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1 Career and Education

1997-date	<i>Professor</i> , Department of Computer Science, University of Western Ontario, CANADA <i>Department Chair</i> (1997-2002) Cross appointments to departments of Applied Mathematics and Mathematics
2001-date	<i>Member, Board of Directors</i> , Descartes Systems Group (NASDAQ DSGX, TSE DSG) <i>Chairman of the Board</i> (2003-2007)
1998-2009	<i>Member, Board of Directors</i> , Maplesoft
1996-1998	<i>Responsable Scientifique</i> (Scientific Director), Projet SAFIR Institut National de Recherche en Informatique et en Automatique, FRANCE
1995-1997	<i>Professeur</i> , Dept. d'Informatique, Université de Nice–Sophia Antipolis, FRANCE <i>Titularisation</i> (tenure) awarded January 1996.
1984-1997	<i>Research Staff Member</i> , IBM T.J. Watson Research Center, Yorktown Heights NY, USA
1982-1984	<i>Lecturer</i> (during PhD), Dept. of Computer Science, University of Waterloo, CANADA
1981-1986	<i>PhD</i> , Computer Science, University of Waterloo, CANADA
1979-1981	<i>MMath</i> , Applied Mathematics, University of Waterloo, CANADA
1976-1979	<i>BSc</i> , Honours Mathematics and Honours Physics, U. New Brunswick, CANADA

2 Professional Biography

From 1981 to 1984, during my PhD studies at Waterloo, I was one of the first investigators to study the practical use of parallel computation in computer algebra. I was also heavily involved in the creation of the Maple computer algebra system as one of its original authors. Maple has since become a standard tool for mathematical computing, with more than three million users world-wide, and is the basis of the Maplesoft company.

From 1984 to 1995, I was a research staff member at the IBM T.J. Watson Research Center at Yorktown Heights. There, I conducted and directed research on computer algebra systems and compilers. I was one of the principal authors of the Axiom computer algebra system and was the principal architect of the Aldor programming language (then called “A[#]”). Axiom was unique with its architecture based on the abstract structures of modern algebra, and Aldor provided the first optimizing compiler for a language with full support for dependent types.

Since 1996 I have been a professor, first at the Université de Nice–Sophia Antipolis and then at the University of Western Ontario. As a professor, I have taught a variety of subjects, including programming languages and compilers, and I have conducted research in computer algebra systems, compilers, and pen-based computer interfaces. I continue to develop new courses and coach the programming contest team.

My initial appointment at UWO was as department chair for Computer Science. I led the department through a major expansion phase, setting out the department’s first academic plan, doubling the number of faculty and students, quadrupling research funding, introducing new programs and building new space.

During this period, I led the creation of ORCCA, the Ontario Research Centre for Computer Algebra, now recognized internationally as the leading centre for the subject. With colleagues, I have created the MathML standard and have pioneered the area of symbolic-numeric algorithms for polynomials. With colleagues, I have organized a number of major research projects in the areas of compilers, computer algebra and mathematical data communications. These have been funded by ESPRIT in Europe, and NSERC, ORDCF, CANARIE, MITACS, Maplesoft and Microsoft in Canada. Through this, I have gained considerable international experience establishing collaborations, organizing conferences, presenting research and recruiting in 43 countries on 6 continents.

Beyond my academic activities, I have broad leadership experience in the corporate world. From 1985 to 1995, I lead a research and development team at IBM. In 1988 I was a co-founder of Maplesoft, now a profitable corporation with about 100 employees. In 2003, I accepted the position of Chairman of the Board for the Descartes Systems Group, a publicly traded corporation with about 300 employees and a current market capitalization of about 375 million USD. As Descartes Chairman of the Board, with management and board colleagues, we achieved a corporate turn-around to sustained and substantial profitability following nine years of heavy losses.

3 Prizes, Awards, Honours

- 2009 **Top Authors in Scientific Computing**
Ranked in top 10 authors in scientific computing by Microsoft Academic Search
- 2007 **Omond Solandt Award,**
Canadian Operational Research Society
(for outstanding contribution to operational research in Canada: *developing innovative transportation and logistics solutions ... and for the resulting economic contributions.*)
Descartes Systems Group, Ltd. (Personal role: Chairman of the Board)
- 2006 **Best Business Turnaround Award,** International Business Awards (Stevie)
Descartes Systems Group, Ltd. (Personal role: Chairman of the Board)
- 2004 **NSERC Synergy Award for Innovation**
Natural Sciences and Engineering Research Council of Canada
(for outstanding achievements of university-industry collaboration)
Team from Maplesoft, U. Waterloo, U. Western Ontario, Simon Fraser U.
- 2004 **Student Nomination, Award of Excellence in Undergraduate Teaching**
Western Alumni Association, University Student's Council and Bank of Nova Scotia
- 2003–date **CAS Faculty Fellow,** IBM Centre for Advanced Studies, Toronto
- 2002–2003 **Distinguished Research Professorship,** Faculty of Science, U Western Ontario
- 2002 **IWAY Award for New Technology Development,** CANARIE
Canadian Network for the Advancement of Research, Industry and Education
(for work in standards for mathematics on the world wide web)

The IWAY awards are presented to individuals or groups who have made significant contributions to Canada's information society. Past recipients include John Manley, Canadian Deputy Prime Minister (2001), John Roth, Vice Chairman and CEO of Nortel (2000), Michael Lazaridis, President and founder of Research in Motion (1997), Frank McKenna, Premier of New Brunswick (1996).
- 1999 **Premier's Research Excellence Award,** Province of Ontario
(for work in computer programming languages)
- 1994 **Patent Application Invention Achievement Award,** IBM Corporation.
- 1994 **Research Division Award,** IBM Research
(for work in automatic differentiation)
- 1992 **Outstanding Innovation Award,** IBM Research
(for work in computer algebra)
- 1979–1983 **NSERC 1967 Science Scholarship,**
Natural Sciences and Engineering Research Council of Canada.
- 1979 **Walter Baker Memorial Prize in Physics,** University of New Brunswick.
- 1978 **Hugh Moore Prize for Physics,** University of New Brunswick.
- 1978 **APICS Mathematics Prize,**
Atlantic Provinces Interuniversity Committee on the Sciences.
- 1976-1978 **Undergraduate Scholarships,** University of New Brunswick
Special Entrance Scholarship, Alumni Undergraduate Scholarship, William Somerville Scholarship, Florence L. Murray Memorial Scholarship, Summer Research Scholarship (APICS), Alumni Undergraduate Scholarship, Thomas Harrison Memorial Scholarship.

4 Leadership

- Ongoing **Conference Organizer**
- Have been a lead organizer of 38 scientific conferences, workshops and special sessions.
 - These include area top-tier conferences, such as ISSAC, as well as smaller workshops, such as SNAP, to springboard emerging areas.
- 2003.09-2007.05 **Chairman of the Board**
The Descartes Systems Group Inc. (NASDAQ DSGX, TSE DSG)
- Descartes provides software-as-a-service logistics solutions for supply chain management.
 - With management and board, led company to profitability after 9 years of losses.
 - Trailing 12 month revenues USD 84.3 million, GAAP net income USD 13.5 million, EBITDA USD 22.3 million. Market capitalization USD 378 million.
 - Experience in:
Mergers and acquisitions, initial public stock offering, Sarbanes-Oxley compliance, board and executive recruiting, compensation and termination, class action defense, US and Ontario (Canada) securities regulatory environment and corporate governance.
- 1999.07-date **Founding Director**
Ontario Research Centre for Computer Algebra
- With colleagues, created ORCCA, with NSERC, ORDCF and private sector funding.
 - Now viewed by many as the world-wide leading centre for computer algebra.
 - This is the principal laboratory for 9 faculty in 3 departments, Computer Science at Waterloo and Applied Mathematics and Computer Science at Western.
- 1997.07-2002.06 **Chair**
Department of Computer Science, University of Western Ontario, Canada
- Led the department through a period of qualitative growth in teaching and research.
 - Oversaw the introduction of several degree programs, including honours specializations in Bioinformatics and in Software Engineering, and the *first joint program in North America* in Computing and Law (BSc/LLB).
 - Directed recruitment of new faculty members to build research strength at international levels in strategic areas. By end of term had hired 1/2 of all current faculty.
 - Expanded and enhanced physical facilities, including new construction and substantial renovations in three buildings.
 - Implemented all new procedures of initial collective agreement with new faculty union.
 - Raised \$2 Million in cash and in-kind contributions from private sector sources to support program expansion under the Ontario Access to Opportunities Program.
 - Summary of departmental growth during period as chair:
- | | Start (1996/97) | End (2001/02) |
|-----------------------------------|-----------------|---------------|
| Faculty (tenure track + contract) | 18 (14+4) | 31 (23+8) |
| Office + systems staff | 10 | 12 |
| Undergrad half course registrants | 4670 | 9560 |
| Undergrad program enrollments | 235 | 450 |
| Graduate students | 40 | 109 |
| Annual research funding | \$546,000 | \$2,391,000 |
| Number of research grants | 30 | 66 |
| Research staff | 5 | 18 |

The department was then largest in the Faculty of Science (for undergraduate teaching) and in the Faculty of Graduate Studies (for academic graduate programs).

- 1996.03-1999.02 **Chairman** *FRISCO Consortium*
ESPRIT Fourth Framework, Long Term Research Project 21.024
- Research consortium of five laboratories in France, Italy, Spain and UK.
 - Annual budget of CAD 750,000.
 - Led project management committee, resolved issues between partners, formed overall consensus.
- 1996.06-1998.12 **Responsable Scientifique** (Scientific Director), Projet SAFIR
Institut National de Recherche en Informatique et en Automatique, France
- Headed research project with a scientific staff of 30 researchers (15 permanent).
 - In collaboration, mounted two ESPRIT research consortia.
- 1995.07-1997.06 **Elected Chair** *ACM SIGSAM*
- SIGSAM is the international professional society for those working in computer algebra.
- 1995.07-1996.06 **Initial Chair** *ISSAC Steering Committee*
- ISSAC is the flagship annual international conference in computer algebra.

5 Research Summary

Symbolic mathematical computation provides algorithms and software to do mathematics, manipulating equations and expressions rather than just numbers or text.

My research goal has been *to identify and solve the main questions to make symbolic mathematical computation more effective*. This has involved developing new areas of investigation and bringing them into the core of what we now view as computer algebra today.

This work has centered on the following key questions:

- (i) What new programming language and compiler technology is needed?
- (ii) How can we expand the domain of symbolic mathematical computation ?
- (iii) How should computer algebra systems interact with each other and the World Wide Web?
- (iv) How to use mathematical handwriting recognition for collaborative interfaces?

Together these questions provide the elements of a natural, powerful environment for symbolic mathematical computation. Highlights of this work are summarized below. A technical overview of some aspects is provided by chapters in the Computer Algebra Handbook (Springer Verlag 2003): *Aldor*, *Hybrid Methods*, and *MathML*.

Computer Algebra Systems

I was one of the founding authors of the **Maple** computer algebra system, together with Keith Geddes and Gaston Gonnet at U. Waterloo. From the start, Maple set new directions in computer algebra system design. It is today one of the most used packages for mathematical software, with more than 3 million users. My research group continues to contribute new ideas to Maple, and for this has been part of the team receiving the *2004 NSERC Synergy Award for Innovation*.

I was also one of the principal designers of **Axiom**, at IBM Research, with R. Jenks, B. Trager and contributions from several others. We took a fundamentally different approach to computer algebra system design, taking the formal structures of modern algebra as programming interfaces, and using parametric polymorphism and type categories well before they were used in mainstream applications. Axiom stimulated similar research projects at Berkeley and Tektronix, the design of the popular Magma system, and is now an open source project with an active user community. For this work, I received the *Outstanding Innovation Award* from IBM Research in 1992. My recent work in this area examines questions in memory management and mathematical object semantics to allow multiple computer algebra systems to operate in a tightly coupled manner.

Programming Languages and Compilers

Mathematical problems have a richer, more well-defined structure than other computational problems so it is not surprising that a number of programming language issues are first seen in the area of symbolic mathematical computation. Starting at IBM Research, I led an effort to create **Aldor**, a programming language for symbolic and numeric mathematical computation. The formulation of the *Aldor* language has tried to balance theoretical elegance with practical efficiency. Types and functions are first class values. Dependent types are fully supported, but their semantics have been carefully defined using type categories to allow effective optimization. The implementation of the optimizing compiler and libraries involved some 35 person-years at IBM and a follow-on European ESPRIT project. Aldor was adopted by the Numerical Algorithms Group as the extension language for Axiom, and it is now available freely from Aldor.org. This work has been the basis for an *Ontario Premier's Research Excellence Award* (1999–2003) and an *NSERC Strategic Project* (2002–2006).

Pen-Based Mathematical Computing

Current pen-based computing devices use sophisticated methods to achieve reasonable handwriting recognition rates. These methods are not directly applicable, however, to mathematics, primarily for three reasons: (1) mathematical notation is two dimensional, with elements of both handwriting and drawing, (2) mathematical notation uses a vocabulary of thousands of symbols, with no well-defined stroke order, unlike e.g. English or Chinese, (3) there is not a fixed set of mathematical “words” that would allow the usual use of dictionary-based methods. I currently lead a research group, significantly supported by Microsoft and Maplesoft, investigating these questions. I have found two fruitful approaches to be the use of local convex hull methods in vector spaces of orthogonal series coefficients and the use of statistical methods based on mathematical document archives. In addition I currently serve as lead editor in the creation of **InkML**, the W3C draft standard for digital ink.

Mathematical Algorithms

Symbolic-Numeric Algorithms for Polynomials The exact algorithms of symbolic computation break down when applied to polynomials with approximate coefficients. The 1995 paper by Corless, Gianni, Trager and myself imported the ideas of backward error analysis and singular value decomposition to computer algebra to give a well-defined meaning to the approximate GCD of polynomials and solution of polynomial systems. This work had a major impact in the computer algebra community, motivating my group to organize SNAP 96, which is remembered as an influential milestone. The following year saw an explosion of papers by many authors. This continues to be a hot area, with multiple conferences devoted to the subject. My more recent contributions to the area include absolute irreducibility testing (1997), functional decomposition (1999), implicitization (2000), factorization (2001, 2002), greatest common divisors (2004) and initial value problems (2005).

Extended Domains for Symbolic Computation Computer algebra cannot algorithmically treat many problems that are straightforward to do by hand. For example, it is difficult in computer algebra to work with matrices of unknown size, polynomials of unknown degree or with coefficients in a field of unknown characteristic. When objects such as these are encountered, current computer algebra systems fall back on ineffective term rewriting techniques. I have recently been exploring what can be done to make computer algebra *more* symbolic, providing algorithms for a broader class of mathematical expressions. As a first step, I have considered the case of “symbolic polynomials,” meaning multivariate polynomials over some ring where the exponents may themselves be multivariate integer valued polynomials. Under suitable conditions these can be shown to form a unique factorization domain, and I have developed algorithms to compute their GCD, factorization (2006, 2007) and functional decomposition (2008). Most recently, I have investigated algorithms for abstract matrices with regions of symbolic size (2008-2009) and a generalized notion of abstract domain decomposition (2010).

Automatic Differentiation Related to my work in computer algebra systems and compilers, I have developed and put into practice new ideas in automatic differentiation. Automatic differentiation is the study of techniques to augment computer programs so they compute not only their original numerical values, but also the function’s analytic derivatives. This lies in the area between computer algebra and compilers. My work, together with colleagues at IBM, led to monthly savings of \$1 Million in circuit simulation, an *IBM Research Division Award* in 1994, and two US Patents in 2001 and 2002.

Mathematical Data Communications and Knowledge Management

I have been one of the principals in the creation of two related standards for the exchange of mathematical data in distributed or web-based applications. **MathML** is a World Wide Web Consortium standard for the markup of mathematical expressions, capturing both meaning and appearance. My most significant contribution was to unify two opposing viewpoints with a framework supporting both notation and semantic markup. MathML has now been widely adopted by software vendors and is the representation of mathematics in all US patent documents. **OpenMath** is an extensible standard supported by the EU for the semantic markup of mathematical objects. It has been used as the basis of OmDoc, as an extension mechanism for MathML, and for the implementation of mathematical web services. For work on MathML and OpenMath, I received the *CANARIE IWAY Award for New Technology Development* in 2002. Recently, I have directed my research group in developing techniques to use these technologies to provide mathematical web services, accessible both to individuals and client programs. I believe the ideas in mathematical service description and discovery can play an important role in the future of self-organizing behaviour in large mathematical software systems.

Summary of Research Output

Type	≤ 2003	2004	2005	2006	2007	2008	2009	2010	Total
Major software productions									6
Refereed articles	35	7	12	12	12	11	11	8	108
Standard definitions	4							2	6
Patents	2								2
Books	9								9
Refereed abstracts	5	2	3	4	1	8	2	3	28
Editorial works	3			1	2	1	1	3	11
Reports and selected other contribs.	24	2	2	4				1	33
Invited conference presentations	45	5	3	6	5	2	6	1	73
Invited talks at universities, etc.	33	2	1	3		3	5	3	50
Highly qualified personnel trained	64	3	4	4	13	3	9	10	110

6 Publications

6.1 Refereed Articles in Journals, Conference Proceedings and Book Chapters

2010

- [1] *Digital Ink Compression via Functional Approximation*, Vadim Mazalov and Stephen Watt, *Proc. Proc. 12th International Conference on Frontiers in Handwriting Recognition*, (ICFHR 2010), Nov 16-18 2010, Kolkata, India, (to appear).
- [2] *An Interface for Math e-Learning on Pen-Based Mobile Devices*, Mitsushi Fujimoto and Stephen Watt, *E-Proc. Mathematical User Interfaces Workshop 2010*, (MATHUI 2010), July 10 2010, Paris, France, (to appear).
- [3] *An Analytic Model for Colluding Processes*, Stephen M. Watt, *Proc. International Conference on Parallel Computer Algebra*, (PARCA 2010), June 29-3 July 2010, Tambov, Russia, (to appear).
- [4] *Type Specialization in Aldor*, Laurentiu Dragan and Stephen Watt, pp. 73–84, *Proc. 12th International Workshop on Computer Algebra in Scientific Computing*, (CASC 2010), Sept 6-12 2010, Tsakhkadzor, Armenia, Springer Verlag LNCS 6244.
- [5] *Symbolic Domain Decomposition*, Jacques Carette, Alan P. Sexton, Volker Sorge and Stephen M. Watt, pp. 172–188, *Proc. Intelligent Computer Mathematics: 10th International Conference, AISC 2010, 17th Symposium, Calculemus 2010, and 9th International Conference, MKM 2010*, (CICM 2010), July 5-10 2010, Paris, France, Springer Verlag LNAI 6167.
- [6] *Improved Classification through Runoff Elections*, Oleg Golubitsky and Stephen M. Watt, pp. 59–64, *Proc. International Workshop on Document Analysis Systems*, (DAS 2010), June 9-11 2010, Boston, USA, ACM Press.
- [7] *Towards Affine Recognition of Handwritten Mathematical Characters*, Oleg Golubitsky, Vadim Mazalov and Stephen M. Watt, pp. 35–42, *Proc. International Workshop on Document Analysis Systems*, (DAS 2010), June 9-11 2010, Boston, USA, ACM Press.
- [8] *Distance-Based Classification of Handwritten Symbols*, Oleg Golubitsky and Stephen M. Watt, *International Journal of Document Analysis and Recognition*, Vol 13 No 2 pp. 133-146, June 2010, Springer.

2009

- [9] *On the Future of Computer Algebra Systems at the Threshold of 2010 (Invited)*, Stephen M. Watt, pp. 422–430, *Proc. Joint Conference of ASCM 2009 and MACIS 2009: Asian Symposium of Computer Mathematics and Mathematical Aspects of Computer and Information Sciences*, (MACIS 2009), December 14-17 2009, Fukuoka, Japan, COE Lecture Note Vol. 22, Kyushu University, ISSN 1881-4042.
- [10] *Orientation-Independent Recognition of Handwritten Characters with Integral Invariants*, Oleg Golubitsky, Vadim Mazalov and Stephen M. Watt, pp. 252-261, *Proc. Joint Conference of ASCM 2009 and MACIS 2009: Asian Symposium of Computer Mathematics and Mathematical Aspects of Computer and Information Sciences*, (ASCM 2009), December 14-17 2009, Fukuoka, Japan, COE Lecture Note Vol. 22, Kyushu University, ISSN 1881-4042.
- [11] *An Architecture for Generic Extensions*, Cosmin Oancea and Stephen M. Watt, *Science of Computer Programming*, Elsevier (to appear).
- [12] *Computing with Abstract Matrix Structures*, Alan P. Sexton, Volker Sorge and Stephen M. Watt, pp. 325-332, *Proc. 2009 International Symposium on Symbolic and Algebraic Computation*, (ISSAC 2009), July 28-31 2009, Seoul, South Korea, ACM Press.
- [13] *Online Recognition of Multi-Stroke Symbols with Orthogonal Series*, Oleg Golubitsky and Stephen M. Watt, pp. 1265-1269, *Proc. 10th International Conference on Document Analysis and Recognition*, (ICDAR 2009), July 26-29 2009, Barcelona, Spain, IEEE Computer Society.
- [14] *A Collaborative Interface for Multimodal Ink and Audio Documents*, Amit Regmi and Stephen M. Watt, pp. 901-905, *Proc. 10th International Conference on Document Analysis and Recognition*, (ICDAR 2009), July 26-29 2009, Barcelona, Spain, IEEE Computer Society.

- [15] *Confidence Measures in Recognizing Handwritten Mathematical Symbols*, Oleg Golubitsky and Stephen M. Watt, pp. 460-466, *Proc. Conferences on Intelligent Computer Mathematics 2009: 16th Symposium on the Integration of Symbolic Computation and Mechanized Reasoning and 8th International Conference on Mathematical Knowledge Management*, (MKM 2009), July 10-12 2009, Grand Bend, Canada, Springer Verlag LNAI 5625.
- [16] *Algorithms for the Functional Decomposition of Laurent Polynomials*, Stephen M. Watt, pp. 186-200, *Proc. Conferences on Intelligent Computer Mathematics 2009: 16th Symposium on the Integration of Symbolic Computation and Mechanized Reasoning and 8th International Conference on Mathematical Knowledge Management*, (Calculemus 2009), July 6-7 2009, Grand Bend, Canada, Springer Verlag LNAI 5625.
- [17] *Reasoning with Generic Cases in the Arithmetic of Abstract Matrices*, Alan P. Sexton, Volker Sorge and Stephen M. Watt, pp. 138-153, *Proc. Conferences on Intelligent Computer Mathematics 2009: 16th Symposium on the Integration of Symbolic Computation and Mechanized Reasoning and 8th International Conference on Mathematical Knowledge Management*, (Calculemus 2009), July 6-7 2009, Grand Bend, Canada, Springer Verlag LNAI 5625.
- [18] *A New Approach to Parallelising Tracing Algorithms*, Cosmin E. Oancea, Alan Mycroft and Stephen M. Watt, pp. 10-19, *Proc. 2009 International Symposium on Memory Management*, (ISMM 2009), Jun 19-20 2009, Dublin, Ireland, ACM Press.
- [19] *Online Computation of Similarity between Handwritten Characters*, Oleg Golubitsky and Stephen M. Watt, pp. C1-C10, *Proc. Document Recognition and Retrieval XVI*, (DRR XVI), Jan 21-22 2009, San Jose, California USA, SPIE and IS&T.

2008

- [20] *Communicating Mathematics via Pen-Based Computer Interfaces (Invited)*, Elena Smirnova and Stephen M. Watt, pp. 9-18, *Proc. 10th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing*, (SYNASC 2008), Sept 26-29 2008, Timișoara Romania, IEEE Computer Society.
- [21] *Abstract Matrix Arithmetic*, Alan P. Sexton, Volker Sorge and Stephen M. Watt, pp. 61-68, *Proc. 10th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing*, (SYNASC 2008), Sept 26-29 2008, Timișoara Romania, IEEE Computer Society.
- [22] *Online Stroke Modeling for Handwriting Recognition*, Oleg Golubitsky and Stephen M. Watt, pp. 72-80, *Proc. 18th Annual International Conference on Computer Science and Software Engineering*, (CASCON 2008), October 27-30 2008, Toronto, Canada, IBM Canada.
- [23] *An Empirical Measure on the Set of Symbols Occurring in Engineering Mathematics Texts*, Stephen M. Watt, pp. 557-564, *Proc. 8th IAPR International Workshop on Document Analysis Systems*, (DAS 2008), Sept 17-19 2008, Nara, Japan, IEEE Computer Society.
- [24] *Mathematical Document Classification via Symbol Frequency Analysis*, Stephen M. Watt, pp. 29-40, *Proc. Towards Digital Mathematics Library*, (DML 08), July 27 2008, Birmingham, UK, Masaryk University, ISBN 978-80-210-4658-0.
- [25] *Online Mathematical Symbol Recognition using SVMs with Features from Functional Approximation*, Birendra Keshari and Stephen M. Watt, *E-Proc. Mathematical User-Interfaces Workshop 2008*, (MathUI 08), July 27 2008, Birmingham, UK.
- [26] *Adaptive libraries and interactive code generation for Common Lisp*, Geoff Wozniak, Mark Daley and Stephen M. Watt, pp. 30-38, *Proc. 5th European Lisp Workshop (ECOOP 2008)*, (ELW '08), July 7 2008, Paphos, Cyprus.
- [27] *Context-Sensitive Mathematical Character Recognition*, Elena Smirnova and Stephen M. Watt, pp. 604-610, *Proc. IAPR International Conference on Frontiers in Handwriting Recognition*, (ICFHR 2008), August 19-21 2008, Montreal, Canada, Cenparmi, Concordia University, ISBN 1-895193-03-6.
- [28] *Sharing Digital Ink in Heterogeneous Collaborative Environments*, Birendra Keshari, Sriganesh Madhvanath, Manoj Prasad A, Muthuselvam Selvaraj and Stephen M. Watt, pp. 580-585, *Proc. IAPR International Conference on Frontiers in Handwriting Recognition*, (ICFHR 2008), August 19-21 2008, Montreal, Canada, Cenparmi, Concordia University, ISBN 1-895193-03-6.

- [29] *Functional Decomposition of Symbolic Polynomials*, Stephen M. Watt, pp. 353–362, *Proc. International Conference on Computational Science and Its Applications*, (ICCSA 2008), 30 June–3 July 2008, Perugia, Italy, IEEE Computer Society.
- [30] *Symbolic Polynomials with Sparse Exponents*, Stephen M. Watt, pp. 91–97, *Proc. Milestones in Computer Algebra: a Conference in Honour of Keith Geddes’ 60th Birthday* (MICA 2008), May 1-3 2008, Stonehaven Bay, Trinidad and Tobago University of Western Ontario ISBN 978-0-7714-2682-7.

2007

- [31] *Representing and Characterizing Handwritten Mathematical Symbols Through Succinct Functional Approximation*, Bruce W. Char and Stephen M. Watt, pp. 1198–1202, *Proc. International Conference on Document Analysis and Recognition*, (ICDAR), September 23-26 2007, Curitiba, Brazil, IEEE Press.
- [32] *Hybrid Mathematical Symbol Recognition Using Support Vector Machines*, Birendra Keshari and Stephen M. Watt, pp. 859–863, *Proc. International Conference on Document Analysis and Recognition*, (ICDAR), September 23-26 2007, Curitiba, Brazil, IEEE Press.
- [33] *New Aspects of InkML for Pen-Based Computing*, Stephen M. Watt, pp. 456–460, *Proc. International Conference on Document Analysis and Recognition*, (ICDAR), Sept 23-26 2007, Curitiba, Brazil, IEEE Press
- [34] *Aspects of Mathematical Expression Analysis in Arabic Handwriting*, Elena Smirnova and Stephen M. Watt, pp. 1183-1187, *Proc. International Conference on Document Analysis and Recognition*, (ICDAR), September 23-26 2007, Curitiba, Brazil, IEEE Press.
- [35] *Streaming-Archival InkML Conversion*, Birendra Keshari and Stephen M. Watt, pp. 1253–1257, *Proc. International Conference on Document Analysis and Recognition*, (ICDAR), September 23-26 2007, Curitiba, Brazil, IEEE Press.
- [36] *Generation and Optimization of Code using Coxeter Lattice Paths (Invited)*, Thomas J. Ashby, Anthony D. Kennedy and Stephen M. Watt, *Proc. International Workshop on Parallel Symbolic Computation*, pp. 1–10, (PASCO’07), July 27-28 2007, London, Canada, ACM Press.
- [37] *Multiprocessed Parallelism Support in Aldor on SMPs and Multicores*, Marc Moreno Maza, Ben Stephenson, Stephen M. Watt and Yuzhen Xie, pp. 60–68, *Proc. Parallel Symbolic Computation*, (PASCO), July 27-28 2007, London, Canada, ACM Press.
- [38] *What Happened to Languages for Symbolic Mathematical Computation?*, Stephen M. Watt, pp. 80–91, *Proc. Programming Languages for Mechanized Mathematics*, (PLMMS), June 29-30 2007, Hagenberg, Austria, RISC-Linz.
- [39] *A Cross-Application Architecture for Pen-Based Mathematical Interfaces*, Elena Smirnova and Stephen M. Watt, 5 pages, *Proc. Mathematical User Interfaces*, (MathUI), June 27 2007, Hagenberg, Austria, ActiveMath.org.
- [40] *Generic Programming Techniques in Aldor*, Manuel Bronstein, M. Moreno Maza and S. M. Watt, pp. 72–77, *Proc. Fifth Asian Workshop on Foundations of Software*, (AWFS), June 1-3 2007, Xiamen, China, University of Xiamen.
- [41] *Dynamic ADTs: a “Don’t Ask, Don’t Tell” Policy for Data Abstraction*, Geoff Wozniak, Mark Daley and Stephen M. Watt, pp. 209–220, *Proc. International Lisp Conference*, (ILC), April 1-4 2007, Cambridge UK, Association of Lisp Users.
- [42] *Two Families of Algorithms for Symbolic Polynomials (Invited)*, Stephen M. Watt, in *Computer Algebra 2006: Latest Advances in Symbolic Algorithms — Proceedings of the Waterloo Workshop*, pp. 193–210 I. Kotsireas, E. Zima (editors) World Scientific.

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- [150] *On the Functional Decomposition of Multivariate Laurent Polynomials*, Stephen M. Watt, (ECCAD 2008), May 10 2008, Shepherdstown WV, USA.
- [151] *A Note on the Functional Decomposition of Symbolic Polynomials*, Stephen M. Watt, pp. 215–216, *Proc. Milestones in Computer Algebra: a conference in honour of Keith Geddes' 60th birthday*, (MICA 2008), May 1-3 2008, Stonehaven Bay, Trinidad and Tobago, University of Western Ontario ISBN 978-0-7714-2682-7.
- [152] *A Preliminary Report on the Set of Symbols Occurring in Engineering Mathematics Texts*, Stephen M. Watt, pp. 217–219, *Proc. Milestones in Computer Algebra: a conference in honour of Keith Geddes' 60th birthday*, (MICA 2008), May 1-3 2008, Stonehaven Bay, Trinidad and Tobago, University of Western Ontario ISBN 978-0-7714-2682-7.
- [153] *Sparse Exponents in Symbolic Polynomials*, Matthew Malenfant and Stephen M. Watt, *Proc. Symposium on Algebraic Geometry and Its Applications: In honor of the 60th birthday of Gilles Lachaud*, (SAGA 2007), May 7-11 2007, U. Polynésie Française.
- [154] *Improving Pen-Based Mathematical Interfaces (Invited)*, Stephen M. Watt, pp. 12-, *Proc. 8th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing*, (SYNASC 2006), Sept 26-29 2006, Timișoara Romania, IEEE Press.
- [155] *Algorithms for Symbolic Polynomials (Invited)*, Stephen M. Watt, pp. 302-, *Proc. 9th International Workshop on Computer Algebra in Scientific Computing*, (CASC 2006), September 11-15 2006, Chișinău, Moldova, Springer Verlag LNCS 4194.
- [156] *An Algorithm for PDE Consistency under Constraints with an Application to Relativistic Cosmology*, Stephen M. Watt, *Proc. 2006 Conference on the Applications of Computer Algebra*, (ACA 2006), June 26-29 2006, Varna, Bulgaria.
- [157] *Symbolic Computation versus Computer Algebra*, Stephen M. Watt, *Proc. 2006 Conference on the Applications of Computer Algebra*, (ACA 2006), June 26-29 2006, Varna, Bulgaria.

- [158] *An Abstract, Coordinate-Free, Vector Algebra Package*, Songxin Liang, David J. Jeffrey and Stephen M. Watt, *Proc. Asian Symposium on Computer Mathematics*, (ASCM 2005), December 8-10 2005, Seoul Korea.
- [159] *On the Approximate GCD in Initial Value Problems*, Stephen Watt. Proc. 2005 Applications of Computer Algebra, 31 Jul-3 Aug 2005, Nara, Japan, IMACS.
- [160] *Components for Pen-Based Mathematical Interfaces*, Elena Smirnova, Clare So, Stephen Watt and Xiaofang Xie. Proc. 2005 Applications of Computer Algebra, 31 Jul-3 Aug 2005, Nara, Japan, IMACS.
- [161] *Optimizing Compilation for Symbolic-Numeric Computing (Invited)*, S.M. Watt. 6th International Symposium on Symbolic and Numeric Algorithms for Scientific Computation (SYNASC 2004), pp 18, 26-30 September 2004, Timișoara Romania, MITRON Press ISBN 973-661-441-7.
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- [163] *Interoperability of Languages with Generics, using Aldor, C++ and Java*, Y. Chicha, F. Defaix and S.M. Watt. Proc. 1999 Frisco Workshop, pp 9-10, April 28-29, 1999, Oxford, UK, FRISCO Consortium Report 5.6.1, ESPRIT LTR 21.024, <http://www.nag.co.uk/Projects/Frisco/ws/proceedings.ps>.
- [164] *Approximate Polynomial Decomposition*, R.M. Corless, M.W. Giesbrecht, D.J. Jeffrey, Xianping Liu and S.M. Watt. Proc. 1999 Frisco Workshop, pp 6-8, April 28-29, 1999, Oxford, UK, FRISCO Consortium Report 5.6.1, ESPRIT LTR 21.024 <http://www.nag.co.uk/Projects/Frisco/ws/proceedings.ps>.
- [165] *Absolute Factorization of Bivariate Polynomials with Floating Point Coefficients*, A. Galligo and S.M. Watt. Proc. 1996 Workshop on Symbolic-Numeric Algebra for Polynomials (SNAP 96), pp.15, July 15-17, 1996, INRIA Sophia Antipolis, France, <http://www-sop.inria.fr/galaad/conf/1996/SNAP96/procs.ps>.
- [166] *Construction of Algebraic Error Control Codes on the Elliptic Riemann Surface*, M. Hassner, W. Burge, S.M. Watt. IEEE Symposium on Information Theory, pp. 57, June 19-24 1988, Kobe Japan, IEEE Press 1988.
- [167] *Abstract Datatypes, Multiple Views and Multiple Inheritance in Scratchpad II*, S.M. Watt and R.D. Jenks. Proceedings of the Programming Language Technology ITL Conference, February 10-12 1987, Tucson Arizona, IBM Corporation.

6.8 Research Reports

Reports subsequently published elsewhere are not listed.

- [168] *GIDL User Guide*, Cosmin Oancea and Stephen M. Watt. Ontario Research Centre for Computer Algebra, U. Western Ontario Report TR-06-09 (55 pages), 2006.
- [169] *Alma User Guide*, Cosmin Oancea and Stephen M. Watt. Ontario Research Centre for Computer Algebra, U. Western Ontario Report TR-06-08 (7 pages), 2006.
- [170] *reflex: A Scanner Transformer for Unicode Grammars*, S.L. Huerter and S.M. Watt. Ontario Research Centre for Computer Algebra, U. Western Ontario Report TR-06-07 (34 pages), 2006.
- [171] *Mathematics on the NET – CA:MONET*, E. Smirnova and S.M. Watt. CANARIE E-Content Program Final Project Report (25 pages), 2004.
- [172] *Symbolic Solver Services – Wrapper Tool*, E. Smirnova and S.M. Watt. The MONET Consortium (IST-2001-34145) Technical Report (61 pages), 2004.
- [173] *Content-Faithful Stylesheets for MathML*, I. Rodionov and S.M. Watt. Ontario Research Centre for Computer Algebra, U. Western Ontario Report TR-00-24, 2000.
- [174] *Automation of the Aldor/C++ Interface: User’s Guide*, Y. Chicha, F. Defaix and S.M. Watt. FRISCO Consortium Report D2.2.2c, 1999 (Also UWO CS Dept TR-537).
- [175] *Automation of the Aldor/C++ Interface: Technical Reference*, Y. Chicha, F. Defaix and S.M. Watt. FRISCO Consortium Report D2.2.2b, 1999 (Also UWO CS Dept TR-538).
- [176] *A C++ to XML Translator*, Y. Chicha, F. Defaix and S.M. Watt. FRISCO Consortium Report D2.2.2a, 1998 (Also UWO CS Dept TR-536).

- [177] *An Object Model Correspondence for Aldor and C++*, M. Gaëtano and S.M. Watt. FRISCO Consortium Report D2.2.1, 1997.
- [178] *An HTML-Native Math Proposal*, S. Buswell, S. Dalmas, S. Devitt, A. Diaz, M. Gaëtano, R. Sutor, T. van Belle and S. Watt. W3C Working Group on HTML Mathematics, March 1997.
- [179] *A[#] Language Reference, V0.35*, S.M. Watt. IBM Research Report RC 19530, 1994.
- [180] *A First Report on the A[#] Compiler (including benchmarks)*, S.M. Watt, P.A. Broadbery, S.S. Dooley, P. Iglio, S.C. Morrison, J.M. Steinbach and R.S. Sutor. IBM Research Report RC 19529, 1994.
- [181] *FOAM: A First Order Abstract Machine, V 0.35*, S.M. Watt, P.A. Broadbery, P. Iglio, S.C. Morrison and J.M. Steinbach. IBM Research Report RC 19528, 1994.
- [182] *Bounded Parallelism in Computer Algebra*, S.M. Watt. U. Waterloo Research Report CS-86-12, 1986.
- [183] *Factorisation d'Opérateurs Différentiels du Second Ordre*, J. Della Dora and S.M. Watt. Institut National Polytechnique de Grenoble, Laboratoire TIM3 Research report RR 634 -M-, November 1986.
- [184] *On the Design and Performance of the Maple System (extended version)*, B.W. Char, G.J. Fee, K.O. Geddes, G.H. Gonnet, M.B. Monagan and S.M. Watt. U. Waterloo Research Report CS-84-13, 1984.
- [185] *Arrays and Tables in Maple*, S.M. Watt. U. Waterloo Research Report CS-83-10, 1983.

6.9 Selected Other Contributions

- [186] *The Perpetual Youth of Solomon Marcus*, Stephen M. Watt. 1 pp. in *Meetings with Solomon Marcus*, Gheorghe Păun (editor), Spandugino Publishing, (to appear).
- [187] *Manuel Eric Bronstein: in memoriam*, Stephen M. Watt. ACM SIGSAM Bulletin Vol 39 No 4 (Issue 154) pp 144–145, Dec 2005.
- [188] *Approximate Computation of Pseudovarieties*, R.M. Corless, Hiroshi Kai and S.M. Watt. ACM SIGSAM Bulletin Vol 37 No 3 (Issue 145) pp 67–71, Sep 2003.
- [189] *Examples of MathML*, S.M. Watt and Xuehong Li. ACM SIGSAM Bulletin, Vol 33 No 1 Issue 127 pp 1-4 (Mar 1999).
- [190] *Report on the SNAP minisymposium at SIAM '98*, R.M. Corless and S.M. Watt. ACM SIGSAM Bulletin, Vol 32 No 2 Issue 124 pp 35-37 (Jun 1998).
- [191] *Domains and Subdomains in Scratchpad II*, S. M. Watt. Scratchpad II Newsletter, Vol 2 No 1 pp 3-5 (Nov 1987).
- [192] *Construction of Algebraic Error Control Codes (ECC) on the Elliptic Riemann Surface*, M. Hassner, W.H. Burge and S.M. Watt. Scratchpad II Newsletter, Vol 2 No 1 pp 5-8 (Nov 1987).
- [193] *Streams and Power Series*, W.H. Burge, S.M. Watt and S.C. Morrison. Scratchpad II Newsletter, Vol 2 no 1 pp 9-12 (Nov 1987).
- [194] *Mappings as First Class Objects*, S.M. Watt and W.H. Burge. Scratchpad II Newsletter, Vol 2 No 1 pp 13-17 (Nov 1987).
- [195] *Algebra Snapshot: Linear Ordinary Differential Operators*, S.M. Watt and J. Della Dora. Scratchpad II Newsletter, Vol 1 No 2 pp 14-18 (Jan 1986).

7 Major Software Productions

- 2005-date **The Mathink Interface**
Principal architect, implementation by students, postdocs and staff at UWO
- Experimental pen-based mathematical user interface
 - Provides recognition of free-hand equations using arbitrary mathematical symbols, as well as geometric sketching and uninterpreted drawing.
- 1999-date **MathML Tools** Principal architect, implementation by postdocs and staff at UWO
1996-2001 **MathML Standard** Principal co-author with 9 other members of W3C working group
- Developed MathML, the standard for representing mathematical expressions on the World Wide Web and in digital libraries.
Personally contributed HTML-native strategy (became XML) and the separation of notation and semantic markup
 - Developed a suite of tools for manipulating MathML, including
 - conversion of MathML to and from \TeX (preserving implicit semantics)
 - Graphical notation selection tools
 - Modular XML Schemas for MathML
 - XSLT stylesheets for rendering Content MathML
 - Mathematical handwriting recognition
- 1990-date **The ALDOR Programming Language and Compiler**
Principal architect
Implementation with colleagues at IBM, NAG, INRIA and elsewhere
- This has been an approximately 45 man-year effort, starting from pure research and leading to some 250,000 lines of product-level code for the compiler and 250,000 lines for program libraries
 - Known as A^\sharp during development at IBM, and *AXIOM-XL* initially at NAG
 - 1994: First release of Aldor by NAG incorporated in Axiom release 2.0
 - 2002: First release by `Aldor.org` as independent software package
 - 2007: Open source release by `Aldor.org`
- 1991 **The FORTDIFF Package for Automatic Differentiation**
Principal architect, with R.D. Jenks at IBM Research
- A system to analyze Fortran programs and augment them with analytic derivatives
 - Used by IBM Burlington to optimize circuit simulations
- 1984-1991 **AXIOM Computer Algebra System**
with R.D. Jenks, B.M. Trager and R.S. Sutor at IBM Research
- Co-developed IBM's research system, as Scratchpad II
 - Commercialized by NAG Ltd. (Oxford), as AXIOM
- 1997-date **MAPLE Computer Algebra System**
1980-1984 with K.O. Geddes, G.H. Gonnet and later others at U. Waterloo
- Participated from the outset as one of the original authors of Maple
 - Director of largest research center contributing to Maple
 - Maple is now one of the leading commercial packages in this area with over 3,000,000 users (see Technology Transfer)

8 Invited Presentations

8.1 Keynote, Plenary and Other Invited Conference Presentations

2011

- ⟨1⟩ *Keynote presentation (title TBA)*, 4th International Workshop on Symbolic-Numeric Computation (SNC 2011), San Jose, California, 7-9 June 2011.

2010

- ⟨2⟩ *The Mathematics of Mathematical Handwriting Recognition*, 12th International Symposium on Symbolic and Numeric Algorithms for Scientific Computation (SYNASC 2010), Timișoara, Romania, 23-26 September 2010.

2009

- ⟨3⟩ *On the Future of Computer Algebra Systems at the Threshold of 2010*, Mathematical Aspects of Computer and Information Sciences (MACIS 2009), Software Science Session, Fukuoka, Japan, 14-17 December 2009.
- ⟨4⟩ *Symbolic Symbolic Computation*, Tunisia-Japan Workshop on Symbolic Computation in Software Science, Gammarth, Tunisia, 22-24 September 2009.
- ⟨5⟩ *On the Mathematics of Calligraphy*, International Conference On Mathematics Mechanization – In honor of professor Wen-Tsun Wu’s ninetieth birthday, Key Laboratory of Mathematics Mechanization, Chinese Academy of Sciences, Beijing, China, 11-13 May 2009.
- ⟨6⟩ *Algorithms for the Functional Decomposition of Symbolic Polynomials*, Polynomial Computer Algebra 2009, Steklov and Euler International Mathematics Institutes, St Petersburg, Russia, 8-12 April 2009.
- ⟨7⟩ *The Spectacular Successes and Failures of Symbolic Computation (Panel Session)*, NSF Workshop on Future Directions of Symbolic Computation Research and Their Applications to Domain Science, University of Rhode Island, 1 May 2009.
- ⟨8⟩ *Dependent Types, Multi-Sorted Algebras and Categorical Programming*, Applied Computational Category Theory 2009, York, England, 22 March 2009.

2008

- ⟨9⟩ *How to Work with Polynomials of Symbolic Degree*, International Conference on Applications of Computer Algebra (ACA 2008), RISC, Castle of Hagenberg, Austria, 27-30 July 2008.
- ⟨10⟩ *New Algorithms for Symbolic Polynomials*, Second Chinese SALSA Workshop, Beihang University, Beijing, China, 25-27 April 2008.

2007

- ⟨11⟩ *The Role of Categorical Languages*, NSF CDI Workshop on the Role of Symbolic, Numeric and Algebraic Computation in Cyber-Enabled Discovery and Innovation, National Science Foundation, Arlington VA, USA, 30-31 October 2007.
- ⟨12⟩ *Respecting Implicit Semantics in Mathematical Markup*, ICIAM Session on Web Mathematics, Zurich, Switzerland, 16-20 July 2007.
- ⟨13⟩ *InkML and Mathematics*, 8th OpenMath Meeting, Schloss Hagenberg, Austria, 26 Jun 2007.
- ⟨14⟩ *Computer Algebra: What is it Now and What Should it be Tomorrow? (Invited Panelist)*, East Coast Computer Algebra Day, Washington College, Chesterwown MD USA, 21 April 2007.
- ⟨15⟩ *Type Categories and Mathematical Categories in Aldor*, Applied and Computational Category Theory 2007 (ACCAT 2007), Braga, Portugal, 25 March 2007.

2006

- ⟨16⟩ *Mathematics on the Web Roundtable*, International Conference on Digital Typography & Electronic Publishing (TUG 2006), Marrakech, Morocco, 11 Nov 2006.
- ⟨17⟩ *Improving Pen-Based Mathematical Interfaces*, 8th International Symposium on Symbolic and Numeric Algorithms for Scientific Computation (SYNASC 2006), Timișoara, Romania, 28 September 2006.

- ⟨18⟩ *Algorithms for Symbolic Polynomials*, Computer Algebra in Scientific Computing 2006 (CASC 2006), Chişinău, Moldova, 12 September 2006.
- ⟨19⟩ *Using tomorrow's technology today: Manuel Bronstein's work with computer algebra software*, CAFE, Computer Algebra and Functional Equations: An international conference, in memory of Manuel Bronstein (CAFE 2006), Sophia Antipolis, France, 13 July 2006.
- ⟨20⟩ *Two Families of Algorithms for Symbolic Polynomials*, Challenges in Symbolic Computation Software, Schloss Dagstuhl Seminar, Wadern Germany, 2 July 2006.
- ⟨21⟩ *Making Computer Algebra More Symbolic*, Transgressive Computing 2006: A conference in honor of Jean Della Dora (TC 2006), Granada, Spain, 16 April 2006.

2000-2005

- ⟨22⟩ *InkML*, Special Session — International Conference on Document Analysis and Recognition, Seoul, South Korea, 31 Aug 2005.
- ⟨23⟩ *A Context for Pen-Based Mathematical Computing*, Internet Accessible Mathematical Computation (IAMC 2005), Beijing, China, 24 July 2005.
- ⟨24⟩ *The Road Between Symbolic and Numeric Computing (after dinner talk)*, International Workshop on Symbolic-Numeric Computation (SNC 2005), Xi'an, China, 20 July 2005.
- ⟨25⟩ *Optimizing Compilation for Symbolic-Numeric Computing*, 6th International Symposium on Symbolic and Numeric Algorithms for Scientific Computation (SYNASC 2004), Timișoara, Romania, 27 Sept 2004.
- ⟨26⟩ *Strategies for Pen-Based Mathematics*, IMACS Applications of Computer Algebra conference (ACA 2004), Beaumont Texas, USA, 23 July 2004.
- ⟨27⟩ *The Role of OpenMath in High-Level Semantic Correspondences for Mathematics*, 10 Years of OpenMath conference, Helsinki, Finland, 22 May 2004.
- ⟨28⟩ *The History of Computer Algebra in Waterloo (after dinner talk)*, East Coast Computer Algebra Day, Waterloo, Canada, 8 May 2004.
- ⟨29⟩ *Interfaces for Mathematical Components*, Future of Scientific Computing, CCNY, New York, 30 Apr 2004.
- ⟨30⟩ *Foundations in Computer Algebra (after dinner talk)*, ISSAC 2003, Philadelphia, USA, 5 Aug 2003.
- ⟨31⟩ *A Study in the Integration of Computer Algebra Systems*, International Congress of Mathematical Software, Beijing, China, 19 Aug 2002.
- ⟨32⟩ *What Lies Ahead for Symbolic Mathematics Systems?*, Plenary presentation, Maple Summer Workshop 2002, Waterloo, Canada, 29 Jul 2002.
- ⟨33⟩ *Mathematical Communication and the Web*, Algebraic Computing in Algebra, Analysis and Geometry Summer School, Santander, Spain, 5 Jul 2002.
- ⟨34⟩ *Algebraic Computing with Generics [Aldor]*, Algebraic Computing in Algebra, Analysis and Geometry Summer School, Santander, Spain, 4 Jul 2002.
- ⟨35⟩ *Semantics-Preserving Transformations for Mathematical Markup*, OpenMath Thematic Network Workshop, Nice, France, 2 Mar 2002.
- ⟨36⟩ *Aldor: The language and recent directions*, Plenary presentation, Workshop on Future Directions in Categorical Programming Languages, London, Canada, 26 Jul 2001.
- ⟨37⟩ *Computer Algebra Systems for the Next Decade*, Plenary presentation, ISSAC 2001, London Canada, 24 July 2001.
- ⟨38⟩ *Choices in Building Computer Algebra Systems*, Plenary presentation, COCOA VII Conference, Kingston Canada, 20 July 2001.
- ⟨39⟩ *What is MathML and Why Should I Care?*, Symbolic Linear Algebra Conference, Rabat, Morocco, 30 May 2001.
- ⟨40⟩ *Automatic Differentiation and Symbolic-Numeric Algorithms for Polynomials*, Plenary presentation, AD 2000 Conference, Nice, France, 21 Jun 2000.

1990–1999

- ⟨41⟩ *Software for integrating symbolic and numeric computation*, ICIAM 1999 Minisymposium on Integrating Symbolic and Numeric Computations, Edinburgh, Scotland, 9 Jul 1999.
- ⟨42⟩ *Stylesheets for Mathematical Web Pages*, IMACS ACA Minisymposium on Mathematics on the Internet, El Escorial, Spain, 26 Jun 1999.
- ⟨43⟩ *Software Architectures for Mathematical Structures*, Plenary presentation, Conference on Technology in Mathematics Education at the Secondary and Tertiary Levels, Brock University, St Catharines, Canada, 4 Jun 1999.
- ⟨44⟩ *On Approximate Polynomial Factorization*, SIAM 1998 Minisymposium on Symbolic-Numeric Algorithms for Polynomials, Toronto, Canada, 16 Jul 1998.
- ⟨45⟩ *Preconditioning nonlinear constraint systems with Groebner bases*, Workshop on Computer Algebra in Industry, The Fields Institute for Research in Mathematical Sciences, Toronto, Canada, 10 Mar 1998.
- ⟨46⟩ *Computer Algebra Systems*, Plenary presentation, COCOA V Conference on Computational Commutative Algebra, Herstmonceaux Castle, East Sussex, England, 2 Jun 1997.
- ⟨47⟩ *Introduction to the FRISCO Project*, FRISCO 1997 Open Workshop, Sophia Antipolis, France, 18 Mar 1997.
- ⟨48⟩ *Introduction to the FRISCO Project*, FRISCO Open Workshop on The Needs of Industry in Polynomial System Solving, Addlink, Barcelona, Spain, 23 Oct 1996.
- ⟨49⟩ *Motivations in the Design of Aldor*, Computer Algebra Workshop, INFORMATIK'96 (Joint annual meeting of German GI and Austrian CG), Klagenfurt, Austria, 24 Sep 1996.
- ⟨50⟩ *Le typage en Calcul Formel*, Seminaire “Esquisses et Calcul Formel” PRC/GDR AMI, Université Paris 7, France, 20 Jun 1996.
- ⟨51⟩ *Systems Issues in Computer Algebra – Past, Present and Future*, Maths for Information Technology national meeting, Computing Laboratory, Oxford, England, 16 Apr 1996.
- ⟨52⟩ *The A[#] Programming Language: Reconstructing an Algebra System from Elementary Particles*, German Axiom Users' Group Meeting, U. Karlsruhe, Germany, 21 Mar 1996.
- ⟨53⟩ *Programming Language Support For Memory Management*, Workshop on Computer Algebra Software, Schloss Dagstuhl, Wadern, Germany, 6 Feb 1996.
- ⟨54⟩ *What's In A Name?*, Colloquium on Languages and Interfaces for Mathematical Software — NAG Annual General Meeting, Wolfson Building, Oxford, England, 29 Sept 1995.
- ⟨55⟩ *The A[#] Programming Language and Its Compiler*, Workshop on Computational Conformal Geometry, Iraklion, Crete, 12 June 1995.
- ⟨56⟩ *The Five W-s of Symbolic/Numeric Computation*, Plenary presentation, 1995 East Coast Computer Algebra Day, Newark, Delaware, 8 Apr 1995.
- ⟨57⟩ *The State of the A[#] Compiler*, POSSO Workshop on Software, Paris, France, 4 Mar 1995.
- ⟨58⟩ *A[#] Programming Language Workshop*, Full day short-course, with Broadbery, Dooley and Steinbach. Workshop for New Technology for Symbolic Computational Mathematics and Applications in Research and Education, CAIP Center, Rutgers University, New Jersey, 10 Jun 94.
- ⟨59⟩ *The A[#] Programming Language and Its Compiler*, Workshop on Computational Group Theory, Geometry Center, Univerisy of Minnesota, 4 Jan 1994.
- ⟨60⟩ *The A[#] Programming Language and its Compiler*, Journées Axiom Meeting, Paris, France, 26 Oct 1993.
- ⟨61⟩ *The A[#] Programming Language and its Compiler*, Workshop on Application-Specific Symbolic Techniques in High Performance Computing Environments, Fields Institute for Research in Mathematical Sciences, Waterloo, Canada, 17 Oct 1993.
- ⟨62⟩ *Axiom and A[#]: Computer Algebra with Abstract Datatypes*, Short course of three lectures. Second Brazilian School for Computer Algebra, National Laboratory for Scientific Computation (LNCC), Rio de Janeiro, Brazil, 22-23 Jul 1993.
- ⟨63⟩ *Algebraic Simplification for Computational Differentiation*, Theory Institute on Combinatorial Challenges in Computational Differentiation, Argonne National Laboratory, Illinois, 24 May 1993.

- ⟨64⟩ *The A[#] Programming Language and Its Compiler*, CATHODE ESPRIT Workshop, Han-sur-Lesse, Belgium, 22 Mar 1993.
- ⟨65⟩ *Programming Structures for Symbolic Computation*, Plenary Presentation, IBM Europe Institute, Oberlech, Austria, 30 Jul 1991.

1980–1989

- ⟨66⟩ *The Scratchpad System for Computer Algebra*, Gesellschaft für Informatik Meeting, Munich, Germany, Nov 1989.
- ⟨67⟩ *Structures for Computational Algebra in Scratchpad*, Special session on Computational Algebra, AMS Meeting, Hoboken, New Jersey, 21 Oct 1989.
- ⟨68⟩ *Using Scratchpad for Differential Algebra*, Five day short course, with Trager and Bronstein. Institute for Mathematics and its Applications, Workshop on Symbolic Solution of Differential Equations, Minnesota, 26-30 Jun 1989.
- ⟨69⟩ *Domain Driven Expression Display in Scratchpad II*, Environments for Computational Mathematics, Special Interest Group Meeting, ACM SIGGRAPH Conference, Los Angeles, California, 30 Jul 1987.
- ⟨70⟩ *Techniques for Parallelism in Computer Algebra*, Workshop on Computer Algebra Systems (SMU/Los Alamos/TI), Dallas, Texas, 27 Feb 1987.
- ⟨71⟩ *Un cours intensif sur Scratchpad II*, Six lectures. Journées de Calcul Formel, Luminy, France, 2-6 Jun 1986.
- ⟨72⟩ *Scratchpad II – A new system for computer algebra*, IBM–CSRI Meeting, Computer Science Research Institute, University of Toronto, Canada, 25 Nov 1985.
- ⟨73⟩ *Collusion to Decrease Expected Execution Time*, Research Presentation, 2nd Annual General Meeting of the Institute for Computer Research, University of Waterloo, Canada, 2 May 1983.
- ⟨74⟩ *The Maple System for Computer Algebra*, Research Presentation, 1st Annual General Meeting of the Institute for Computer Research, University of Waterloo, Canada, 4 Nov 1982.

8.2 Invited Presentations at Universities and Other Organizations

2010

- ⟨75⟩ *The Mathematics of Mathematical Handwriting Recognition*, CARMA Colloquium, Dept of Mathematics, University of Newcastle, Australia, 16 October 2010.
- ⟨76⟩ *The Mathematics of Mathematical Handwriting Recognition*, Topical Research in Computer Science Seminar, University of Western Ontario, London, Canada, 15 Sept 2010.
- ⟨77⟩ *How to “Win” at University*, First Year Residence Program, University of Western Ontario, London, Canada, 31 March 2010.

2000–2009

- ⟨78⟩ *Algorithms for Symbolic Polynomials*, Colloquium, Mathematics Department, University of Western Ontario, Canada, 12 Nov 2009.
- ⟨79⟩ *Geometric Methods in Mathematical Handwriting Recognition*, Colloquium, Microsoft Development Center, Belgrade, Serbia, 1 Oct 2009.
- ⟨80⟩ *The Mathematics of Mathematical Handwriting Recognition*, Colloquium, Faculty of Computer Science, University of New Brunswick, Fredericton, Canada, 2 June 2009.
- ⟨81⟩ *Computer Algebra’s Deep, Dark Secrets (or Why Won’t Maple do this thing?!?)*, Maplesoft E-Symposium, Broadcast by Maplesoft, 15 Apr 2009.
- ⟨82⟩ *Pen-Based Computing*, Computer Science Undergraduate Society Day, University of Western Ontario, London, Canada, 7 Feb 2009.
- ⟨83⟩ *Computer Algebra’s Dirty Little Secret*, Topical Research in Computer Science Seminar, University of Western Ontario, London, Canada, 5 Nov 2008.

- ⟨84⟩ *Advances in Algorithms for Symbolic Polynomials*, Colloquium, Mathematics Department, North Carolina State University, 19 Mar 2008.
- ⟨85⟩ *Symbolic Polynomials and Symbolic Matrices – or – How two simple ideas make arithmetic possible*, Joint Lab Meeting, Maplesoft, Waterloo, Canada, 8 Feb 2008.
- ⟨86⟩ *Expression Analysis for Pen-Based Mathematical Interfaces*, Colloquium, CS and EE Departments, University Politehnica of Bucharest, 8 Sept 2006.
- ⟨87⟩ *A Context for Pen-Based Mathematical Computing*, Colloquium, Dept of Mathematics, University of Queensland, Brisbane Australia, 17 Feb 2006.
- ⟨88⟩ *A Context for Pen-Based Mathematical Computing*, Colloquium, Dept of Mathematics, University of Sydney, Sydney Australia, 16 Feb 2006.
- ⟨89⟩ *A Framework for Pen-Based Mathematical Computing*, Colloquium, Institute of Software, Chinese Academy of Sciences, Beijing, 28 Jul 2005.
- ⟨90⟩ *Strategies for Pen-Based Mathematics*, Computer Science Colloquium, Drexel University, Philadelphia, 13 Oct 2004.
- ⟨91⟩ *Compiling Aldor*, France Day Symposium, University of Western Ontario, 29 Jan 2004.
- ⟨92⟩ *Motivations in the Design of Aldor*, Colloquium, Institute for Systems Software, Chinese Academy of Sciences, Beijing, 27 Oct 2003.
- ⟨93⟩ *The Current Status of MathML and Math on the Web*, Colloquium, Mathematics Mechanization Research Institute, Chinese Academy of Sciences, Beijing, 24 Oct 2003.
- ⟨94⟩ *The Current Status of MathML and Math on the Web*, CoLab Talk, Department of Mathematics, Simon Fraser University, Canada, 22 Aug 2003.
- ⟨95⟩ *What is MathML and Why Should We Care?*, Mathematics Colloquium, North Carolina State University, 11 Feb 2002.
- ⟨96⟩ *What is MathML and Why Should I Care?*, Dept of Applied Mathematics Colloquium, University of Western Ontario, 13 Feb 2001.
- ⟨97⟩ *Aldor: The language and recent directions*, INRIA, Sophia Antipolis, France, 15 Jun 2000.

1990–1999

- ⟨98⟩ *Computer Algebra Systems: Past, Present and Future*, Mathematical Sciences Interdepartmental Colloquium, University of Western Ontario, London, Canada, 10 Feb 98.
- ⟨99⟩ *Lessons in Language Design: What A[#] can teach Java*, Computer Science Open House, IBM Research, Hawthorne, New York, 7 Jan 97.
- ⟨100⟩ *Motivations in the Design of Aldor*, Computer Science Colloquium, University of Western Ontario, London, Ontario, Canada, 4 Nov 96.
- ⟨101⟩ *The Role of the Chef in French Science*, Math Tea, IBM T.J. Watson Research Center, Yorktown Heights, New York, 17 Oct 96.
- ⟨102⟩ *The A[#] Programming Language: Reconstructing an Algebra System from Elementary Particles*, Seminar, CERN, Geneva, Switzerland, 12 Jul 96.
- ⟨103⟩ *The A[#] Programming Language: Reconstructing an Algebra System from Elementary Particles*, Computer Algebra Colloquium, GMD, Bonn, Germany, 9 Apr 96.
- ⟨104⟩ *Inside The A[#] Compiler*, Computer Algebra Seminar, ETH Zurich, Switzerland, 6 Dec 95.
- ⟨105⟩ *The State of the A[#] Compiler*, SAFIR Seminar, INRIA Sophia-Antipolis, France, 24 Mar 95.
- ⟨106⟩ *The A[#] Programming Language and Its Compiler*, Computer Science Colloquium, Rensselaer Polytechnic Institute, Troy, New York, 1 Dec 94.
- ⟨107⟩ *The A[#] Programming Language, Its Compiler, and Prospects for Parallel Programs*, Algorithms Seminar, Department of Computer and Information Sciences, University of Delaware, Newark, Delaware, 24 Oct 94.
- ⟨108⟩ *Optimizing A Very High Level Language for Scientific Computation*, High Performance Computing Colloquium, National Laboratory for Scientific Computation (LNCC), Rio de Janeiro, Brazil, 21 Jul 93.

- ⟨109⟩ *The A[#] Programming Language and Its Compiler*, Numerical Algorithms Group, Limited, Oxford, England, 18 Mar 93.
- ⟨110⟩ *The A[#] Programming Language and Its Compiler*, Supercomputer Computation Research Institute Colloquium, Florida State University, Tallahassee, 17 Jan 93.
- ⟨111⟩ *Axiom's Programming Language and Compiler*, Computer Science Colloquium, Rensselaer Polytechnic Institute, Troy, New York, 6 Nov 92.
- ⟨112⟩ *Designs for Symbolic Computation*, Computer Science Colloquium, Drexel University, Philadelphia, 8 Nov 91.

1980–1989

- ⟨113⟩ *The Scratchpad System for Algorithmic Mathematics*, Colloquium, Oak Ridge National Laboratory, Tennessee, 19 May 89.
- ⟨114⟩ *The Scratchpad II System for Algorithmic Mathematics*, Colloquium, Gesellschaft für Mathematik und Datenverarbeitung, Bonn, Germany, 15 Nov 88.
- ⟨115⟩ *The Scratchpad II Type System*, Computer Science Colloquium, Rensselaer Polytechnic Institute, Troy, New York, 29 Oct 87.
- ⟨116⟩ *Techniques for Parallelism in Computer Algebra*, Parallel Processing Seminar, Bolt, Baranek and Neumann, Cambridge, Massachusetts, 26 Jun 87.
- ⟨117⟩ *A Short Course on Scratchpad II*, Six lectures. Institute for Computer Research, University of Waterloo, Canada, 20-22 May 87.
- ⟨118⟩ *Techniques for Parallelism in Computer Algebra*, Computer Science Seminar, Southern Methodist University, Texas, 27 Feb 87.
- ⟨119⟩ *Multiple Views and Multiple Inheritance in Scratchpad II*, Programming Languages Seminar, IBM T.J. Watson Research Center, Hawthorne, New York, 16 Jan 87.
- ⟨120⟩ *The Scratchpad II Abstract Datatype Language and System*, Computer Science Colloquium, IBM T.J. Watson Research Center, Hawthorne, New York, 18 Dec 86.
- ⟨121⟩ *Scratchpad II – Un nouveau système de calcul formel*, Colloquium, IBM Paris Scientific Center, France, 30 May 86.
- ⟨122⟩ *Programming Language Aspects of Scratchpad II*, Colloquium, City University of New York Graduate Center, New York, 22 Apr 86.
- ⟨123⟩ *A System for Parallel Computer Algebra Programs*, Colloquium, Xerox PARC Computer Science Lab, Palo Alto, California, 25 Mar 85.
- ⟨124⟩ *The Maple System for Computer Algebra*, Colloquium, University of New Brunswick, Canada, 11 Apr 83.

9 Research Grants

9.1 Grants since 1995 over \$ 1,000,000

- 2002-2004 *MONET: Mathematics on the Internet*
 ESPRIT Fifth Framework, IST-2001-34145
- Euro 1,000,000
 - Personal Role: UWO Principal Investigator
 - Partners: Numerical Algorithms Group Ltd (UK), U. Bath (UK), U. Western Ontario (CA), Stilo Technology Ltd (UK), U. Manchester (UK), TU Eindhoven (NL), U. Nice (FR)
 - The European funds cannot be spent in Canada
 - Overall goal: To develop a software architecture and tools for semantically meaningful interactions involving mathematics on the web
- 1999-2004 *Ontario Research Centre for Computer Algebra*
 Ontario Research and Development Challenge Fund
- CAD 1,540,000 over 4 years to build centre (Total budget CAD 4,600,000 over 4 years)
 - Personal Role: Principal Investigator and Director of the centre
 - Partners: U. Western Ontario, U. Waterloo, Waterloo Maple Inc. (six investigators)
 - Supports building renovations, two research chairs, several junior positions, travel and equipment
- 1998-2003 *Collaborative Research and Development Grant*
 Natural Sciences and Engineering Research Council (Canada)
- CAD 2,300,000 from NSERC and WMI
 - Personal Role: UWO Principal Investigator
 - Partners: U. Waterloo, U. Western Ontario, Waterloo Maple Inc. (five investigators)
 - Supports research in computer algebra in areas of mutual interest to the partners
- 1996-1999 *OpenMath: Accessing and Using Mathematical Information Electronically*
 ESPRIT Fourth Framework, Multimedia Standards 24.969
- European Union grant of 1,700,000 Euro (\approx CAD 2,600,000), with partial matching funds for global three year budget of 2,900,000 Euro (\approx CAD 4,500,000)
 - Personal Role: Formed consortium and secured funding (together with other principals). INRIA Principal Investigator until 1997, when moved to UWO
 - Partners: INRIA (F), NAG Ltd (UK), Springer Verlag (G), RIACA (NL), and five associate partners
- 1996-1999 *FRISCO: A Framework for Integrated Symbolic-Numeric Computation*
 ESPRIT Fourth Framework, Long Term Research 21.024
- European Union grant of 1,630,000 Euro (\approx CAD 2,500,000), with partial matching funds for global three year budget of 2,600,000 Euro (\approx CAD 4,000,000)
 - Personal role: INRIA Principal Investigator and Chairman of Consortium
 - Partners: CNRS (F), INRIA (F), NAG Limited (UK), U. Cantabria (E), U. Pisa (I)
 - Overall goal: To deliver highly efficient and versatile polynomial system solvers in state of the art scientific software.

9.2 Grants since 1995 under \$ 1,000,000

- 2007-2012 *The Domain of Computer Algebra* NSERC (Canada)
- CAD 142,500 over 5 years
- 2007-2009 *Mathematics of Computer Algebra and Analysis* MITACS Networks of Centres of Excellence
- MITACS: CAD 274,000 over two years (CAD 68,000 U Western Ontario)
 - Maplesoft: CAD 200,000 over two years (CAD 50,000 U Western Ontario)
 - Principal Investigators: M. Monagan (SFU), G. Labahn (Waterloo), S. Watt (UWO).
Co-investigators at SFU, UW, UWO.
 - In both years two additional student internships are awarded.
- 2007 *Symbolic-Numeric and Parallel Symbolic Computing Conferences*
MITACS Network of Centres of Excellence and the Fields Institute
- MITACS: CAD 6,000
 - Fields: CAD 6,000
 - Co-principals: M. Moreno Maza, S. Watt
- 2004-2008 *Pen-Based Mathematics for the Tablet PC* Microsoft Canada
- CAD 758,000 over four years
 - Principal Investigators: G. Labahn (Waterloo), S. Watt (UWO)
- 2005-2007 *Mathematics of Computer Algebra and Analysis* MITACS Networks of Centres of Excellence
- MITACS: CAD 310,000 over two years (CAD 77,500 U Western Ontario)
 - Maplesoft: CAD 200,000 over two years (CAD 50,000 U Western Ontario)
 - Principal Investigators: P. Borwein (SFU), M. Giesbrecht (Waterloo), S. Watt (UWO).
Co-investigators at SFU, UW, UWO, Calgary, Dalhousie, McMaster, UQàM.
 - In both years one additional student internship (CAD 45,000) was awarded.
- 2004 *Synergy Award for Innovation* NSERC (Canada)
- CAD 25,000
 - Awarded to ORCCA for collaboration with Maplesoft
- 2004 *IAMC Workshop Grant* Consejería de Educacion, Gobierno de Cantabria
- CAD 3230
- 2003-2004 *CA:MONET Canadian Mathematics on the Net* CANARIE
- CAD 200,000 over one year
- 2003-2005 *Mathematics of Computer Algebra and Analysis* MITACS Networks of Centres of Excellence
- MITACS: CAD 400,000 over two years (CAD 100,000 U Western Ontario)
 - Maplesoft: CAD 254,000 over two years (CAD 127,000 U Western Ontario)
 - Principal Investigators: P. Borwein (SFU), M. Giesbrecht (Waterloo), S. Watt (UWO).
Co-investigators at SFU, UW, UWO, Calgary, McMaster, UQàM.
- 2002-2006 *Compiler Middleware for optimizing evolving programming languages*
NSERC (Canada) Strategic Project
- CAD 651,520 over four years
 - Principal Investigator: S. Watt. Co-investigators: M. Giesbrecht, M. Moreno Maza
- 2002-2007 *Programming Languages and Computer Algebra* NSERC (Canada)
- CAD 155,000 over five years
- 2001 *Workshop on Future Directions for Categorical Programming Languages*
The Fields Institute for Research in Mathematical Sciences
- CAD 3,000

- 2000-2003 *Travel Grant* French Embassy (Ottawa, Canada)
- Research travel to INRIA Sophia Antipolis: 2000 CAD 1 400, 2001 CAD 2 179, 2002 CAD 2 032 (1 299 Euro), 2003 CAD 2 700
- 2000 *Symbolic Computation Server* NSERC Equipment Grant
- CAD 40,461 to purchase a large memory computation server
 - with M. Giesbrecht (PI), R. Corless, D. Jeffrey, G. Reid
 - No 1 ranked equipment grant in the NSERC 2000 competition in Computer Science
- 1999-2003 *Generally Applicable Programming Language Constructs Motivated by Symbolic Mathematical Computation*
Premier's Research Excellence Award, Province of Ontario
- CAD 150,000 over three years for research staff
 - Award based on individual merit and research track record
- 1999-2001 *Symbolic Analysis* MITACS Networks of Centres of Excellence Grant
- UWO budget CAD 65,000 over two years (three investigators)
 - Personal Role: UWO Co-Principal Investigator
 - Partners: Simon Fraser U., UWO, UBC, U. Calgary, UQàM, Waterloo Maple Inc.
- 1998-2002 *Programming Language Support for Symbolic Mathematical Computation*
Natural Science and Engineering Research Council (Canada)
- CAD 110,000 over four years
- 1997-1999 *Faculty of Science Start-up Grant* University of Western Ontario
- CAD 35,000 individual start-up grant
- 1996 *Study of automatic differentiation for optics* ESSILOR Corporation
- Four month budget: 100,000 FF \approx 18,000 US \$
 - Personal role: scientific director
 - Overall goal: Optimize graduated focus lenses using automatic differentiation

10 Technology Transfer

- 2001-date *Aldor.org*
with colleagues at NAG, INRIA and UWO
- Free public release of an optimizing compiler for the Aldor programming language
- 1999-date *Ontario Research Centre for Computer Algebra*
with colleagues at U Western Ontario and U Waterloo
- University laboratory provides mathematical algorithms under research contract to Maplesoft inc.
- 1991-2001 *Numerical Algorithms Group, Ltd*
with colleagues at IBM
- Taking a research computer algebra system, Scratchpad II, to a commercial product, Axiom.
- 1996 *SAFIR Project*
with colleagues at INRIA
- Oversaw various industrial contracts (from US \$20,000-\$100,000 equiv.):
Aerospatiale, Dassault, Électricité de France, etc.
 - Use of Odyssee for automatic differentiation in industry.
 - Solution of non-linear equations in industrial problems (FRISCO):
integration of PoSSo library in ILog Solver.
- 1991 *Automatic Differentiation for Circuit Simulation*
S.M. Watt, R.D. Jenks, B. Grossman (IBM)
- Applied computer algebra techniques to automatic differentiation to improve IBM Burlington's device simulation by an order of magnitude.
 - This is being used to test new integrated circuit technologies before manufacture.
 - Yields US \$1,000,000/month savings to IBM Burlington
 - Awarded 2 US Patents
- 1988-date *Waterloo Maple Inc.*
Co-founded with G.H. Gonnet, K.O. Geddes, et. al.
- Incorporated to disseminate computer algebra software.
 - Served as Director from 1998 to 2009, when we sold the company.
- 1987 *Symbolic Computation for Error Correcting Codes*
M. Hassner, W.H. Burge, S.M. Watt (IBM)
- Developed error correcting codes based on elliptic ϑ -series
 - Derived technology now incorporated in IBM BlueJay disk controller hardware.

11 Teaching Philosophy

Written in response to an anonymous student nomination for the Award of Excellence in Undergraduate Teaching sponsored by the Western Alumni Association, University Student's Council and Bank of Nova Scotia.
November 1, 2004

After returning from a study/research leave, I found that my approach to teaching had changed significantly.

I used to be concerned with covering a certain amount of material in each lecture, and on what the “take home message” should be for each class. Now I am principally concerned with the questions “Why is this interesting?” and “How will this help me?” from the students’ point of view. Unless these questions are answered, then who cares what the take-home message is?

So, what I hope to accomplish when I step into one of my classrooms is:

- to bring the subject to life and kindle the students’ *desire* to learn it
- to keep attuned to the class to make sure that learning is actually happening right there on the spot.

Unless learning is happening, you are not teaching!

12 Program Development

Sep’97-Dec’04

Department of Computer Science, University of Western Ontario

Together with colleagues in the department and other faculties, led or oversaw the creation of the following degree programs or specializations at the University of Western Ontario:

- Combined Honors BSc/LLB Computer Science and Law Program
- Four-Year Honors BSc Computer Science with Software Engineering Specialization
- Four-Year General BSc Computer Science with Software Engineering Specialization
- Four-Year Honors BA Computer Science and Media, Information and Technoculture
- Four-Year General BA in Computer Science and Media, Information and Technoculture
- Four-Year General BACS Administrative and Commercial Studies and Computer Science
- Four-Year BSc Honors Computer Science with Bioinformatics Specialization
- Four-Year BSc Honors Applied Quantitative Information Technology (AQIT) Program
- Minor in Computer Algebra

13 Courses Taught

13.1 Courses at the University of Western Ontario, Canada

All courses developed from scratch, except CS 211 and CS 390.

- Sep'10-Dec'10 *CS 9883 Topics in Digital Ink and Handwriting Recognition (once)*
Department of Computer Science, University of Western Ontario
- Sep'07-Dec'10 *CS 1025 [formerly 025] Computer Science Fundamentals I (four times)*
Department of Computer Science, University of Western Ontario
- Volunteered to teach advanced first year course to encourage CS enrollments.
 - Teacher rating by students: 6.2/7, 6.3/7, 6.3/7 (fall 2010 not yet rated)
- Sep'05-Dec'10 *CS 4447/9545 [formerly 447/545] Compiler Theory (five times)*
Department of Computer Science, University of Western Ontario
- Teacher rating by students: 6.0/7, 6.7/7, (other years not rated due to small class size)
 - Developed a “teaching compiler” for C written in Java for students to extend.
- Jan'98-Dec'10 *CS 9888 [formerly 888] Topics in Programming Languages and Their Implementation (eleven times)*
Department of Computer Science, University of Western Ontario
- Jan'00-Apr'07 *CS 342 Organization of Programming Languages (six times) [34-137 students, avg 65]*
Department of Computer Science, University of Western Ontario
- Teacher rating by students: 6.4/7, 5.3/7, 5.9/7 (most recent 3 years)
 - Developed 500 pages typeset notes
- Sep'04-Dec'04 *CS 211 Software Tools and Systems Programming [90 students]*
Department of Computer Science, University of Western Ontario
- Teacher rating by students: 5.5/7
- Sept'01-Dec'01 *AM 475/563 Applications of Computer Algebra*
Department of Applied Mathematics, University of Western Ontario
- Co-taught with Profs. Corless, Jeffrey, Reid
 - Teacher rating by students: 5.5/7
- Sept'99-Apr'00 *CS 827 Research Seminars in Computer Algebra*
Department of Computer Science, University of Western Ontario
- Co-taught with Profs. Corless and Giesbrecht
- Sept'98-Apr'01 *CS 422/539 Numerical Computing II: Foundations of Computer Algebra (twice)*
Department of Computer Science, University of Western Ontario
- Co-taught with Profs. Corless and Giesbrecht
- Sept'98-Dec'98 *CS 825a The Implications of Moore's Law*
Department of Computer Science, University of Western Ontario (Graduate level)
- Sep'97-Dec'98 *CS 390 Industrial Internship (four times)*
Department of Computer Science, University of Western Ontario

13.2 Courses at the Université de Nice–Sophia Antipolis, France

	All courses developed from scratch, except “Algorithms and Programming”
Jan’96-May’96	<i>Advanced Methods in Computer Algebra Systems</i> DEA Math, University of Nice-Sophia Antipolis (Graduate level)
Nov’95-May’96	<i>M4. Code Generation and Optimization</i> Maitrise Informatique, University of Nice-Sophia Antipolis (Senior level)
Nov’95-Jan’96	<i>L2. Fundamental Programming — C++</i> Licence Informatique, University of Nice-Sophia Antipolis (Junior level)
Nov’95-May’96	<i>Algorithms and Programming</i> DEUG Math-Info, University of Nice-Sophia Antipolis (Freshman level)
Nov’95	<i>Large-Scale Industrial Software</i> DEUG Common Trunk, University of Nice-Sophia Antipolis (Freshman level)

13.3 Courses at the University of Waterloo, Canada

May’84-Aug’84	<i>CS 369/569: Switching Theory and Digital Networks (twice)</i>
Jan’82-Apr’82	University of Waterloo, Dept. of Computer Science
May’84-Aug’84	<i>CS371: Numerical Approximation</i> University of Waterloo, Dept. of Computer Science

13.4 Research-Level Minicourses

July 1-5 2002	<i>Computer Algebra Software</i> Summer school on Algebraic Computing in Algebra, Analysis and Geometry, U. Cantabria, Santander, Spain.
Sept 26-28 2000	<i>The Aldor Programming Language and the Implementation of Its Compiler</i> (with Martin Dunstan) Four day course at the Maxwell Institute, U. Edingurgh Scotland.
July 19 1994	<i>A[#] Programming Language Workshop</i> (with Broadbery and Dooley) One day course in conjunction with ISSAC 94, Oxford England.
June 10 1994	<i>A[#] Programming Language Workshop</i> (with Broadbery, Dooley and Steinbach) One day course within the Workshop for New Technology for Symbolic Computational Mathematics and Applications in Research and Education CAIP Center, Rutgers University
July 22-23 1993	<i>Axiom and A[#]: Computer Algebra with Abstract Datatypes</i> Second Brazilian School for Computer Algebra National Laboratory for Scientific Computation (LNCC), Rio de Janeiro, Brazil
June 26-30 1989	<i>Minicourse: Using Scratchpad for Differential Algebra</i> (with Bronstein and Trager) Workshop on Symbolic Solution of Differential Equations Institute for Mathematics and its Applications, Minnesota
May 20-22 1987	<i>A Short Course on Scratchpad II</i> Institute for Computer Research, University of Waterloo
June 2-6 1986	<i>Un cours intensif sur Scratchpad II</i> Journées de Calcul Formel, CIRM, Luminy France

14 Training of Highly Qualified Personnel

14.1 Postdoctoral Fellows

**Ontario Research Centre for Computer Algebra
Department of Computer Science, University of Western Ontario**

2008-2009	Oleg Golubitsky (Moscow State University, Russia), Mathematical Handwriting Recognition
2006-2007	Jeliazko Polihoronov (Florida State University, USA), Pen-based mathematical interfaces
2007	Laurentiu Dragan (U. Western Ontario, Canada), Compilers
2006-2007	Oleg Golubitsky (Moscow State University, Russia), Compilers and Computer Algebra
2006-2007	Ben Stephenson (U. Western Ontario, Canada), Compilers
2003-2007	Elena Smirnova (St Petersburg, Russia), Communication of Mathematical Data
2005-2006	Cosmin Oancea (U. Western Ontario, Canada), Compilers
2002-2003	Hiroshi Kai (Ehime U., Japan) [Joint with R. Corless], Symbolic-Numeric Algorithms
2002-2003	François Lemaire (U. Lille I) [Joint with G. Reid], Algebraic Algorithms
2001-2002	Lihong Zhi (U. Beijing) [Joint with R. Corless], Symbolic Numeric Algorithms
2000-2002	William Naylor (U. Bath), Communication of Mathematical Data
2000-2001	Arne Storjohann (ETH Zurich) [Joint with M. Giesbrecht], Symbolic Linear Algebra
1998-2001	Ilias Kotsireas (U. Paris VI) [Joint with R. Corless], Algebraic Algorithms

Projet SAFIR, INRIA Sophia Antipolis, France

1995-1996	Cristèle Faure (U. Nice), Automatic Differentiation
1995-1996	Nicole Rostaing (U. Nice), Automatic Differentiation

IBM T.J. Watson Research Center, Yorktown Heights, NY

1994	Theresa Gómez-Díaz (U. Limoges), Compilers
1993-1995	Pietro Iglio (U. Pisa), Compilers
1993	Gerald Baumgartner (Purdue U.), Compilers
1990	Knut Wolf (GMD), Compilers
1989	Florian Bundshuh (U. Karlsruhe), Compilers
1986-1987	Marc Gaëtano (U. Nice), Compilers

14.2 Research Assistants (full time)

2007-2008	Jeliazko Polihoronov (Florida State University, USA), Pen-based mathematical interfaces
2006-2007	Sandy Huerter (U. Western Ontario), Compilers
2005	Nathanael Brittain (U. Western Ontario), Compilers
2001-2004	Igor Rodionov (U. Western Ontario), MathML
2001-2002	Elena Smirnova (U. Paris XII, U. St Petersburg), MathML
2001-2002	Luca Padovani (U. Bologna), MathML

14.3 Doctoral Student Supervision

Current Doctoral Students

- 2010-date Pavel Bourdykine, *Topic: Compilers*
Department of Computer Science, University of Western Ontario
- 2010-date Rui Hu, *Topic: Pen-based mathematical interfaces*
Department of Computer Science, University of Western Ontario
- 2010-date Vadim Mazalov, *Topic: Pen-based mathematical interfaces*
Department of Computer Science, University of Western Ontario

Past Doctoral Students

- 2008-2009 Hospice Kokou Hougbo, *Topic: Pen-based mathematical interfaces (incomplete)*
Department of Computer Science, University of Western Ontario
- 2005-2009 Xin Li (*co-supervised with M. Moreno Maza*),
Thesis: "Toward High-performance Polynomial System Solvers Based on Triangular Decompositions"
Department of Computer Science, University of Western Ontario
- 2003-2008 Geoff Wozniak (*co-supervised with M. Daley*),
Thesis: "Structuring Data via Behavioural Synthesis"
Department of Computer Science, University of Western Ontario
- 2003-2007 Laurentiu Dragan,
Thesis: "On Measuring and Optimizing the Performance of Parametric Polymorphism"
Department of Computer Science, University of Western Ontario
- 2002-2007 Yuzhen Xie (*co-supervised with M. Moreno Maza*),
Thesis: "Fast Algorithms, Modular Methods, Parallel Approaches and Software Engineering for Solving Polynomial Systems Symbolically"
Department of Computer Science, University of Western Ontario
- 2001-2007 Xiaofang Xie, *Thesis: "On the Recognition of Handwritten Mathematical Symbols"*
Department of Computer Science, University of Western Ontario
- 2000-2005 Cosmin Oancea, *Thesis: "Parametric Polymorphism for Software Component Architectures and Related Optimizations"*
Department of Computer Science, University of Western Ontario
- 1997-2002 Yannis Chicha, *Thesis: "Practical Aspects of Interacting Garbage Collectors"*
Department of Computer Science, University of Western Ontario

14.4 Masters Student Supervision

Current Masters Students

- 2011 to start Abdullah Eid Almeahmadi
Department of Computer Science, University of Western Ontario
- 2011 to start Mona Saleh Alshehri
Department of Computer Science, University of Western Ontario
- 2009-date Andrew Chan,
Topic: Computer Holography
Department of Computer Science, University of Western Ontario

Past Masters Students

- 2009-2010 Vadim Mazalov, *Thesis: “Geometric Techniques for Digital Ink”*
Department of Computer Science, University of Western Ontario
- 2008-2010 Maria Teresa Infante Velazquez,
Thesis: “Metrics and Neatening of Handwritten Characters”
Department of Computer Science, University of Western Ontario
- 2008-2010 Rachita Mohan, *Thesis: “Uniform Treatment of Code and Data in the Web Setting”*
Department of Computer Science, University of Western Ontario
- 2008-2010 Nivedita Patil, *Thesis: “Interactive Computer Manipulation of Formal Sums”*
Department of Computer Science, University of Western Ontario
- 2008-2009 Rui Hu, *Thesis: “Portable Implementation of Digital Ink: Collaboration and Calligraphy”*
Department of Computer Science, University of Western Ontario
- 2008-2009 Pavel Bourdykine, *Thesis: “Type Safety without Objects in Java”*
Department of Computer Science, University of Western Ontario
- 2007-2009 Amit Regmi, *Thesis: “Supporting Multimodal Collaboration with Digital Ink and Audio”*
Department of Computer Science, University of Western Ontario
- 2006-2008 Birendra Keshari,
Thesis: “Techniques for Transformation and Exchange of Standardized Digital Ink”
Department of Computer Science, University of Western Ontario
- 2005-2007 Matthew Malenfant,
Thesis: “A Comparison of Two Families of Algorithms for Symbolic Polynomials”
Department of Computer Science, University of Western Ontario
- 2003-2007 Michael Lloyd, *Thesis: “Mapping Aldor Generics for Software Component Architectures”*
Department of Computer Science, University of Western Ontario
- 2004-2006 Songxin (Derek) Liang (*co-supervised with D. Jeffrey*),
Thesis: “A Rule-Based Component-Free Vector Algebra Package”
Department of Applied Mathematics, University of Western Ontario
- 2003-2005 Clare So, *Thesis: “An Analysis of Mathematical Expressions Used in Practice”*
Department of Computer Science, University of Western Ontario
- 2003-2004 Kevin Durdle, *Thesis: “Supporting Mathematical Handwriting Recognition through an Extended Digital Ink Framework”*
Department of Computer Science, University of Western Ontario
- 2002-2004 Xiaojie Wu, *Thesis: “Achieving Interoperability of Pen Computing among Heterogeneous Devices and Digital Ink Formats”*
Department of Computer Science, University of Western Ontario
- 2001-2003 Laurentiu Dragan, *Topic: Run time systems for generic programming languages*
Department of Computer Science, University of Western Ontario (transfer to PhD)
- 2001-2002 Yuzhen Xie, *Thesis: “A Family of Modular XML Schema for MathML”*
Department of Computer Science, University of Western Ontario
- 2000-2002 Huanling Lu
Thesis: “On Parameterized Polymorphism in Java: a NextGen compiler based on GJ”
Department of Computer Science, University of Western Ontario
- 2000-2002 Bo Wan, *Thesis: “Interactive Mathematical Handwriting Recognition for the Pocket PC”*
Department of Computer Science, University of Western Ontario

- 2000-2001 Xiaofang Xie (*co-supervised with R. Corless*)
Thesis: "Symbolic Circuit Analysis in Maple"
 Department of Applied Mathematics, University of Western Ontario
- 1999-2001 Igor Rodionov, *Thesis: "Tools for MathML"*
 Department of Computer Science, University of Western Ontario
- 1999-2001 Dicheng Liu (*co-supervised with R. Corless*)
Project: Notational Selection Tools for Mathematical Stylesheets
 Department of Computer Science, University of Western Ontario
- 1998-2001 Nabil Obeid, *Thesis: "On the Simplification of Symbolic Tensor Expressions"*
 Department of Computer Science, University of Western Ontario
- 1998-2000 Marc Tessier, *Converted to course-work Masters.*
 Department of Computer Science, University of Western Ontario
- 1998-1999 Xuehong Li, *Thesis: "XML and the Communication of Mathematical Objects"*
 Department of Computer Science, University of Western Ontario
- 1995-1996 *DEA Informatique: Yannis Chicha*
Thesis: "Animation of Functional Programs"
 Ecole Supérieure en Sciences Informatiques, Université de Nice–Sophia Antipolis
- 1995-1996 *DEA Informatique: Noël Arnous*
Thesis: "Progressive Scientific Visualization"
 Ecole Supérieure en Sciences Informatiques, Université de Nice–Sophia Antipolis

14.5 Undergraduate Student Supervision

Past Bachelor Students

- 2008-2009 *HBSc: Lisa Theng*
Topic: Representation of Calligraphy
 Department of Computer Science, University of Western Ontario
- 2005-2006 *HBSc: Matthew McLaughlin*
Topic: Collaborative digital ink (Incomplete)
 Department of Computer Science, University of Western Ontario
- 2005-2006 *HBSc: Steve Tetrault*
Topic: Software architecture (Incomplete)
 Department of Computer Science, University of Western Ontario
- 2002-2003 *HBSc: Clare So*
Thesis: "Implicit Grouping in Mathematical Expression Recognition"
 Department of Computer Science, University of Western Ontario
- 2002-2003 *HBSc: Michael Lloyd*
Thesis: "Server Support for Aldor Generics in GIDL"
 Department of Computer Science, University of Western Ontario
- 2002-2003 *HBSc: Susan Howey*
Thesis: "Fine Grained Parallel XML Markup for Music"
 Department of Computer Science, University of Western Ontario
- 2000-2001 *HBSc: Greg Collins*
Thesis: "An Improved Runtime System for Aldor"
 Department of Computer Science, University of Western Ontario

- 2000-2001 *HBSc*: Andrew Dennison
Thesis: “Representation of Fortran Programs in XML”
 Department of Computer Science, University of Western Ontario
- 1999-2000 *HBSc*: Arthur Louie
Thesis: “Handwriting Recognition for Mathematics using a CrossPad Device”
 Department of Applied Mathematics, University of Western Ontario
- 1998-1999 *HBSc*: Peter Huerter
Thesis: “A Floating Point Interval Arithmetic Optimization for the Aldor Compiler”
 Department of Computer Science, University of Western Ontario
- 1998-1999 *BSc*: Mark Phipps
Project: “Activity Monitor for Prevention of Repetitive Stress Injury”
 Department of Computer Science, University of Western Ontario
- 1997-1998 *HBSc*: Marc Incitti
Thesis: “Translation of TeX Math to MathML”
 Department of Computer Science, University of Western Ontario
- 1997-1998 *HBSc*: Eric Wright
Thesis: “Adaptive Graphing of Bivariate Real Functions”
 Department of Computer Science, University of Western Ontario

14.6 Summer Undergraduate Research Interns

University of Western Ontario

- 2010 Joseph Choi (NSERC USRA), Michael Friesen
- 2009 Michael Friesen (NSERC USRA), Srinadh Babu Navuru (IIT Guwahati)
- 2007 Pavel Bourdykine, Shankar Kaura
- 2005 Matt McLaughlin
- 2003 Michael Lloyd (NSERC USRA)
- 2003 Clare So (NSERC USRA)
- 2003 Kevin Durdle
- 2002 Michael Lloyd, Clare So
- 2001 Trevor Bruen (NSERC USRA)
- 2001 Greg Collins, James Millistver
- 2000 Trevor Bruen, Robert James, Arthur Louie
- 1999 Peter Huerter, James Miller (high school student), Igor Rodionov
- 1993-1995 12 Internship students at IBM from Bath, Berkeley $\times 3$, Cambridge, Cornell, NYU $\times 2$, Ohio State, Pisa, Princeton, Waterloo.

15 Outreach and Coaching

2009-date	<i>Coach</i> , UWO Programming Teams Prepared teams to participate in ACM International Collegiate Programming Contest Team ranks in North-Eastern North America region: 2010: Mustangs 19/112, Disciples 40/112 2009: Mustangs 32/113, Disciples 42/113
Apr 2010	<i>Outreach Presenter</i> , Matthews Hall School, London Ontario, Presentation <i>Bits and Bytes</i>
Mar 2010	<i>Speaker</i> , University of Western Ontario, Residence Education and Programs How to “Win” at University
2008-date	<i>Organizer</i> , Topical Research In Computer Science Seminar Series A bi-weekly series of general seminars aimed at grad students in computer science at UWO
Nov 2006	<i>Outreach Presenter</i> , University Labs School, London Ontario, Presentation <i>Bits and Bytes</i>
2000-2003	<i>Team Canada Selection Committee</i> (Youth Science Foundation) Selected the team to represent Canada at international science fairs
1997-2002	Organized Computer Science Department’s outreach strategy
May 2000	<i>Judge</i> , Canada Wide Science Fair
1991-1993	<i>Organizer</i> , NSF Young Scholars Program Day Conferences at IBM T.J. Watson Research Center Presentations by Don Coppersmith, Benoit Mandelbrot, Cliff Pickover and others

16 Institutional Service

16.1 University of Western Ontario

University

2002-date	<i>UWO-Fields Committee</i> , Advises on projects for the Fields Institute to fund.
2007	<i>McIntosh Gallery Strategic Planning Committee</i>
2006-2008	<i>Board of Governors</i> , McIntosh Gallery Committee
2006	<i>University Senate</i> , Subcommittee on Priorities in Academic Development (SUPAD, ADF)
2005-2006	<i>University Senate</i> , Nominating Committee (Algerate)
2005	<i>University Secretary</i> (officer) <i>Selection Committee</i>
2004-2006	<i>University Senate</i> , Elected representative of the Faculty of Science
2004	<i>France Day Organizing Committee</i> , Office of International Research
2002	<i>Bioinformatics Steering Committee</i> , Engineering, Science and Medicine
1998-1999	<i>Instructional Technology Resource Center Advisory Committee</i> (ITS)
1998	<i>Director of Industry Liaison Selection Committee</i>

Faculty of Engineering

2005-2008	<i>Promotion and Tenure Committee</i> (elected), Dept of Civil and Environmental Engineering
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Faculty of Science

2006-2008	<i>Chair Selection Committee</i> (elected), Dept of Computer Science
2004-2007	<i>Promotion and Tenure Committee</i> (elected), Dept of Applied Mathematics
2003	<i>Chair Selection Committee</i> (elected), Dept of Statistics and Actuarial Science
2000-2003	<i>Teaching Award Selection Committee</i>
2000	<i>Research Plan Committee</i>
2000	<i>Helmuth Prize Nomination Committee</i>
2000	<i>Canada Research Chair Nomination Committee</i>
1998-2000	<i>Distinguished Research Professor Selection Committee</i>
1998	<i>Florence Bucke Award Selection Committee</i>

Department of Computer Science

2010-date	<i>University Outreach</i>
2010-date	<i>Alumni/Industry Outreach</i>
2009-date	<i>ACM International Collegiate Programming Contest (ICPC) Coach</i>
2008-date	<i>Topical Research in Computer Science (TRICS) Seminar Organizer</i>
2005-date	<i>Research Committee</i> (Chair 2005-2010)
2006-'09 & '10-date	<i>Promotion and Tenure Committee</i> (elected)
2005-'07 & '09-date	<i>Nominating Committee</i> (Chair 2006-2007)
2009-2010	<i>Awards Committee</i>
2007-2008	<i>Colloquium Committee</i>
2006-2009	<i>PhD Comprehensive Examinations Committee</i>
2006-2007	<i>Space and Resource Committee</i>
2005-'07 & '08-'09	<i>Appointments Committee</i> (elected)
2005-2009	<i>Constitution Committee</i>
2002-2003	<i>Canada Research Chair Selection Committee</i>

1997-2002 Computer Science Department Chair

Ex officio chair of various departmental committees and member of others, including: *Appointments* (Chair), *Promotion and Tenure Committee* (Chair, prior to collective agreement), *Annual Performance Evaluation* (Chair), *Workload Committee* (Chair), *Departmental Executive Committee* (Chair), *Graduate Executive Committee*, *Undergraduate Committee*, *Resource Planning Committee*, *Colloquium Committee*

16.2 INRIA Sophia Antipolis (France)

- 1996-1998 *Responsable Scientific du Projet Safir*
1995-1998 *Comité des Projets*
Management committee composed of project directors

16.3 Université de Nice–Sophia Antipolis, Faculté de Science (France)

- 1995-1996 *Commission de Spécialistes, 27e Section*
Appointments committee consisting of full professors in computer science

16.4 IBM Research Division, Mathematical Sciences Department (USA)

- 1997 *Postdoctoral Award Committee*
1991 *Research Staff Evaluation Review Committee*

16.5 University of Waterloo, Department of Computer Science

- 1983-1984 *Curriculum Committee*

17 Professional and Boards and Committees

17.1 Boards of Directors

- 2005-date *Board of Directors*, The Fields Institute for Research in Mathematical Sciences
 1999-2000 A non-profit centre for international mathematical research.
 • Committee Service: Nominating (Chair, 2007-date)
- 2001-date *Board of Directors*, Descartes Systems Group (Nasdaq DSGX)
 DSGroup is a publicly traded company providing software-as-a-service logistics solutions.
 • Chairman of the Board 2003-2007
 • Committee Service: Audit (2001-2004), Compensation (2001-date),
 Governance (Chair, 2002-date) and Nominating (2004-date, Chair 2007-date)
- 1998-2009 *Board of Directors*, Maplesoft (was Waterloo Maple Inc.)
 A private company providing leading software for symbolic mathematical computing.
 • Participated in growth from start-up to acquisition.
 • Served on Audit and Compensation committees, plus many other roles.
- 2001-2002 *Board of Directors*, MITACS (network investigator representative)
 A Canadian Network of Centres of Excellence for research in
 Mathematics of Information Technology and Complex Systems

17.2 Offices, Steering Committees, Working Groups

- 2009-date *Symbolic and Numeric Algorithms for Scientific Computing, Steering Committee*
 Responsible for organizing the SYNASC annual conferences.
- 2009-2012 *Trustee* (elected), Calculemus Interest Group
- 2008-2010 *Electronic Products and Services Committee*, Canadian Mathematics Society
- 2006-date *Applications of Computer Algebra Conference Board*
 Responsible for organizing the ACA annual conferences.
- 2005-2007 *Initial Chair, SNC Steering Committee*
 SNC is the international conference series on symbolic-numeric computing.
- 2005-date *W3C Multimodal Working Group*, World Wide Web Consortium
 Developing standards for interactions on the web, including InkML for digital ink.
 Chair of InkML activity 2006-date.
- 1999-date *Member of the Corporation*
 The Fields Institute for Research in Mathematical Sciences
- 1997-date *Editorial Board*, Journal of Symbolic Computation
 • JSC is a top-tier journal in mathematical computing.
- 1996-date *Executive Committee*, OpenMath Society
 Developing standard for software packages to exchange mathematical objects.
- 1996-date *W3C Mathematics Working Group*, World Wide Web Consortium
 Developed the MathML standard for mathematics on the Web.
- 2002-2004 *E-Content Senior Steering Committee*, CANARIE
 Canadian Network for the Advancement of Research, Industry and Education
- 2001-2002 *Information Technology Advisory Council*, City of London, Canada
- 1997-2002 *IBM Executive Advisory Board*, IBM Toronto Laboratory
- 1995-1996 *Initial Chair, ISSAC Steering Committee*
 • ISSAC is the flagship annual international conference in computer algebra.
- 1986-1991 *Associate Editor, ACM SIGSAM Bulletin*
 ACM Special Interest Group on Symbolic and Algebraic Manipulation

18 Conference Organization

18.1 General Chair, Program Committee Chair or Other Principal Office

2010

- {1} Co-chair, *12th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing, Symbolic Computation Track* (SYNASC 2010), September 23-26, 2010 (Timișoara, Romania).
- {2} PC Chair, *International Symposium on Symbolic and Algebraic Computation* (ISSAC 2010), July 25-28, 2010 (Munich, Germany).
- {3} Co-chair, *2010 Workshop on Compact Computer Algebra* (CCA 2010), 6 Jul 2010 (Paris, France).
- {4} Co-chair, *Applications of Computer Algebra, Parallel Computer Algebra Session* (ACA 2010), June 24-June 27, 2010 (Vlora, Albania).
- {5} Scientific Committee Co-chair, *International Conference on Parallel Computer Algebra* (PARCA 2010), June 29-July 3, 2010 (Tambov, Russia).

2009

- {6} PC Chair, *11th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing* (SYNASC 2009), 26-29 September 2009 (Timișoara, Romania).
- {7} General Chair, *Conferences on Intelligent Computational Mathematics 2009* (CICM 2009), 5-13 Jul 2009 (Grand Bend, Canada).
- {8} Co-chair, *2009 Workshop on Compact Computer Algebra* (CCA 2009), 10 Jul 2009 (Grand Bend, Canada).
- {9} Co-chair, *2009 Workshop on Pen-Based Computer Mathematics* (PenMath 2009), 8-9 Jul 2009 (Grand Bend, Canada).
- {10} General Chair and PC Co-chair, *Mathematical Knowledge Management 2009* (MKM 2009), 6-8 Jul 2009 (Grand Bend, Canada).
- {11} Co-organizer, *NSF Workshop on Future Directions of Symbolic Computation Research and Their Applications to the Domain Sciences* (NSF), April 30-May 1, 2009 (Kingston RI, USA).

2008

- {12} Co-organizer, *Compact Computer Algebra (Special session in Applications of Computer Algebra)* (CCA 2008), 27-30 Jul 2008 (Hagenberg, Austria).
- {13} Co-organizer, *Aldor & Axiom Workshp: Categorical Programming Languages 2008* (CATLAN 2008), 24-26 Jul 2008 (Hagenberg, Austria).
- {14} General Chair, *Milestones in Computer Algebra 2008: A conference in Honour of Keith Geddes' 60th Birthday* (MICA 2008), 1-3 May 2008 (Stonehaven Bay, Trinidad and Tobago).

2007

- {15} Session Organizer, *Algorithmic Challenges in Polynomial and Linear Algebra, Canadian Mathematics Society Winter Meeting* (CMS 2007), Dec 8-10 2007 (London, Canada).
- {16} Co-organizer, *Workshop on the Role of Symbolic, Numeric and Algebraic Computation in Cyber-Enabled Discovery and Inovation, National Science Foundation* (CDI 2007), Oct 30-31 2007 (Arlington VA, USA).
- {17} General Chair, *Symbolic Numeric Computing* (SNC 2007), 25-27 July 2007 (London ON, Canada).

2006

- {18} Co-chair, *Electronic Mathematical Communication (IMA Workshop)* (EMC 2006), 8-9 December 2006 (Minneapolis MN, USA).
- {19} Session Organizer, *Pen-Based Electronic Mathematical Communication, 2006 Conference on Communicating Mathematics in the Digital Era* (PenMath 2006), 15-18 August 2006 (Aveiro, Portugal).
- {20} General Chair, *Manuel Bronstein Memorial Conference* (CAFE 2006), Jul 13 2006 (Sophia Antipolis, France).
- {21} Tutorials Chair, *International Symposium on Symbolic and Algebraic Computation* (ISSAC 2006), 9-12 Jul 2006 (Genova, Italy).
- {22} Co-chair, *Challenges in Computer Algebra Software* (Dagstuhl Seminar 06271), Jul 2-7 2006 (Schloß Dagstuhl, Wadern, Germany).

2005 and earlier

- {23} Co-chair, *Challenges in Linear and Polynomial Algebra in Symbolic Computation Software* (Banff International Research Station), Oct 1-6 2005 (Banff, Canada).
- {24} Session Organizer, *Session on InkML, 2005 Int'l Conference on Document Analysis and Recognition* (ICDAR 2005), Aug 29–Sep 1 2005 (Seoul, Korea).
- {25} Session Organizer, *Special Session on Pen-Based Mathematical Computing, 2005 Conference on Applications of Computer Algebra* (PenMath 2005), Jul 29-Aug 3 2005 (Nara, Japan).
- {26} General Chair, *2004 Workshop on Categorical Programming Languages* (CATLAN 2004), July 8-9 2004 (Santander, Spain).
- {27} General Chair, *Internet Accessible Mathematical Computation* (IAMC 2004), July 8 2004 (Santander, Spain).
- {28} General Chair, *2002 Workshop on Future Directions for Categorical Programming Languages* (CATLAN 02), July 11, 2002 (Lille, France).
- {29} Co-chair, *Workshop on Industrial Applications of Computer Algebra* (INDACA 2002), October 25 2002, The Fields Institute for Research in Mathematical Sciences (Toronto, Canada).
- {30} PC Chair, *MathML International Conference 2002* (MathML02), June 28-30 2002 (Chicago, USA).
- {31} General Chair, *2001 Workshop on Future Directions for Categorical Programming Languages* (CATLAN 01), July 25, 2001 (London, Canada).
- {32} Co-chair, *Minisymposium on Symbolic-Numeric Algebra for Polynomials at 1998 SIAM Annual Meeting* (SIAM 98), (Toronto, Canada).
- {33} Chair, *Special Session on Automatic Differentiation, IMACS 1997 Applications of Computer Algebra Conference* (ACA 97), (Kihei, Hawaii USA).
- {34} Co-chair, *ESPRIT 1997 FRISCO Open Workshop* (FRISCO 97), (Sophia Antipolis, France).
- {35} Co-chair, *1996 Workshop on Symbolic-Numeric Algebra For Polynomials* (SNAP 96), (Sophia Antipolis, France).
- {36} General Chair, *ACM 1995 Int'l Symposium on Symbolic and Algebraic Computation* (ISSAC 95), (Montreal, Canada).
- {37} PC Chair, *1991 Int'l Symposium on Symbolic and Algebraic Computation* (ISSAC 91), (Bonn, Germany). ISSAC is the premier annual conference in the field of computer algebra. In 1991 we had 233 submissions (the highest ever) for a final acceptance rate of 24%.
- {38} Conference Treasurer, *1989 Int'l Symposium on Symbolic and Algebraic Computation* (ISSAC 89), (Portland OR, USA).

18.2 Committee Member**2010**

- {39} Program Committee, *Artificial Intelligence in Symbolic Computation* (AISC 2010), July 9-10, 2010 (Paris, France).
- {40} Program Committee, *17th Symposium on the Integration of Symbolic Computation and Mechanized Reasoning* (Calcelemus 2010), July 5-6, 2010 (Paris, France).
- {41} Program Committee, *Workshop on Programming Languages for Mechanized Mathematics Systems* (PLMMS 2010), July 5, 2010 (Paris, France).
- {42} Organizing Committee, *East Coast Computer Algebra Day* (ECCAD 2010), May 15, 2010 (Atlanta GA, USA).
- {43} Program Committee, *Polynomial Computer Algebra* (PCA), April 2-7, 2009 (Saint Petersburg, Russia).

2009

- {44} Program Committee, *Symbolic Numeric Computation* (SNC 2009), August 3-5, 2009 (Kyoto, Japan).
- {45} Program Committee, *International Symposium on Symbolic and Algebraic Computation* (ISSAC 2009), July 28-31, 2009 (Seoul, South Korea).
- {46} Program Committee, *OpenMath Workshop* (OpenMath 2009), July 9, 2009 (Grand Bend, Canada).
- {47} Program Committee, *Polynomial Computer Algebra* (PCA), April 8-12, 2009 (Saint Petersburg, Russia).

2008

- {48} Program Committee, *10th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing* (SYNASC 2008), 26-29 September 2008 (Timișoara, Romania).
- {49} Program Committee, *9th International Conference on Artificial Intelligence and Symbolic Computation* (AISC 2008), 31 Jul-2 Aug 2008 (Birmingham, UK).
- {50} Program Committee, *6th International Conference on Mathematical Knowledge Management* (MKM 2008), 28-30 July 2008 (Birmingham, UK).
- {51} Program Committee, *Second Workshop on Programming Languages for Mechanized Mathematics* (PLMMS 2008), 28-29 Jul 2008 (Birmingham, UK).

2007

- {52} Program Committee, *Workshop on W3C's Multimodal Architecture and Interfaces* (W3C-MMI 2007), 16-17 November 2007 (Fujisawa, Japan).
- {53} Program Committee, *9th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing* (SYNASC 2007), 26-29 September 2007 (Timișoara, Romania).
- {54} Program Committee, *6th International Conference on Mathematical Knowledge Management* (MKM 2007), 27-30 June 2007 (Linz, Austria).

2006

- {55} Program Committee, *8th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing* (SYNASC 2006), 26-29 September 2006 (Timișoara, Romania).
- {56} Program Committee, *Mathematical Theory Exploration Workshop* (MTE 2006), 26-29 September 2006 (Timișoara, Romania).
- {57} Program Committee, *International Conference on Artificial Intelligence and Symbolic Computation* (AISC 2006), 20-22 September 2006 (Beijing, China).
- {58} Program Committee, *Fifth International Conference on Mathematical Knowledge Management 2006* (MKM 2006), 14-16 August 2006 (Ashridge, Berkhamsted, UK).
- {59} Program Committee, *13th Symposium on the Integration of Symbolic Computation and Mechanized Reasoning 2006* (Calculus 2006), 7-8 July 2006 (Genoa, Italy).
- {60} Program Committee, *Transgressive Computing 2006* (TC 2006), 24-26 Apr 2006 (Granada, Spain).

2005 and earlier

- {61} Program Committee, *International Workshop on Symbolic-Numeric Computation* (SNC 2005), July 19-21 2005 (Xi'an, China).
- {62} Program Committee, *Fourth International Workshop on Mathematical Knowledge Management* (MKM 2005), July 15-17 2005 (Bremen, Germany).
- {63} Scientific Committee, *19th International Symposium on High Performance Computing Systems and Applications* (HPCS 2005), May 15-18 2005 (Guelph, Canada).
- {64} Advisory Council, *12th Annual East Coast Computer Algebra Day* (ECCAD 2005), March 12 2005 (Ashland Ohio, USA).
- {65} Program Committee, *International Symposium on Symbolic and Algebraic Computation* (ISSAC 2004), July 4-7 2004 (Santander, Spain).
- {66} Advisory Committee, *East Coast Computer Algebra Day* (ECCAD 2004), May 8 2004 (Waterloo, Canada).

- {67} *Program Committee, 10th Symposium on the Integration of Symbolic Computatin and Mechanized Reasoning 2003* (Calculus 2003), September 10-12, 2003 (Rome, Italy).
- {68} *Program Committee, International Conference on Mathematical Knowledge Management* (MKM 2003), February 16-18, 2003 (Bologna, Italy).
- {69} *Program Committee, International Symposium on Symbolic and Algebraic Computation* (ISSAC 2002), July 7-10 2002 (Lille, France).
- {70} *Program Committee, ACM 1999 International Symposium on Symbolic and Algebraic Computation* (ISSAC 99), (Vancouver, Canada).
- {71} *Program Committee, ESPRIT 1999 FRISCO Open Workshop* (FRISCO 99), (Oxford, England).
- {72} *Program Committee, Special Session on Mathematical Software at ICM'98* (ICM 98), (Berlin, Germany).
- {73} *Program Committee, 1998: 15th International Conference on Automated Deduction* (CADE 15), (Lindau, Germany).
- {74} *Program Committee, First International Symposium on Parallel Symbolic Computation* (PASCO 94), (Linz, Austria).
- {75} *Program Committee, Computers and Mathematics '89* (CM 89), (MIT, Cambridge Mass., USA).

19 Evaluation

Department Reviewer

- The Fields Institute for Research in Mathematical Sciences, Canada
 - Chair of external review committee for IT infrastructure, June 2010
- University of Northern British Columbia, Canada
 - External reviewer of Computer Science Program, January 2008
- Institut National de Recherche en Informatique et en Automatique, France
 - Projet *SPACES*, February 2002

Proposal Reviewer

- Grant proposal reviewer for national research councils (multiple proposals in each case):
 - Austria: FWF
 - Canada: NSERC GSC 330+331 (Comp & Info Science A+B), GSC 17 (Space and Astronomy)
 - UK: EPSRC
 - USA: NSF
- CANARIE, Canadian Network for the Advancement of Research, Industry and Education
 - As steering committee member, 60 proposals
- Canadian Foundation for Innovation

Candidate Reviewer

- Appointment, tenure, promotion and award dossiers for universities, institutes and academies, including
 - Austria: Austrian Academy of Sciences
 - Canada: Simon Fraser U., Technical U. Nova Scotia
 - China: Chinese Academy of Sciences
 - France: INRIA
 - Germany: U. Kassel
 - UK: U. Cambridge, U. St Andrews
 - USA: U. Delaware, Drexel U., Washington College

External Thesis Examiner

- External examiner for doctoral theses at other institutions:
 - Canada: U. Waterloo
 - France: Ecole Polytechnique [X], U. Paris 6, LITP Grenoble
 - Italy: U. Bologna
 - Morocco: U. Marrakech
 - Switzerland: ETH Zurich
 - USA: Rensselaer Polytechnic Institute
- Extradepartmental examiner for theses at U Western Ontario:
 - Applied Mathematics: PhD (5) and MSc (3)
 - Mathematics: PhD (1)
 - Law: LL.M (4)

Referee

- Numerous conferences and journals, including ISSAC, CADE, Calculemus, MKM, SNC, J. Symbolic Computation