the coordination and the management of the software engineering activities.

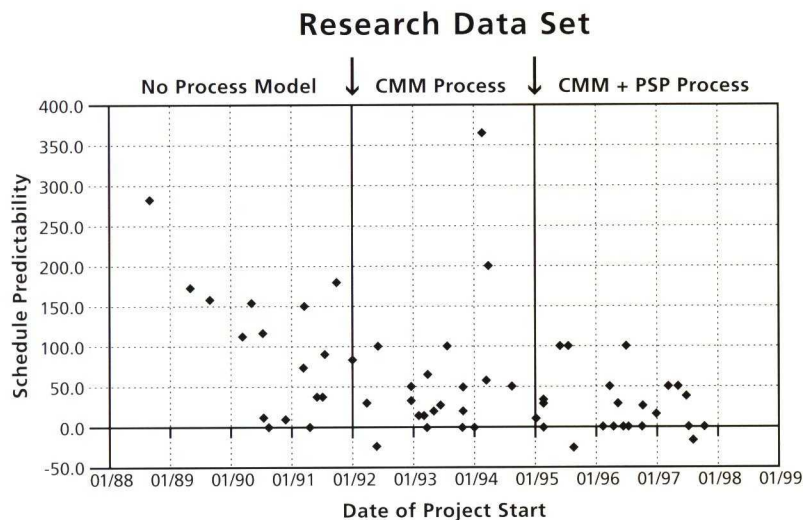
▷ **SERN STUDENTS IN INDUSTRY**

Nortel Networks has been involved in SERN since the program's inception. Adrian Damian (centre) did his masters research on simulation of network models under a research contract from Nortel. His research involved working at the University of Calgary and at Nortel labs in Ottawa, and was supervised by Dr. Brian Unger. George Shi (left) has recently started a research project supervised by Dr. Frank Maurer, and Tim Yue (right) is a software designer supervised by Dr. Armin Eberlein.



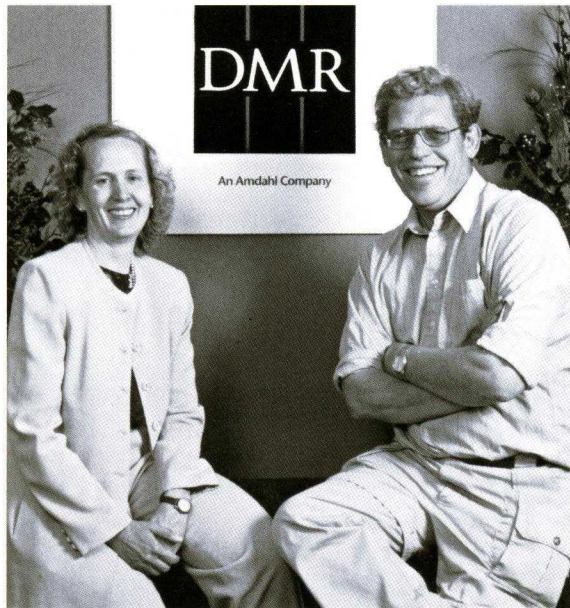
▽ **SCHEDULE PREDICTABILITY**

John Frankovich investigated the impact on real-world projects of effort and schedule predictability that results from supplementing the Capability Maturity Model with the Personal Software Process, and found a statistically significant impact. This figure from his thesis shows a steady decline in Schedule Predictability through the three methodologies: no process; Capability Maturity Model process; and Capability Maturity Model with the Personal Software Process. Schedule Predictability is defined as the difference between Actual Schedule and Estimated Schedule.



SOME SERN COURSE TITLES

- Requirements Engineering
- Managing the Software Life Cycle
- Software Process Management
- Software Quality Management
- Managing the Software Engineering Research Process
- Trends in Software Engineering
- Software Process Modeling
- Software Design Patterns
- Domain Analysis and Engineering
- Software Engineering for Internet Applications
- Software Metrics
- Software Production Engineering Economics
- Software Reliability and Testing
- Hardware/Software Codesign
- Software Architectures
- Organizational Management
- Human Resources and Organizational Dynamics
- Fundamentals of Project Management
- Object-Oriented Analysis and Design
- Advanced Object Oriented Systems
- Disciplined Software Engineering
- Project Planning and Control

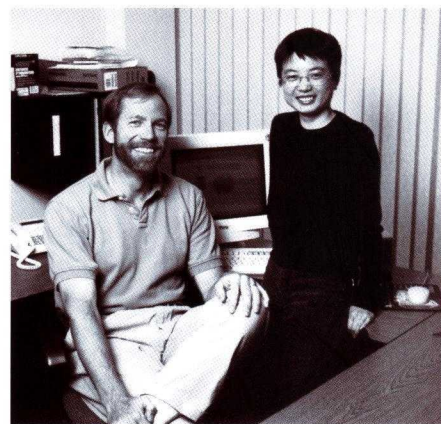
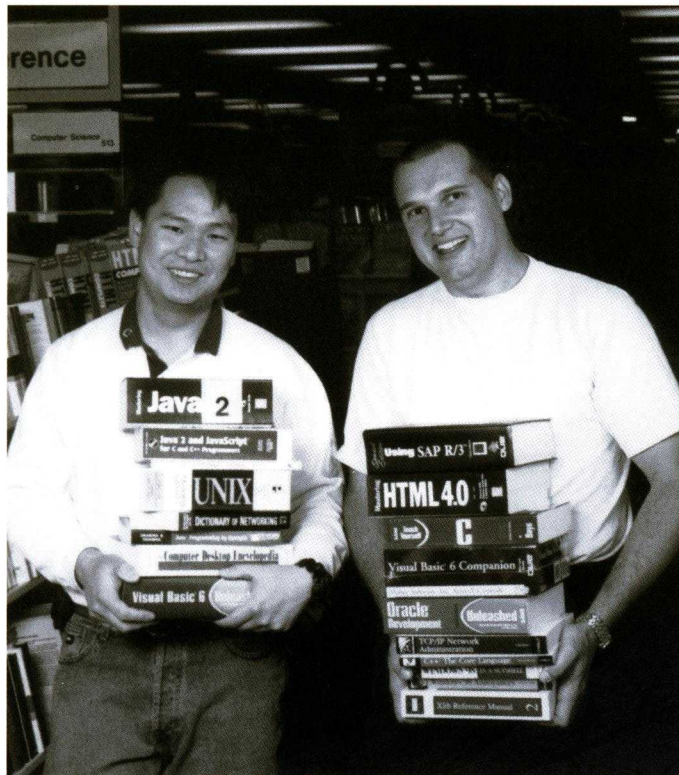


◀ USING THE BALANCED SCORECARD

Tricia Sterner is a Senior Software Engineer at DMR Consulting Group Inc. Because traditional financial measures do not reflect all of an organization's objectives, and therefore fall short when measuring the business value of software process improvement initiatives, Tricia, with her supervisor Dr. Mike Smith, is using the Balanced Scorecard to determine the business value associated with software process improvement. By using industry-based case studies of organizations using the Software Engineering Institute's Capability Maturity Model for software process improvement, Tricia will examine the benefits of using the Balanced Scorecard over traditional financial performance measurements. The Balanced Scorecard translates an organization's objectives into four perspectives: financial, customer, business process and employee. The Capability Maturity Model provides a framework to assess and progressively improve processes used in delivery of information technology products and is a de facto standard for software process improvement.

BOOK PRIZES

In 1998, Dr. Mildred L. G. Shaw donated a \$10,000 endowment to provide graduate book prizes, two of which will be awarded each year to students in the M.Sc. Software Engineering specialization. Recipients of the awards are students who have achieved academic excellence; demonstrated their ability to work collaboratively and in teams; actively participated in class discussions and are clearly applying course work in the workplace. Milan Springl (right) and Tim Yue (left) were the first recipients of this award in 1999.



△ DESIGN AND EVALUATION

Danfeng Hong is shown here at her workplace, Isotel Research (now Intel Corp.), with the President of Isotel, Duane Sharman. For her thesis work, Danfeng is designing a web browser for handheld devices, and will evaluate the use of the browser in industry. Her research was supported by Isotel Research, and continues to be supported by Intel.

▷ **SERN ATTRACTS TOP STUDENTS**

Pictured here receiving a Killam scholarship from Dr. Terry White, President of the University of Calgary, is Daniela Damian, the first graduate of the Software Engineering masters program. Daniela is now undertaking doctoral research on the role of groupware technology in supporting requirements engineering.

The Software Engineering Research program attracts top students from around the world who successfully compete across all disciplines for the top research awards given by the University. One such award is the Killam Scholarship, the highest graduate award at the University of Calgary. Six Killam awards, each comprising \$20,100 plus a \$3,000 research allowance, are made annually to graduate students in a doctoral program. The award is for two years and is renewable in open competition.



Seated from left, Claudine Simson, Vice-President, Global External Research and Intellectual Property, Nortel Networks; and Mildred Shaw, Industrial Research Chair in Software Engineering, the University of Calgary. Standing, from the left, John ApSimon, Vice-President, Research and External, Carleton University; Tom Brzustowski, President of NSERC; James Nininger, The Conference Board of Canada; and Peter Munsche, Assistant Vice-President, Technology Transfer, University of Toronto.

◁ **SYNERGY AWARD FOR
UNIVERSITY / INDUSTRY
COLLABORATION**

The Synergy Awards for University/Industry R&D Partnerships are awarded each year by the Natural Sciences and Engineering Research Council of Canada (NSERC) and The Conference Board of Canada to recognize the achievements of companies and academics who have joined forces to develop innovative new products and services and whose collaboration is a model of effective partnership.

Successful entrants “show effective use of human, technical and financial resources; demonstrate a lasting partnership between university and industry collaborators; provide evidence of tangible commercial results; and document, where applicable, the innovative and long-standing nature of university/industry interaction.” Winners in 1998 included Nortel Networks and Dr. Mildred L. G. Shaw.

SOME SERN THESIS TOPICS

Constraint Graphs: A "Meta-Language" for Concept Maps

A Groupware System for Negotiating Software Requirements

Studies in Distributed Requirements Engineering

Multi-Agent Systems to Support Dynamic Collaboration of Agents in an Open Environment

Programming Distributed Collaborative Interaction Through the World Wide Web

Automated Support for a Customized Personal Software Development Process

Domain Specific Dependencies

Design Patterns in a Knowledge Inference Engine

Design Patterns Applied in Network Simulations

Supplementing the Capability Maturity Model with the Personal Software Process

Integrating Informal and Formal Requirements Methods: A Practical Approach For Systems Employing Spatially Referenced Data

A Business Case for Software Process Improvement

Human-Computer Interaction on Hand-Held Devices

Software Metrics

The Effect on Quality of Code Reused in a Telecom C-based Environment: A Case Study

Application of Artificial Intelligence Techniques to Requirements Engineering

Comparative Assessments of Programming Languages, Processes, and Software Best Practice

Definition of a Set-Based Logic Language for the Runtime Collection of Software Metrics

Design of a Tool for Domain Analysis and Engineering

Development of Tools for Requirements Engineering

Domain Analysis and Engineering

Early Lifecycle Management

Evaluation of Software Metrics from the Perspective of the Theory of Numbers

Feasibility of Bootstrap for the Analysis of Software Data

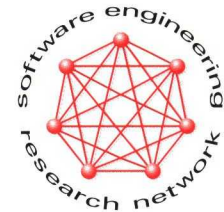
Large Scale Industrial Case Study for Requirements Engineering for Telecommunication Services

Process Improvement for Requirements Engineering

Study of the Applicability of Software Metrics to Create Models of the Development Process

The Use of Conceptual Languages for Requirements Management

Web-Based Dynamic Composition of Software





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Potential industry sponsors contact Greg McAvoy, Chair of the Advisory Board at:
gmcavoy@nortelnetworks.com