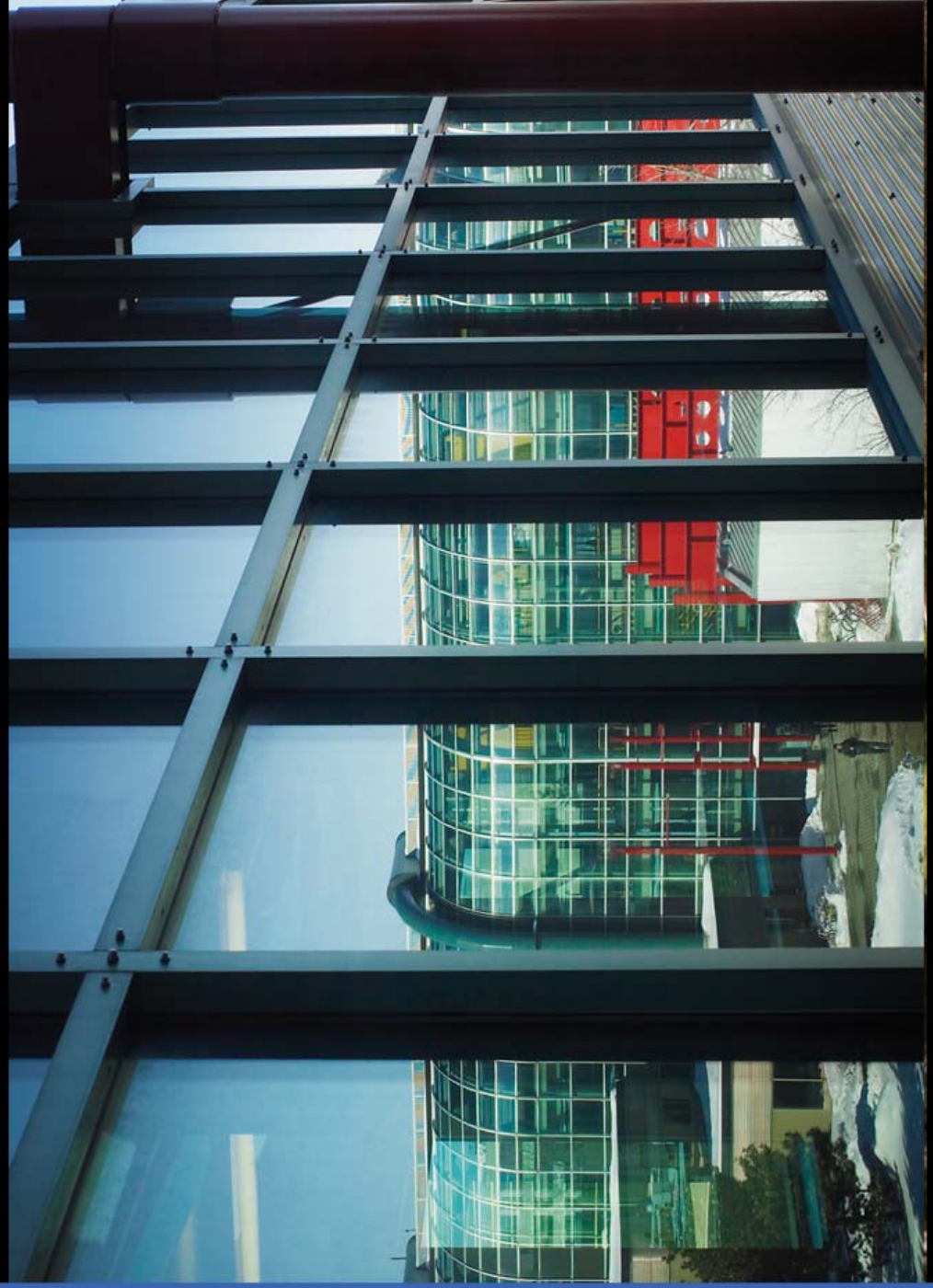
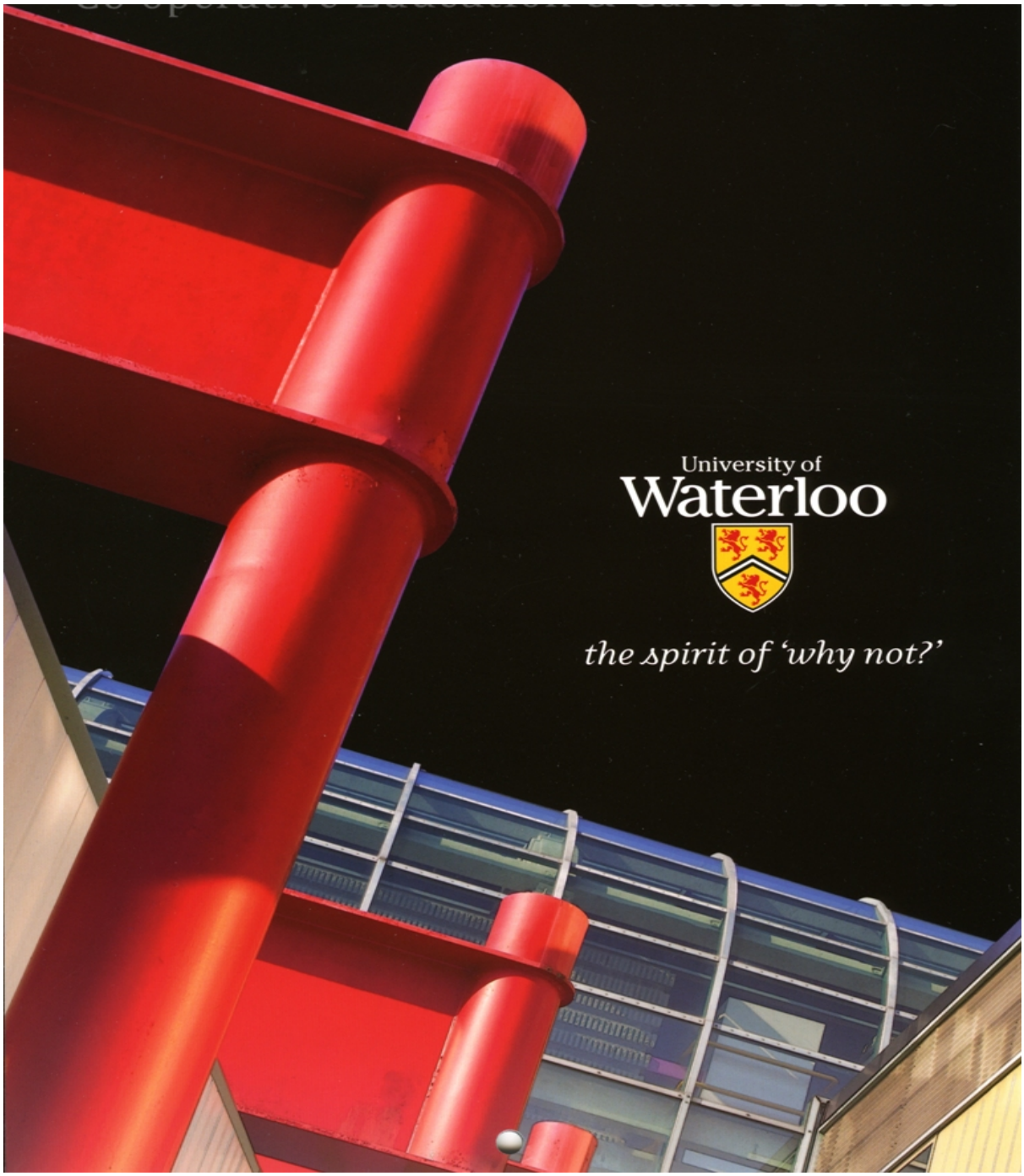


OUT OF THE SHADOW OF ORTHODOXY

WATERLOO@50

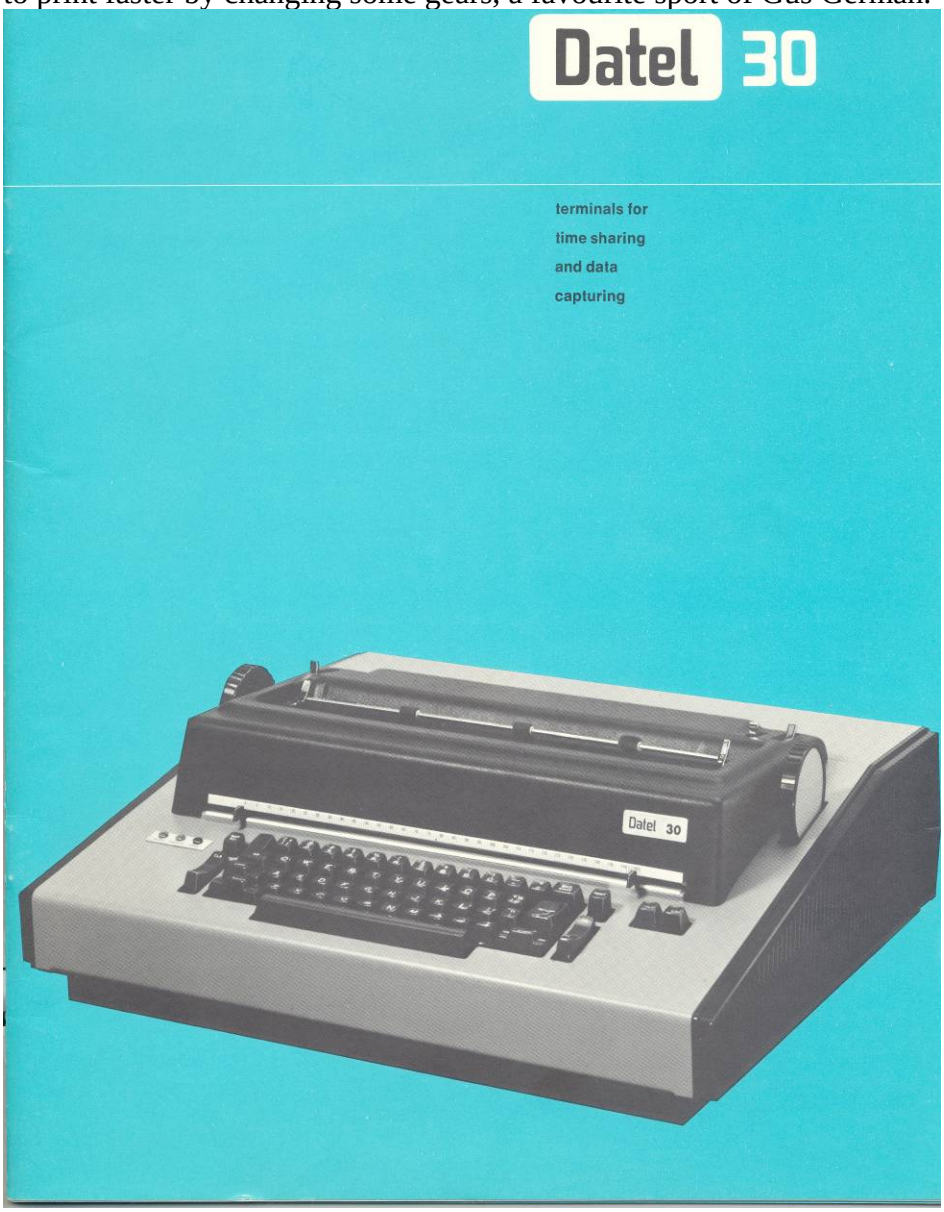
University of Waterloo



By HAROLD ALKEMA AND KENNETH McLAUGHLIN
The University of Waterloo, 2007

407 E Printer

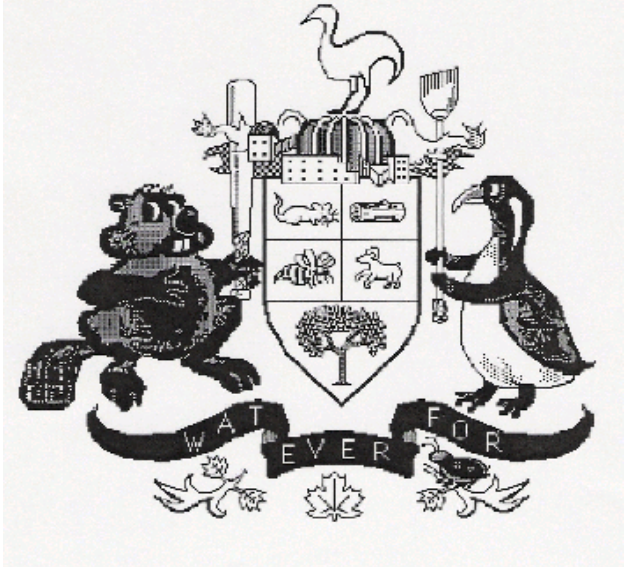
The 407 E was an IBM printer model, acquired by the University of Waterloo (UW). This printer operated on a punch-card system and was one of the first printers used by UW. In Peter Ponzo's history of the Computer Science Department (CSD), Bob Zarnke reported the 407 E Printer to be in use as early as 1962 (Ponzo 26). The 407 E Printer was designed for use with the IBM 1620 computer. The 407E could be made to print faster by changing some gears, a favourite sport of Gus German.



Although this brochure does not show an IBM product and is of a later vintage than the 407 E, it does depict the technical standards of an era when a typewriter was considered a usable computer "terminal." Photo Courtesy of UW Special Collections (Reference number: GA 133-1217).

AA/CS

AA/CS was an acronym that stood for Applied Analysis and Computer Science. This was the official name of the Computer Science Department adopted in 1966 and prompted by the arrival of a group of experts in Functional Equations, who wished to affiliate with the Computer Science Department. The mathematics experts were welcomed by Don Cowan, who became the first chairman of the re-aligned department in that same year (Ponzo 41). In 1975, when Douglas Lawson replaced Pat Fischer as chairman the department reverted to the previous name of Computer Science (CS) (Ponzo 54).



A student designed coat of arms for CSD. The beaver is the mascot for CS, the Penguin is the logo for the Artificial Intelligence Group, and the Flamingo is the mascot for the Computer Systems Group. Photo courtesy of Peter Ponzo, copyright 1992.

APL

APL is an acronym that stands for "A Programing Language." The language is generally noted for its ability to generate matrixes–data elements presented in rows and columns–and for its brevity. It was created in the early 1960s by Ken Iverson, and it was most commonly used in scientific computation. (This definition has been adapted from www.webopedia and www.whatis.techtarget.com).

In November, 1970, R. Roden wrote the following about APL in the Computing Centre Newsletter: *"The APL language developed by K.E. Iverson of IBM, is an extremely concise and powerful language which permits for very complex computing operations to be described with a minimum of programming effort."*

UW Special Collections. GA 133-. Wes Graham Fonds. Series 4.1: UW Files to 1973. R. Roden. "Model 50," Computer Centre Newsletter (Issue 11, November 1970-11, N. Fuller ed.), 6.

Ken Iverson (right) and Arto Juvonen at a conference in Ottawa in 1976. Ken Iverson passed away in 2004. Iverson was one of the most important Computer Scientists of his generation.

APL Interpreter

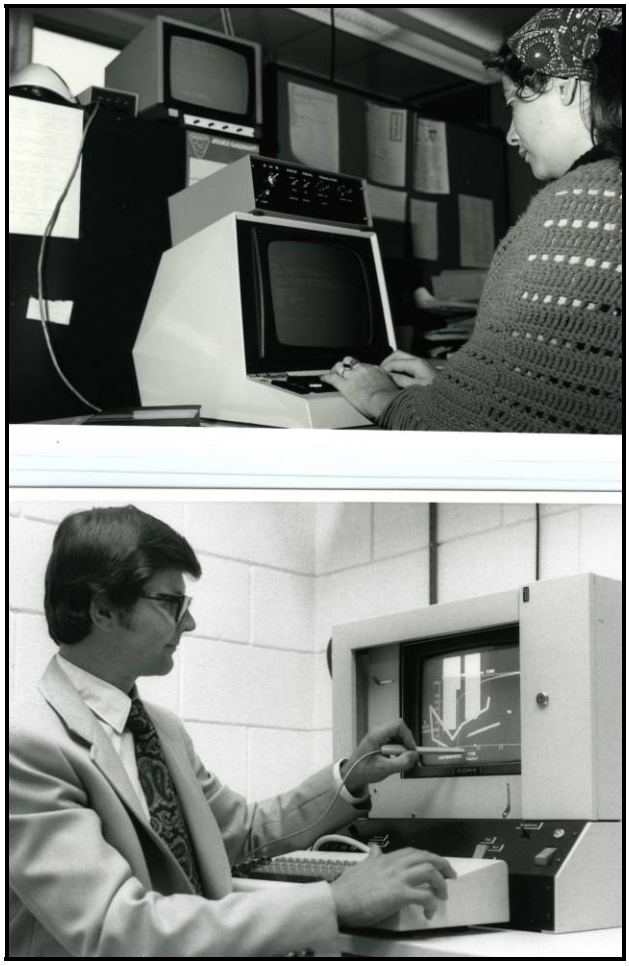
An APL interpreter was designed in 1981 by the Computer Systems Group (CSG) at UW. It was intended to operate with the Micro-WAT computer system (Cowan, Graham, Mackie et al. 30).

UW Special Collection. GA 133-734. Wes Graham Fonds. Series 3.1: Works: Manuscripts. MicroWat – A Personal Workstation of Modular Design, 1982).

Applications

An application is a program or a group of programs designed for end users (i.e. consumers who require a finished bug-free product and generally do not have skills in computer programming or engineering). Software can be divided into two general classes: systems software and applications software. Systems software consists of low-level programs that interact with the computer at a very basic level. This includes operating systems, compilers, and utilities for managing computer resources.

In contrast, applications software (also called end-user programs) include data base programs, word processors, and spreadsheets. Figuratively speaking, applications software sits on top of system's software because it is unable to run without the operating system and system utilities. (This definition has been adapted from www.webopedia.com).



Word processing and computerized drafting are only two examples of computer applications used at UW in the early days of personal computing. Photo courtesy of UW Special Collections/Don Cowan. (J.B. Moore is in the lower picture.)

Application Shell	Application Shell was an electronic tool, designed by the CSG in 1989, that allowed the integration of diverse pieces of microcomputer software into a coherent interface. CSG was still doing research in the late 1980s to find new methods of system integration using this tool (Cowan, Graham, Mackie et al. 32).
Archimedes Cattle Problem	The Archimedes Cattle Problem was a mathematics puzzle, written in the form of a Greek epigram that remained unsolved for more than 2,000 years. It was first published by G.E. Lessing in 1773 and attributed to Archimedes. In 1964, three Waterloo undergraduates—Robert Zarnke, Gus German, and Hugh Williams—solved the problem in their spare time, using a combination of the IBM 7040 and IBM 1620 computers. The solution has 206,545 digits.

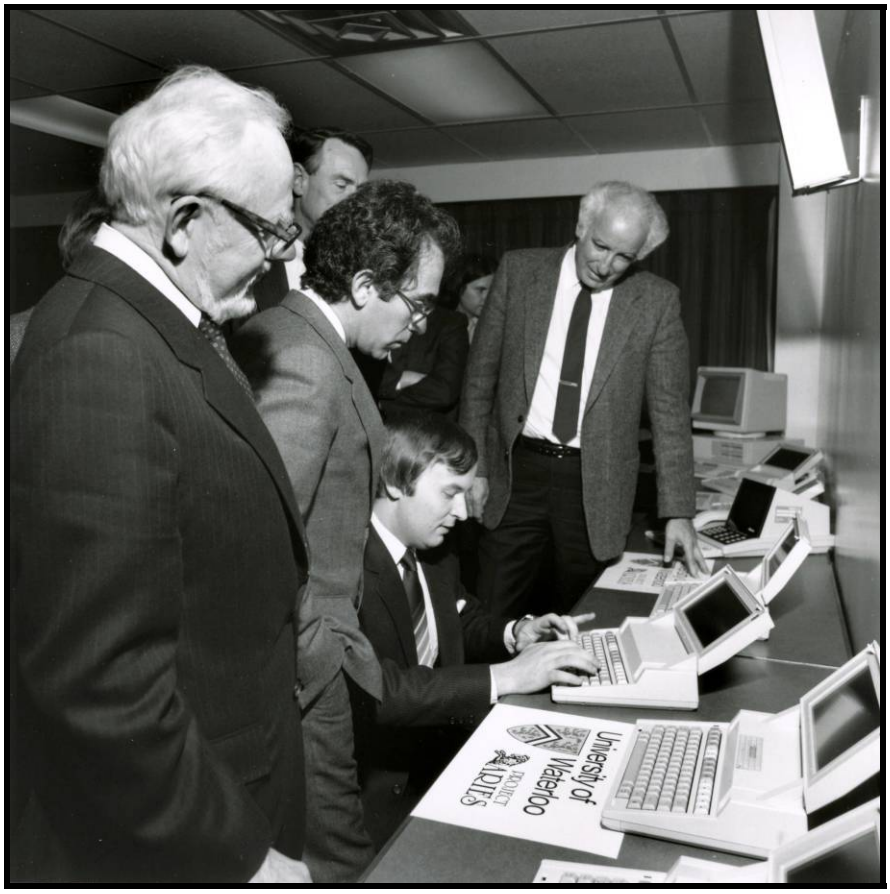
Hugh Williams (foreground), Gus German (seated) and Bob Zarnke (standing, background) with the printed answer to the Archimedes Cattle Problem. The publicity from this was important to UW's reputation for innovative computer applications.

Photo courtesy of the UW Special Collections/Don Cowan.

ARIES Network

Created in 1986, the ARIES Network was designed to support student-owned portable computers for students on campus at UW. In the late 1980s the network was expanded to include desktop microcomputers and distance education students, who accessed the network via Datapac, Bell Canada's packet-operated data-sharing network. In the autumn of 1987, laser-printing facilities were added to the Aries network. The project resulted in the donation of over 500 computers to the university and more than $1.4 million in research support (Cowan, Graham, Mackie et al. 32). ARIES was an acronym that stood for "Applied Research in Education." (Ponzo 93).

UW Special Collections. GA 133-1463. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. University of Waterloo, ARIES Executive Committee, Minutes of the Meeting Held Wednesday, September 23, 1987.



From Left to Right: UW President Douglas Wright, Gregory Sorbara. Minister of Colleges and Universities for Ontario, Terry Stepien of the CSG, and UW Dean of Computing and Communication J. Wesley Graham at a demonstration of the ARIES network in 1984. On this occasion the minister donated $1.6 million to research at UW.

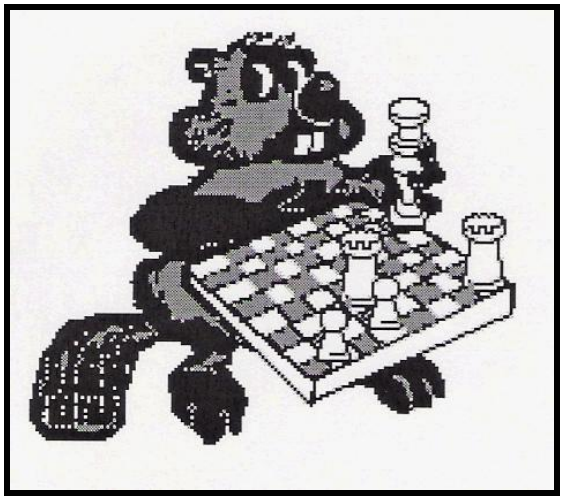
Photo courtesy of UW Special Collections. Reference: GA 133-1493. Wes Graham Fonds. Series 4.2: UW Files Post-1973. *Imprint: the Student News Paper.* Friday, May 2, 1986. Vol. 9, Vo. 1, p.1.

Artificial Intelligence

Artificial Intelligence is the branch of computer science concerned with making computers behave like humans. The term was coined by John McCarthy, of the Massachusetts Institute of Technology (MIT) in 1956. Artificial Intelligence includes:

- Games playing: programming computers to play games such as chess and checkers
- Expert systems: programming computers to make decisions in real life situations (for example some doctors use expert systems to diagnose diseases based on symptoms)
- Natural language: programming computers to understand natural human languages
- Neutral networks: systems that simulate intelligence by attempting to reproduce the types of physical connections that occur in animal brains
- Robotics: programming computers to see and hear and respond to other stimuli

Currently no computers exhibit full artificial intelligence, and the greatest advances have occurred in games playing. In May 1997, an IBM supercomputer defeated world chess champion Gary Kasparov. This material has been taken from www.webopedia.com).

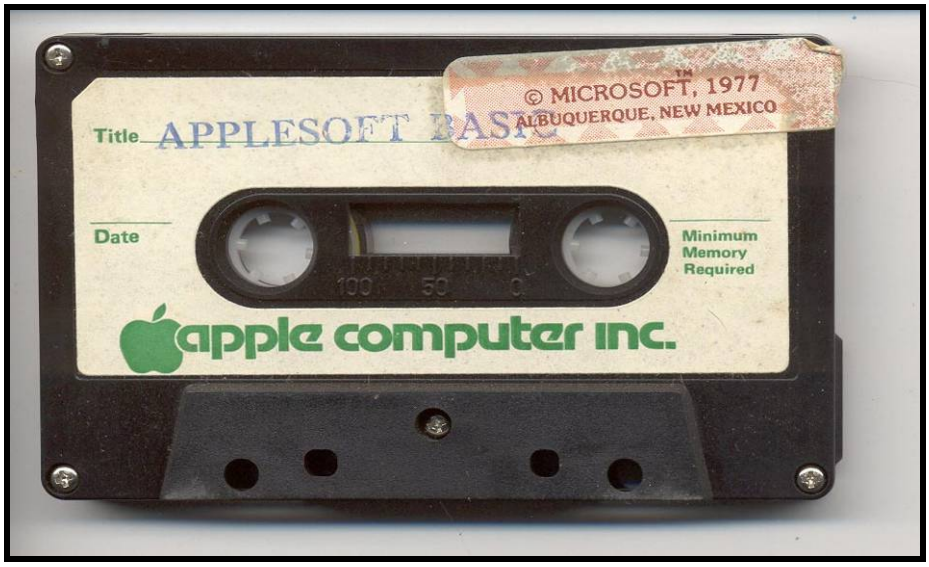


In 1974 UW made its own contribution to artificial intelligence games playing when a chess program called Ribbitt (written by CS students Ron Hansen, Russell Cook, and Jim Parry) won the US Computer Chess championship and placed third in the world championship. Photo courtesy of Peter Ponzo.

Assembler	An assembler is a program that takes basic computer instructions and converts them into a pattern of bits that the computer's processor can use to perform its basic operations. Some people call these instructions assembler language and others use the term assembly language. (This definition has been taken from www.whatis.techtarget.com).
Assembler G or ASMG	Assembler G, also known as ASMG, was a fast assembler written at UW. The program was first installed in March of 1968. It was designed for use with the IBM 360 and 370 computer systems (Cowan, Graham, Mackie et al. 28). The assembler was so effective that it was adopted for general use, even at several IBM laboratories (Cowan, Graham, Mackie et al. 4). Assembler G was maintained for registered users by UW staff for a monthly fee of $100.00 after it was developed under the direction of. R. Petersen. The program was first presented to the computing community at a SHARE Conference held in Houston, Texas in February 1968. In spite of its many similarities to Assembler F, in its May 1976 issue Datapro noted that Assembler G dramatically out preformed ASMF and offered "potential in terms of cost savings and extended features." When the program first appeared, the Computing Centre Newsletter noted that Assembler G was four to five times faster than its immediate predecessor. UW Special Collections. GA 133-859. Wes Graham Fonds. Series 4.1 UW Files to 1973. "Assembler G Maintenance Agreement," 3. UW Special Collections. GA 133-944. Wes Graham Fonds. Series 4.1: UW Files to 1973. Sandra Hope (ed.)"Information About Assembler G," *The Computing Centre Newsletter* (Issue 7, 10 September 1968), 18. UW Special Collections. GA 133-1255. Wes Graham Fonds. Series 4.2: UW Files to 1973. "Assembler G: University of Waterloo," Datapro (May 1976), 70E-886-1a-1b. UW Special Collections. GA 133-944. Wes Graham Fonds. Series 4.1: UW Files to 1973. J.P. Sprung (ed.), "Research and Development." *The Computing Centre Newsletter*. (Issue 2 March 11-2, 1968), 4.

BASIC

BASIC is an acronym that stands for “Beginner’s All-purpose Symbolic Instruction Code.” It is a family of high-level programming languages. In the 1980s, it became widely used on home microcomputers. It is still popular with some computer users. Professor John G. Kemeny and Thomas E. Kurtz of Dartmouth College developed it in 1963.



This is a cassette tape that advertises an early version of the BASIC computer language produced by Microsoft for the Apple II computer. The tape also symbolically depicts the beginnings of the continuing partnership between Microsoft and Apple Computers. The sticker on top reads “MICROSOFT, 1977 Albuquerque, New Mexico.” In that year Microsoft was still headquartered in the Southwestern US city. Image courtesy of Digibarn Computer Museum. Website: www.digibarn.com

BASIC Interpreter	In 1981, the CSG designed a BASIC interpreter for the MicroWAT computer system (Cowan, Graham, Mackie et al. 30). **Jim Welch interview**…. And so we started doing that, but the other thing we did was we developed Waterloo Basic, which was a very successful Basic processor that was used all over the world. It was the second biggest thing after WATFIV. And we wrote books based on that –for students --and because we'd published them through our Structured Computing Systems, it paid the normal sort of 15 percent royalties, but all the other money remained. So, Structured Computing Systems printed the books, shipped them out, and we eventually had to hire somebody full time to just manage the book operation…. So, by about 1980 or so we had about a two to three hundred thousand dollar a year business running. (And of course everybody thought Wesley was brilliant for cooking up this idea.) And we still did occasional seminars and some consulting, but mostly it was a book business – but a pretty good one. Wesley knew this side of the business because along with Dirksen and Cress he had written a WATFIV book that was published by Prentice Hall and at the time it was the biggest seller Prentice Hall ever had. MCLAUGHLIN: Waterloo Basic was your project. JIM WELCH: I wrote the software and then Wesley and I and Ian McPhee later wrote the book. I shouldn't say I wrote it for I didn't write the software alone. Technically in Waterloo Basic Ian and I were the project leaders and we had four others working for us. But then Ian went on to other things and so I carried it through onto the mainframe. So, that was my pet project for maybe three or four years. I think it was 1983, you'd have to verify this – Ian started to become restless, even though he had a shareholding in this Structured Computing Systems he wanted to get on with his life and, try other business opportunities. And so Wesley had the idea of creating Computing Systems. I'd been trying to talk him into doing this for years and he kept saying "no, no, no, we do software at the university". But the fact that Ian was going to leave meant that Wes had to do something, And so what he did was he came up with the concept that we would develop software in the Structured Computing Systems. And this was the time that now microcomputers were coming into play. in those days the IBM PC had not been invented but people were inventing a new microcomputer every week because they were simple enough electronically that anybody with some electronic experience could invent one in their garage. We invented one at the University of Waterloo that we put in the labs. So, we used this as an excuse to move away from the university on the principle that "it's pretty risky to develop software for microcomputers and we shouldn't use public ffmoney for that at the university. We'll do that in Structured Computing Systems". And there was a second motivation for it. The Computer Systems Group had now grown from the original dozen to about two dozen. And we wanted to give the second group some shareholdership in the company. We renamed the company Waterloo

And so they wrote Basic in the new entity and this was the start of the end at the university because I went on a reduced load. I only worked a third of the time for the university and was working two-thirds of my time for WATCOM. At that time I developed FORTRAN and the COBOL and someone else did APL and another did PASCAL. (Boswell did PASCAL for example, Eric Mackie did APL.) And they evolved into a reduced load in the Computer Systems Group to do this. And then we were immediately lucky because Commodore came to the university and they saw that we had this computer lab set up with OUR computer; we already had these computer monitors around and keyboards and we essentially figured out a way of building a computer that used those two entities. And that was done by Jerry Krist, who went on to create Northern Digital, which is a very successful Waterloo company now. So, that was one of his big contributions.

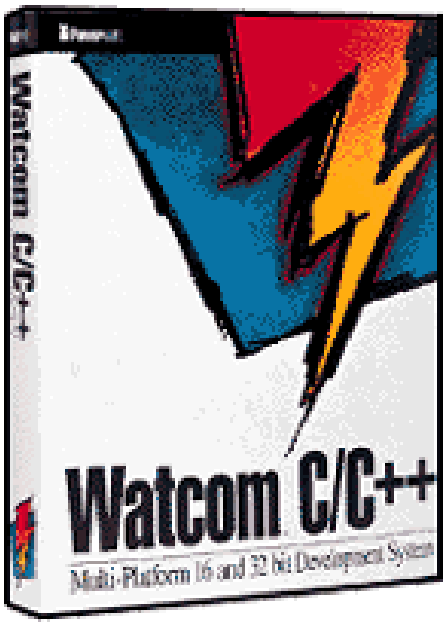
you'd have to verify this – Ian started to get itchy even though he had a shareholding in this Structured Computing Systems he wanted to get on with his life and develop the business aspects. And so Wesley had the idea that we would develop software in the Structured Computing Systems. I had been trying to talk him into doing this for years and he kept saying "no, no, no, we do software at the university". But the fact that Ian was going to leave meant he had to do something, you see. And so what he did was he came up with a concept that we would develop software in the Structured Computing. And this was the time people were inventing a new microcomputer every week because they were simple enough electronically that anybody with some electronic experience could invent one in their garage. And so they were literally inventing them every week, you know. In fact, we invented one here at the University of Waterloo that we stuck out in the labs. So, we sort of used this as an excuse we said "look it, it's pretty risky to develop software for microcomputers and so we shouldn't use public money for

had now grown from the original sort of dozen to about two dozen. And so we wanted to give the second group some shareholdership in the company. And so we renamed the company Waterloo Computing Systems, which we shortened to WATCOM. We refinanced the company by letting additional people and the original people invest in it. And Wesley was like a closet communist, he realized that people wouldn't necessarily have the money right on hand so what he did was he set up like a units program that people would invest over five years and they'd put in – and so it was affordable for a regular guy working in the Computer Systems Group to fund it. Where, it wouldn't have been affordable if they had to plunk it all down in one full swoop. And so he talked in Ian and Jack Schuler and Fred Krigger to quit their jobs at the Computer Systems Group and go to work for this new entity.
And so those guys wrote BASIC in the new entity and I worked – this was the start of my end at the university because I went on a reduced load. So, I only worked like the third the time for the university and was working two-thirds of my time for WATCOM. What I did was I developed FORTRAN and COBOLl and then another guy did APL and another guy did PASCAL. So, Boswell did PASCAL for example, Eric Mackie did APL. And so they took a little bit of their – they became sort of reduced load in the Computer Systems Group to do this. And then we got immediately lucky because Commodore came to the university and they saw that we had this computer lab set up with OUR computer; we already had these computer monitors around and keyboards and so we essentially figured out a way of building a computer that used those two entities. And that was done by Jerry Krist, the guy that actually created Northern Digital, which is a very successful Waterloo company now. So, that was one of his big contributions.

UW Special Collection. GA 133-734. Wes Graham Fonds. Series 3.1: Works: Manuscripts. MicroWat – A Personal Workstation of Modular Design, 1982).

Bendix	The computer division of the Bendix Aviation Corporation produced a first generation general purpose computer in 1956. The model G-15 used a magnetic drum for internal memory storage and was touted as being "thirty times faster than former manual calculation methods." The Bendix G-15 was the first computer used at UW. Mathematics Professor Ralph Stanton used the machine on a trial basis from January 4 to January 11, 1960. Stanton was evaluating the potential of the device to solve advanced mathematics problems (Ponzo 19-20). The machine was installed by Computing Devices Canada and operated by a sales representative from that company. The address below provides a link to an advertisement for the G-15 model: http://www.co.ozaukee.wi.us/history/roadad2.jpg Peter Ponzo's illustration depicting Ralph Stanton at work testing the Benedix G-15. Copyright 1992. UW Special Collections. GA 133-911. Wes Graham Fonds. Series 4.1: UW Files to 1973. "History of the Computer Committee Activities," 1.
	A Bit, or a binary digit, is the smallest unit of data in a computer. A Bit has a single binary value of either 1 or 0. (This definition has been adapted from www.whatis.techtarget.com).
Byte	A byte is an abbreviation for a binary term, a unit of storage capable of holding a single character. On almost all computers, a byte is eight bits. Larger amounts of memory are indicated in terms of milobytes (1,024 bytes), megabytes (1,048,576 bytes), and gigabytes (1,073, 741, 824 bytes). (This definition has been taken from www.webopedia.com).

C (Programming Language)	By 1980, C had become the accepted programming language for developing portable software for computers. In that same year, CSG developed a Waterloo version, WSL—"Waterloo Systems Language" – pronounced "whistle" (Ponzo 94).



The work of CSG team members on the C programming language eventually became the basis of the work done with the language at WATCOM Ltd. In 1989, WATCOM introduced a version of C that many considered superior to implementations of C produced by software industry leaders. The quality of WATCOM's version of C helped to enhance the reputation of the company. In the 1990s, mergers with large US firms followed. This photo shows the package for a late edition of WATCOM C/C++.

Will Watt, "Review of WATCOM C (version 7)." EXE. (October 1989, Vol. 3, Issue 8).

Photo: http://www.integra.co.yu/p-watcom.gif

C Tools	A set of C tools was also constructed, by the CSG in 1987 to accompany the Waterloo C compiler. Many of the tools contained within the software package were similar to the ones available with UNIX. The tools set also contained a full-screen level debugger (Cowan, Graham, Mackie et al. 32).

Cafeteria style computing

Cafeteria style computing was developed in 1962. It was a system that allowed students to put their jobs into a card reader and get the output at a printer nearby. With the arrival of Cafeteria style computing even undergraduate students had access to computers at UW. At the time this was largely unheard of at other schools, but it reflected Wes Graham's vision of making computers available to all UW students.

Between 1964 and 1967, Cafeteria-style computing at UW was severely restricted. When the new IBM 7040-1401 computer installation arrived at UW, it had a card reader that was too difficult for students to operate. As a result, student computing was provided on a "closed shop" basis with technicians feeding cards into the machine for students. In the early days, the technicians also delivered completed assignments to the students and thus won the name wripper n' wrappers.

With the arrival on campus of the IBM 360/75 in 1967, the situation improved only slightly because the machine, too, had an interface that was not fully integrated into the machine. This was clearly unacceptable to Graham and the following year, in 1968, Mike Doyle and Wes Graham rigged the 360 to take student input. The WIDJET System introduced in 1975 made remote job entry possible though a terminal and finally eliminated the need for open shop Cafeteria-style computing.

UW students "queuing" to get the output of their computer programs. Photo courtesy of UW Special Collections/Don Cowan.

COBOL	COBOL is an acronym that stands for "Common Business-Oriented Language." This programming language was first developed in the 1950s by the US Department of Defence and several early computer manufacturers. COBOL's primary domain was in business, finance, and administrative data processing systems for companies and governments. It was probably the most widely used programming language during the 1960s and 1970s and continues to be used today–mostly in major commercial enterprises. In order to accommodate students in the University's Co-op program, Waterloo began to teach COBOL in its undergraduate classes and CSG developed WATBOL in order to support this form of student computing.
	
	A Cobol manual written in Japanese. Photo: http://images.google.ca/imgres?imgurl=http://www.total7.com/images/book_cobol2.gif&imgrefurl=http://www.total7.com/html/book.html&h (site is in Japanese).
COBOL Interpreter	In 1981, the CSG designed a COBOL interpreter for the Micro-WAT computer system. Later in the year, FORTRAN and Pascal interpreters were also built for the Micro-WAT system (Cowan, Graham, Mackie et al. 30).
	UW Special Collection. GA 133-734. Wes Graham Fonds. Series 3.1: Works: Manuscripts. *MicroWat – A Personal Workstation of Modular Design*, 1982.
Compiler	A compiler is a program that translates instructions written in a higher order programming language source code to machine code. Instructions must be written in machine code so that the computer can process them. (This definition is adapted from www.webopedia.com.).

Computing Centre

In the fall of 1960, the Computing Centre at the University of Waterloo was established under Basil Myers, Chairman of Electrical Engineering at UW. It was Myers' resignation two years later to return to the University of Illinois that led to the fortuitous appointment of Wes Graham as Director of the University's Computing Centre and that sent Waterloo on a very different direction in the development of computing services, developing software rather than trying to build hardware for computer systems. This set Waterloo apart from many contemporary universities and would allow Waterloo to establish a unique reputation in the field of computer science. In 1962, the Computing Centre became its own department with Wes Graham as director.

In 1978, the organization changed its name to the Department of Computer Services (DCS) in order to reflect major changes in computing at UW. For example, the department no longer maintained only large DCS computers; in the early 1980s it also began providing support for microcomputers.

In 1997, the department changed its name again and became Information Systems and Technology (IST). This organization maintains UW's computer infrastructure and helps to provide electronic workplace (networking) support and other necessary computer services. Under its various names the department has maintained, repaired and upgraded UW computers and served the computing needs of students. On occasion, the Computer Centre and DCS employees wrote award winning software to improve UW's computer services.

Cory Burgener "A Final Note." *Department of Computing Services University of Waterloo: 25th Anniversary Issue*. (October 1982), 2-3.

http://ist.uwaterloo.ca/

http://communications.uwaterloo.ca/Gazette/1999/sep08/graham.html

http://www.communications.uwaterloo.ca/Gazette/1994/Gazette,%20March%202,%201994/Profile:%20Peter%20Sprung

The Computing Centre staff in the late 1960s. In the back row, on the far left-hand side of the picture is Paul Dirksen, who was to become Deputy Director in 1972, upon his return from a short stint at the University of Manitoba. Photo courtesy of UW Special Collections/Don Cowan.

Computer Science Days

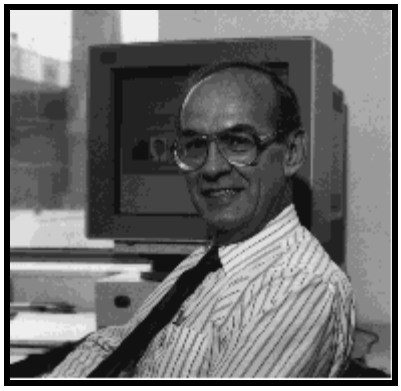
Each Saturday, during the winter months, 200 high school students came to UW to attend lectures on computer programming and vocational guidance in computing. In addition, the students were given access to the computers and they could run simple programs.

Students came from every part of Ontario and the program helped to establish the reputation of UW among the elite of Ontario's High Schools. (All the students who attended Computer Science Days were first-class honours students. Many of them who had considered attending other universities were won over to Waterloo).

The program began in 1964, and by the 1966-67 school year over 4,000 high school students were attending Computer Science Days. By 1975, this number had more than doubled to 10,000 (Ponzo 34).

UW Special Collections. GA 133-943. Wes Graham Fonds. Series UW Files to 1973. "COMPUTER SCIENCE DAY NEWSLETTER," Computing Centre Newsletter (October 11, 1966), 5.

Three visitors prepare to use the IBM 1620 during one UW's Computer Science Days. Photo courtesy of UW Special Collections/Don Cowan.

Computer Systems Group (CSG)	Established in1969 to capitalize on the success of the WATFOR compilers, CSG was a software development and licensing organization on the UW campus. Although not a formal academic unit, the CSG created many programs and hardware systems that supported the teaching of CS courses at UW. The group was devoted to the development and maintenance of software and computer research, and as a non-profit organization it generated most of its income from royalties on software. Surplus funds from CSG software sales were reinvested in computer research at UW. The group was formally recognized as a university-wide research group by the UW Board of Governors at its meeting in February, 1973 and officially returned as a research group to the Faculty of Mathematics in 1992. CSG's website is http://csg.uwaterloo.ca). UW Special Collections. GA 133-916. Wes Graham Fonds. Series 4.1: UW Files to 1973. Memorandum March 26, 1969. UW Special Collections. GA 133-916. Wes Graham Fonds. Series 4.1: UW Files to 1973. A Proposal for a Computer Systems Group, 1, 4-5. UW Special Collections. GA 133-917. Wes Graham Fonds. Series 4.1: UW Files to 1973. Constitution of the Computer Systems Group – University of Waterloo, 1-3. UW Special Collections. GA 133-917. Wes Graham Fonds. Series 4.1: UW Files to 1973. Minutes of Computer Systems Group Meeting, Held Monday 11 June 1973, 2.  Don Cowan as Director of the CSG was a long time colleague of Wes Graham, Paul Dirksen, and Ian McPhee as well as the first Chair of the Department of Computer Science at UW. He is a genuine pioneer in the field, having begun his career at UW in 1960. Photo: http://csg.uwaterloo.ca/

CDC	The acronym for "Control Data Corporation," founded in 1957, in Minneapolis, Minnesota. CDC grew rapidly to become a worldwide, multibillion-dollar enterprise, the major producer of some of the world's most powerful computers and peripheral products and a wide range of vital computer services. The company developed some of the fastest computers of the time, including the CDC 6600, generally considered to be the first supercomputer. In 1992, Control Data Corporation ceased operations and was split into two companies: Ceridian Corporation and Control Data Systems, Inc.

This photo, taken around 1963, shows a Control Data 160A computer at NASA's Goddard Spaceflight Center in Greenbelt Maryland. For an explanation, refer to the annotated image on Dr. Jones W. Jones website as given below. This photo and most of the text above is from Dr. Jones, Associate Professor of Computer Science at Iowa University. Photo: http://www.cs.uiowa.edu/~jones/cdc160/photo/

DALSA Inc.	DALSA Inc. is a spin-off company from the University of Waterloo, created through the research of Savvas Chamberlain, a UW electrical and computer engineering professor. In 1980, Chamberlain pioneered a micro-chip that was as sensitive to light as the human eye. His company manufactures advanced and customized camera equipment and components. In the early 1990s DALSA's sales stood at 10 to $15 million per year and were increasing by 30-35% annually. DALSA products have applications in everything from Hollywood films to medical imaging, from astronomy to still photography. http://newsrelease.uwaterloo.ca/archive/news.php?id=309 In September 1997, DALSA and NSERC launched an Industrial Research Chair in Sensor Technology at UW, providing $1.7 million over five years to help fund the work of Dr. Arokia Nathan, a leader in the field of silicon sensor fabrication. http://www.newsrelease.uwaterloo.ca/archive/news.php?id=850  Savvas Chamberlain is CEO of DALSA Inc., a high-technology firm spun off from the University of Waterloo and based in Waterloo.
Database	A database is a collection of information organized in such a way that a computer program can quickly select desired pieces of information. A database is much like an electronic filing system. The word is frequently abbreviated DB. (This definition is adapted from www.webopedia.com). In 1988, CSG became involved in creating user-friendly databases. The group continued to experiment with structured data in the early 1990s and began some preliminary work on databases for use in multi-media (Ponzo 95).

Datapac network

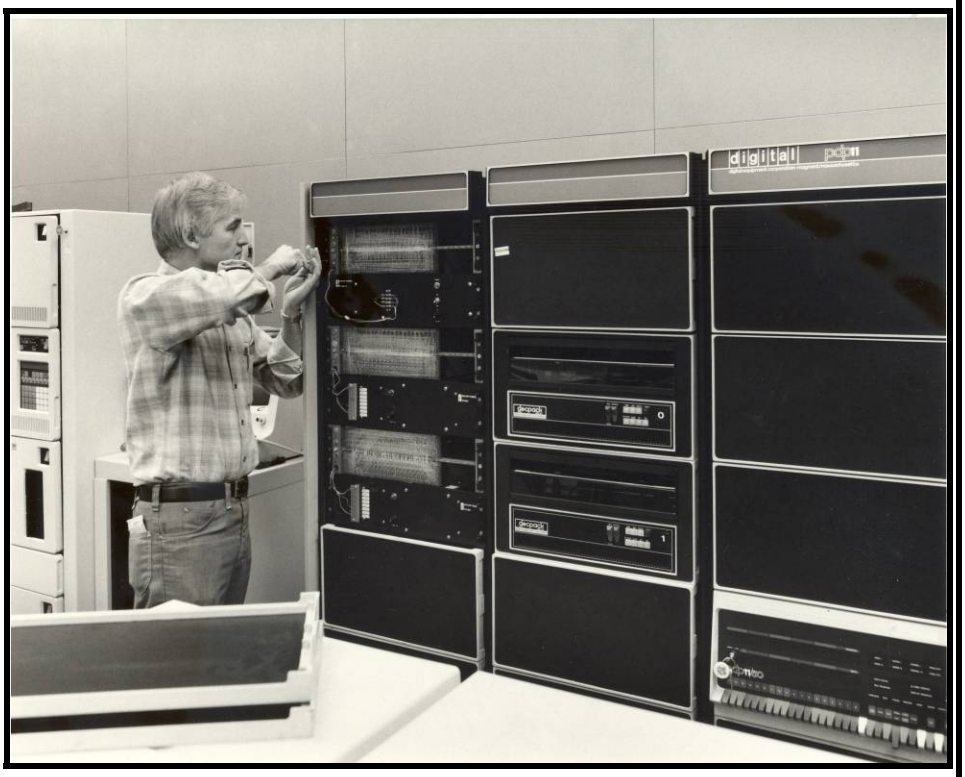
Datapac was the Bell Canada computer network. The Datapac network was a nationwide, common-user data network provided by the Computer Communications Group of the TransCanada Telephone System. The system operated on a packet switching system that was much more efficient than traditional circuit switching networks. Datapac first became available to consumers in 1976.

E.B. Ogle, Long Distance Please: The Story of the TransCanada Telephone System. (Toronto: Collins Publishers, 1979), 285.

UW hooked up its Honeywell 6050 computer to the system in 1978. At the time, Datapac was serving seventy-two cities (Ponzo 51).

DEC

DEC is the acronym for "Digital Equipment Corporation" which was a pioneering company in the American computer industry. It was later acquired by Compaq, which subsequently merged with Hewlett-Packard. As of 2004 DEC product lines were still produced under the HP name.



There are many points of contact between UW and DEC. Some of the highlights include DEC's support for the creation of WATFAC in 1974 and the company's $25 million research agreement with UW in 1984. Here a UW service person (Kim Spencely) works on a DEC donated machine in 1985, one year after the historic agreement between the agencies.

FORGO

This acronym stands for “Fortran to Go.” This interpreter was developed in the early 1960s for the IBM 1620 at the University of Wisconsin. An interpreter using Fortran I-III language, it was intended to facilitate student computing and was the early inspiration for UW’s WATFOR.

The University of Wisconsin at Madison is credited with creating the FORGO interpreter, the program that gave UW its first taste of Cafeteria style computing. UW Professor Wes Graham and mathematics undergraduate student Gus German discovered the program when they accompanied Mathematics Professor Ralph Stanton, who was teaching a summer course at UW-M, to Wisconsin.

UW obtained a copy of FORGO in 1962 and under Wes Graham’s direction, Don Cowan and the Computing Centre Staff modified the program to make it useful to Waterloo and other academic users. UW added an accounting package that counted the exact number of jobs being run using the FORGO program and a “Terminate” function that automatically ended any program that contained too many statements or after a set number of answer cards were punched. The result was a large saving in paper costs. Other UW features assisted students to write working programs by helping them with “DO” loops and with branch statements. On learning of them, other Canadian and American universities requested these modifications from UW.

UW Special Collections. GA 133-1007. Wes Graham Fonds. Series 4.1: UW Files to 1973.

Letter: February 13, 1964, From: John C. Miler, Computing Centre, Montana State College, To: D.D. Cowan, Computing Centre, UW.

Letter: February 11, 1964, From: Mr. Gerald W. Locke, Computer Centre, Texas Technological College, To: D.D. Cowan, Computer Centre, UW.

Letter: February 14, 1964, Mr. Robert M. O’Brien, Computation Centre, Northeastern University, To: Mr. J. Wesley Graham, University of Waterloo.

Image: UW-M’s crest: http://tc.engr.wisc.edu/uw/

FORTRAN	The acronym FORTRAN stands for “FORmula TRANslation” language. Released in 1956, FORTRAN was the very first computer programming language. It has gone through numerous revisions and has mostly been used as a high-level programming language for mathematical and scientific purposes.

Programmer's
Reference Manual
October 15, 1956

THE FORTRAN
AUTOMATIC CODING SYSTEM
FOR THE
IBM 704 EDPM

This manual supersedes all earlier information about the FORTRAN system. It describes the system which will be made available during late 1956, and is intended to permit planning and FORTRAN coding in advance of that time. An Introductory Programmer's Manual and an Operator's Manual will also be issued.

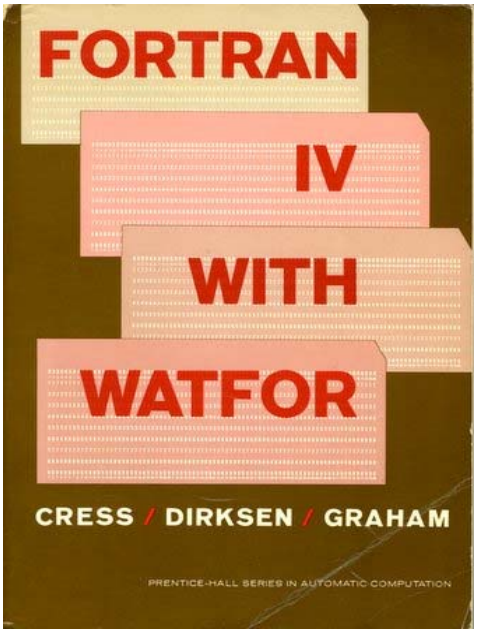
APPLIED SCIENCE DIVISION
AND PROGRAMMING RESEARCH DEPT.
International Business Machines Corporation
590 Madison Ave., New York 22, N. Y.

FORTRAN Manual. Photo: Computer History Museum

Geac	An acronym that stands for “German and Company”. It was a computer corporation founded in 1971 by R. Angus “Gus” German, former UW student and co-creator of *WATFOR*, and his partner Bob Isserdstedt. Geac has become a global enterprise software company that addresses the needs of libraries and other businesses. Geac website: http://www.geac.com/page/default_CORP

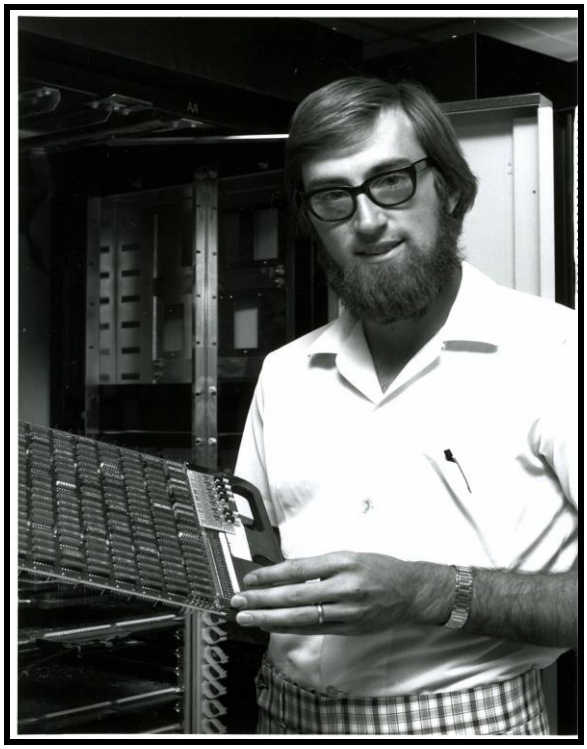
The Grace Murray Hopper Award	This award was given to Paul Dirksen and Paul Cress in 1972 for their work on the WATFOR 360 compiler (later known as WATFIV, once the program was given various language extensions). The award is named for Grace Murray Hopper, the creator of COBOL. The award named in Hopper's honour is given to recognize the contributions of distinguished computer programmers under the age of thirty-five.

Grace Murray Hopper (1906-1992) pioneered the use of compilers and high-level programming languages in the early 1950s. Later she created COBOL. She served in the US navy starting in 1943 and was promoted to the rank of Rear Admiral in 1985. Photo: http://images.google.ca/imgres?imgurl=http://www.hopper.navy.mil/grace/grace.gif&imgrefurl=http://www.hopper.navy.mil/grace/grace.htm&h

High-level language	A high-level language is a programming language such as C, FORTRAN, or Pascal that enables a programmer to write programs that are more or less independent of a particular type of computer. Such languages are considered high-level because they are closer to human languages and further from machine languages. In contrast, assembly languages are considered low-level because they are very close to machine languages. The main advantage of high-level languages over low-level languages is that they are easier to read, write, and maintain. Ultimately, programs written in a high-level language must be translated into machine language by a compiler or interpreter. The first high-level programming languages were designed in the 1950s. Today there are dozens of different languages, including Ada, Algol, BASIC, COBOL, C, C++, FORTRAN, LISP, Pascal and PROLOG. (This definition is from www.webopedia.com).  This is Wes Graham, Paul Dirksen, and Paul Cress' textbook on computing using FORTRAN with the WATFOR 360 compiler. The book was written to follow up the release of the WATFOR 360 program in 1967. It was one of Prentice Hall's best all time sellers with some 250,000 copies sold by 1980. (UW Special Collections. GA 133-746. Wes Graham Fonds. Series 3.1: Works Manuscripts. "Prentice Hall Promotional Material," 1980.) Image courtesy of Paul Dirksen/K.M McLaughlin.
Honeywell	Honeywell is a major American multinational corporation that produces electronic control systems and automation equipment. It is a major supplier of engineering services and avionics for NASA, Boeing, and the United States' Department of Defense.

Honeywell 6050

The 6050 arrived at UW in 1972; it could process 6,000 jobs and 15 million lines of print in a single month. The Honeywell 6050 had more capacity then the IBM 360/75. It also brought electronic mail to UW for the first time. Much beloved by faculty, staff, and students, the machine was known as the "honey bun" or simply the "bun" (Ponzo 51).



Rick Beach with the Honeywell 6050. Photo courtesy of UW Special Collections/Don Cowan, '77-6-28.

HOSTCM

HOSTCM was short for “Host Communications Module,” which was a simple remote file system. HOSTCM was produced to support data sharing on the MicroWAT system. It supported communication with DEC, PDP-11, VAX, and IBM 370 and Series 1/ computers. The system first appeared in 1981 (Cowan, Graham, Mackie et al. 30).

UW Special Collections. GA 133-734. Wes Graham Fonds. Series 3.1: Works: Manuscripts, MicroWAT – A Personal Workstation of Modular Design, 1982, 11.

The illustration above is a price list for a PDP-11, one of the computers supported by the HOSTCM system.

IBM System/360

IBM (International Business Machines) introduced the System/360 in 1964, the first large "family" of computers to use interchangeable software and peripheral equipment. It was a bold departure from the monolithic, one-size-fits-all mainframe. System/360 offered a choice of five processors and nineteen combinations of power, speed, and memory. A user could operate the same magnetic tape and disk products available with other computers but with 100 times more power. System/360 also offered dramatic performance gains, thanks to Solid Logic Technology - half-inch ceramic modules containing circuitry far denser, faster and more reliable than earlier transistors. Link to press release and specifications: http://www-03.ibm.com/ibm/history/exhibits/mainframe/mainframe_PR360.html

IBM 360/40

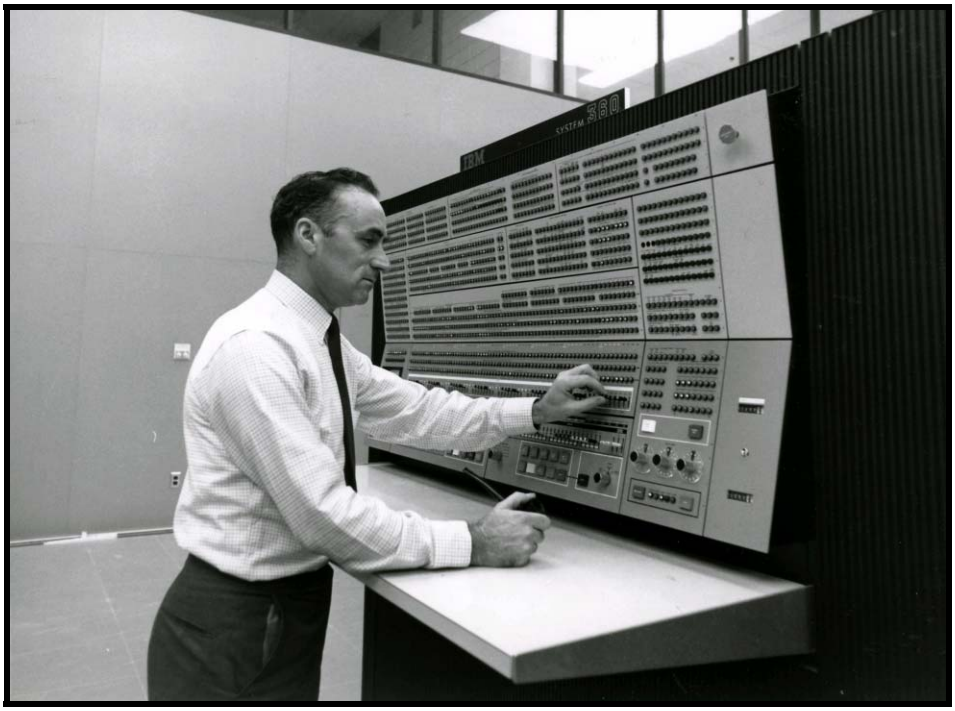
UW installed an IBM 360 model 40 in June of 1966. The acquisition of the computer was a stop-gap measure that allowed university staff, faculty and students to work with the System 360 until the model 75 arrived in January of 1968. At the time, Wes Graham noted: "[A]ny expenditure [on the 360/40] in terms of time, talent, experience and money, would automatically carry over to the model 75." The model 40 was returned to IBM when UW took delivery of the model 75 in 1968. This machine was used to develop WATFOR 360.

UW Special Collections. GA 133-601. Wes Graham Fonds. Series 3.1: Works: Manuscripts, Brief History of Digital Computation, 1966, 51.

The IBM 360/40. Photo: IBM's online archive: http://www-03.ibm.com/ibm/history/exhibits/mainframe/mainframe_2423PH2040.html

IBM 360/75

The IBM 360 model 75 computer was installed at UW in early 1967. It replaced the 7040-1401 integrated computer system installed in 1964. At the time, it was said to be the largest and fastest computer in Canada, with half a million bytes of core memory and an internal speed some twenty times faster than the 7040 (Ponzo 32). The 360/75 could execute about 1 million Instructions Per Second (MIPS). It also had about 1 million bytes of memory.



A UW Staff member (George Hill) working on the main console of the IBM 360/75 in the Mathematics and Computer Building's "Red Room." Photo courtesy UW Archives/Don Cowan.

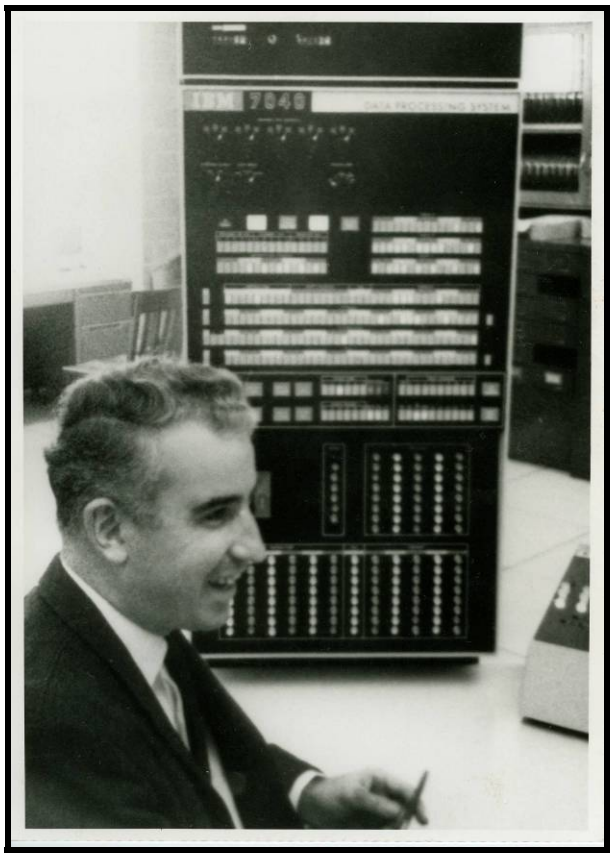
IBM 610

The IBM 610 arrived at UW in early 1960. It was the first computer that the university leased from any manufacturer. It was a digital machine with a patch panel for programming and a paper tape reader that could carry some output. It was used in Electrical Engineering and Mathematics labs. UW's engineers were perhaps the first in Canada to have the option of using a computer in their laboratory work (Ponzo 22).

IBM 1401	The IBM 1401 series, first introduced in 1960 came with three available features, a processing card system, processing tape system, and a data processing system. Each incarnation of the 1401 allowed for additional features to increase speed of processing and data storage capacity. It was one of a number of IBM machines used at UW. Link to IBM archives with full specifications: http://www-03.ibm.com/ibm/history/exhibits/mainframe/mainframe_PP1410.html
IBM 1620	In 1961 the IBM 1620 arrived at UW. The 610 had been brought in merely to fill the gap while faculty and students waited for the arrival of the 1620. The new machine was equipped with Symbolic Programming System (SPS) and a FORTRAN translator. The 1620 also had a paper tape reader for input and was later fitted with a keypunch. In the Spring of 1963, UW purchased the 1620 outright. Previously the university had leased the computer from IBM. The 1620 became much quicker and far more useable after the FORGO compiler was obtained from the University of Wisconsin (Ponzo 21-23). IBM archives link: http://www-03.ibm.com/ibm/history/exhibits/mainframe/mainframe_PP1620.html
	
	From Left to Right: Doug Lawson, lecturer, Prof. J. Wesley Graham, and IBM salesperson Tom McNulty, Manager, IBM Kitchener Office.

IBM 7040 and 1401

In the fall of 1964, the IBM 7040 arrived at UW. It was 100 times faster than the 1620 model then in use. The smaller 1401 computer was to be used to handle input-output. Peripherals included a card reader, eight tape drives, a disk file storage system, and a high-speed printer. The 7040-1401 system was the first such integrated computer installation in Canada. (Ponzo 27).



The IBM 7040. (The machine was worth over $1 million on its own and over $2 million when combined with the 1401 and peripherals). Photo courtesy of UW Special Collections/Don Cowan.

IBM 1710

The IBM 1710 arrived on the UW campus in November 1964, and served as the university's special purpose Process Control computer. It ran twenty-four hours a day, seven days a week, since it had to be constantly available to monitor the experiments conducted by members of the faculty located remotely in research laboratories on campus.

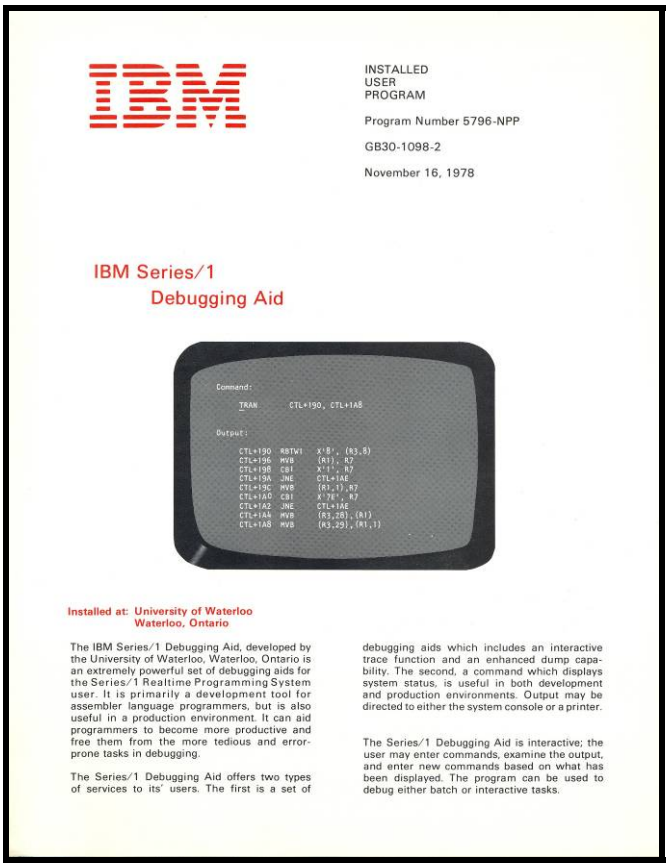
UW Special Collections. GA 133-601. Fonds Series 3.1: Works: Manuscripts. Wes Graham Fonds. Wes Graham, A Brief History of Digital Computation 1966, p.38

IBM Series/1

The IBM Series/1 was a minicomputer that figured heavily in UW's MRJE and WIDJET job entry systems. The MRJE and WIDJET allowed UW to phase out cafeteria-style computing and eliminated associated costs in paper and labour. With UW's help, IBM greatly improved software on the Series/1 and made progress toward construction of the Personal Computers (PCs) networks we know today. UW staff and faculty became adept at writing portable software for minicomputers like the Series/1.

UW Special Collections. GA 133-1412. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. IBM Series/1 Waterloo Interactive Direct Job Entry Terminal System (January 4, 1978), passim.

UW Special Collections. GA 133-1411. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. IBM Series/1 Multileaving Remote Job Entry System (MRJE) (November 16, 1978), passim.



IBM

INSTALLED
USER
PROGRAM

Program Number 5796-NPP

GB30-1098-2

November 16, 1978

IBM Series/1
Debugging Aid

Command:

TRAN CTL+190, CTL+1A8

Output:

```
CTL+190  RBTW1  X'8', (R3,8)
CTL+196  MVB    (R1), R2
CTL+198  CBI    X'1', R7
CTL+19A  JNE    CTL+1AE
CTL+19C  MVB    (R1,1),R7
CTL+1A0  CBI    X'7E', R7
CTL+1A2  JNE    CTL+1AE
CTL+1A4  MVB    (R3,28),(R1)
CTL+1A8  MVB    (R3,29),(R1,1)
```

Installed at: University of Waterloo
Waterloo, Ontario

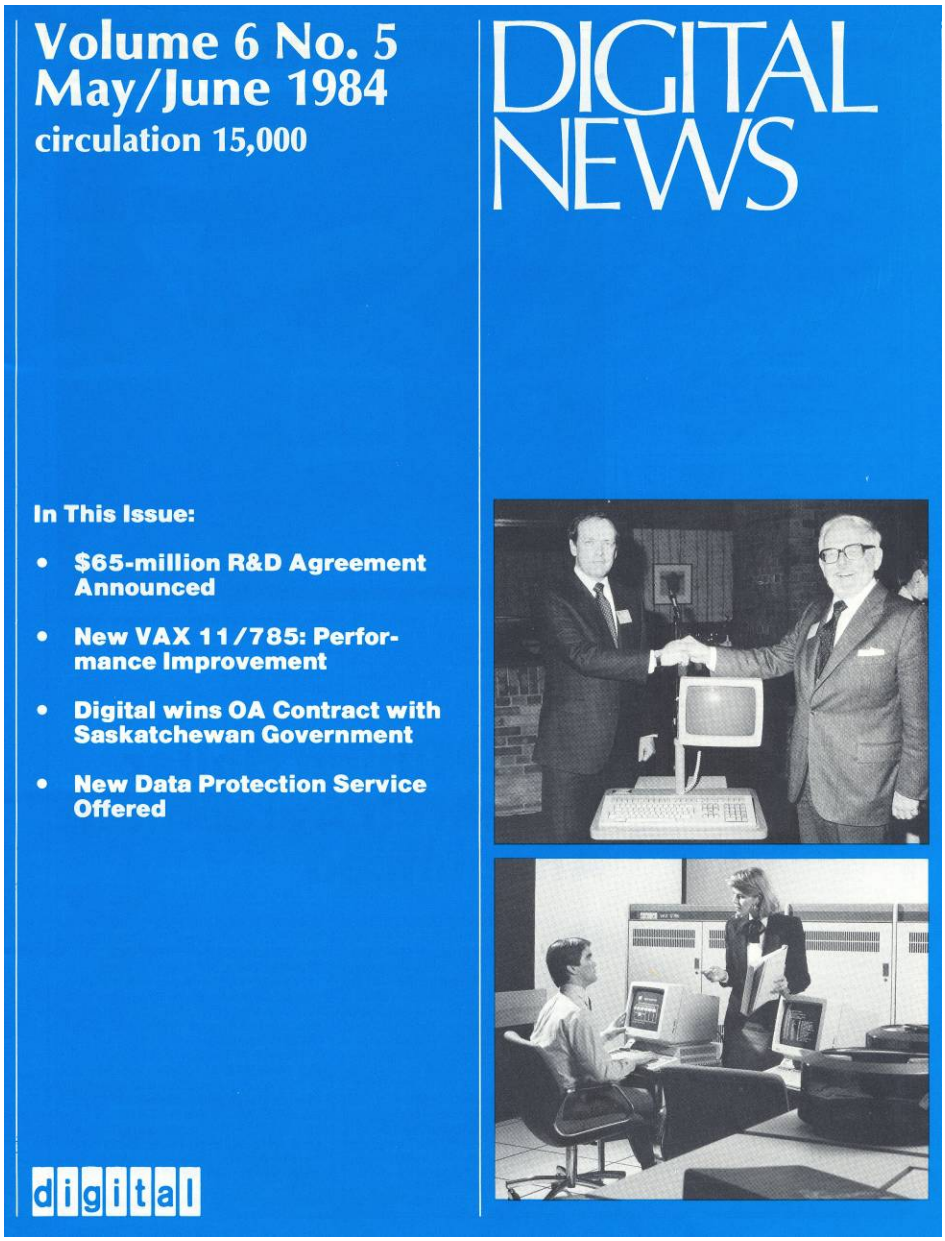
The IBM Series/1 Debugging Aid, developed by the University of Waterloo, Waterloo, Ontario is an extremely powerful set of debugging aids for the Series/1 Realtime Programming System user. It is primarily a development tool for assembler language programmers, but is also useful in a production environment. It can aid programmers to become more productive and free them from the more tedious and error-prone tasks in debugging.

The Series/1 Debugging Aid offers two types of services to its' users. The first is a set of debugging aids which includes an interactive trace function and an enhanced dump capability. The second, a command which displays system status, is useful in both development and production environments. Output may be directed to either the system console or a printer.

The Series/1 Debugging Aid is interactive; the user may enter commands, examine the output, and enter new commands based on what has been displayed. The program can be used to debug either batch or interactive tasks.

As networks became a viable method of delivering computing services to students' minicomputers like the IBM Series/1 and DEC PDP and later VAX computer lines came into wide use at UW. This wide-spread use created a need for a broad range of software. The IBM brochure above is an advertisement for a Series/1 debugging aid. Debugging facilities are always a major feature of any student-oriented software.

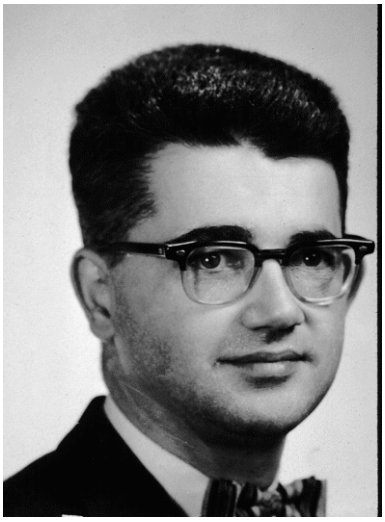
ICR	The ICR, or Institute for Computer Research, was founded in February 1982 with Eric Manning as its director. The purpose of the organization was to strengthen ties between the university and industry. The ICR offered sharing of research through seminars, formal research papers, and campus visits with UW faculty and research staff. By 17 June 1985 the ICR could count eight Corporate Partners, twenty-one Principal Affiliates, and three Affiliates in their corporate information-sharing program. Corporate partners tended to have freer access to UW research materials and paid higher fees than Affiliates. The ICR also encouraged consultation relationships with UW faculty, and helped to coordinate the various research projects. Initially the ICR was a federation of eight existing research groups comprising thirty-four faculty members, twenty-five professional staff and one hundred postgraduate students. The main purpose of the ICR was to promote cohesion among research groups. Until the Davis Centre was completed in 1988, the ICR was housed in five offices in Mathematics and Computer Building starting in early 1985. The office space allowed the ICR to receive visitors from various companies. UW Special Collections. GA 133-1419. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. Draft: 24 April 1985: ICR Corporate Partners Policy, 1, 3-4. UW Special Collections. GA 133-1419. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. Institute for Computer Research Affiliate Membership As of June 17, 1985. +Corporate Partners paid $250,000 over five years for membership, in spite of the cost, ICR added three more companies by October 1985. Source: UW Special Collections. GA 133-1419. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. Memorandum October 11, 1985. From: Eric Manning, To Individual and Federated Group Members, Re: Money. UW Special Collections. GA 133-1420. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. ICR: NSERC Infrastructure Application, 17 September 1982.

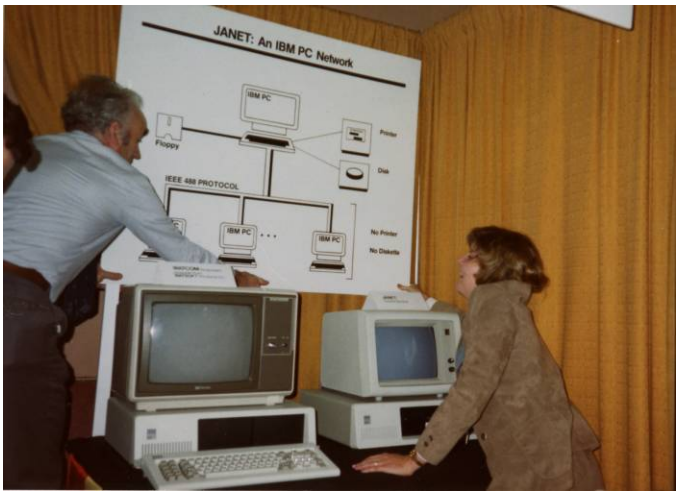


DEC was a founding member of the ICR in 1982. In 1984, the company also announced a $65 million Research and Development Agreement with UW (DEC gave UW $25 million for equipment, and the Government of Ontario provided $40 million for sustained research). Image: UW Special Collections. GA 133-1323. Wes Graham Fonds. Series 4.2: UW Post 1973 Files. Digital News.

Instruction	An instruction is an order given to a computer processor by a computer program. (This has been adopted from www.whatis.techtarget.com).

Intellectual Property Rights	Intellectual Property (IP) refers to any ideas, inventions, technology, biological organisms, software, creative expression (and derivatives thereof), in which a proprietary interest may be claimed. Creative ideas and expressions of the human mind that possess commercial value receive the legal protection of a property right. The major legal mechanisms for protecting intellectual property rights are copyrights, patents, and trademarks. Intellectual property rights enable owners to select who may access and use their property, and to protect it from unauthorized use. At UW individuals who created intellectual property were allowed to retain the IP Rights, which resulted in an environment that encouraged a number of successful spin-off and start-up companies. This policy made UW different from many other universities and has been frequently cited as a key part of the school's success. In other faculties such as Engineering, the patenting of ideas was equally important and the University developed early on a modus vivendi that supported a faculty member's rights to his or her intellectual property.  As the University's Licensing Officer, Peter Sprung assisted in implementing UW's IP policy and in drafting the early agreements that shaped the University's *modus operandi* in these areas. Photo courtesy of UW Special Collections/Don Cowan, 1973.

Interpreter	An interpreter is a program that translates high-level instructions into an intermediate form, which it then executes. In contrast, a compiler simply translates instructions directly into machine language. Compiled programs generally run faster than interpreted programs. The advantage of an interpreter, however, is that it does not need to go through the compilation stage during which machine instructions are generated. This process can be time-consuming if the program is long. The interpreter, on the other hand, can immediately execute high-level programs. For this reason, interpreters are sometimes used in the development of programs, when a programmer wants to add small sections and test them quickly. In addition, interpreters are often used in education because they allow students to program interactively. (This definition has been adapted from www.webopedia.com).
LISP	LISP is an acronym for "list processor," a high-level programming language especially popular for artificial intelligence applications. LISP was developed in the early 1960s by John McCarthy at MIT. (This definition has been taken from www.webopedia .com).
	
	John McCarthy of MIT. Photo: http://www8.informatik.uni-erlangen.de/html/gif/mccarthy.gif
LISP 1.5	By the mid-1960s, LISP had become a programming language important to creation of artificial intelligence. In 1966, UW wrote the LISP 1.5 interpreter program, which was the first accurate implementation for the IBM 360 family of computers (Cowan, Graham, Mackie et al. 27).

JANET	The acronym stands for “Just Another Network” or for “Jerry and Adrian’s Network,” in honour of Adrian Weerheim and Jerry Bolce, the DCS (Department of Computer of Services) employees credited with the design of the network. JANET was a network developed for UW by DCS in 1982. At its inception JANET was designed as a local area network (LAN) to support a lab of IBM Personal Computers (PCs) installed in UW’s Physics labs. In 1984, IBM introduced new network technology and UW responded with upgrades to JANET. In 1989, 400 JANET systems had been set up in installations throughout the world (Cowan, Graham, Mackie et al. 93). At UW roughly 32 JANET networks were in place by that time. UW Special Collections. GA 133-1429. Series 4.2: UW Post-1973 Files. Networks for Education at The University of Waterloo.  Preparations for a Waterloo JANET Network seminar presentation. (George Hill and Shirley Fenton of DCS) Photo: Courtesy UW Special Collections/Don Cowan (no date given).

In this photo, a UW staff-person uses an IBM personal computer of the type that was generally supported on the JANET network. Only with the development of MacJANET, did Apple products become part of JANET networks. Photo courtesy of UW Archives/Don Cowan.

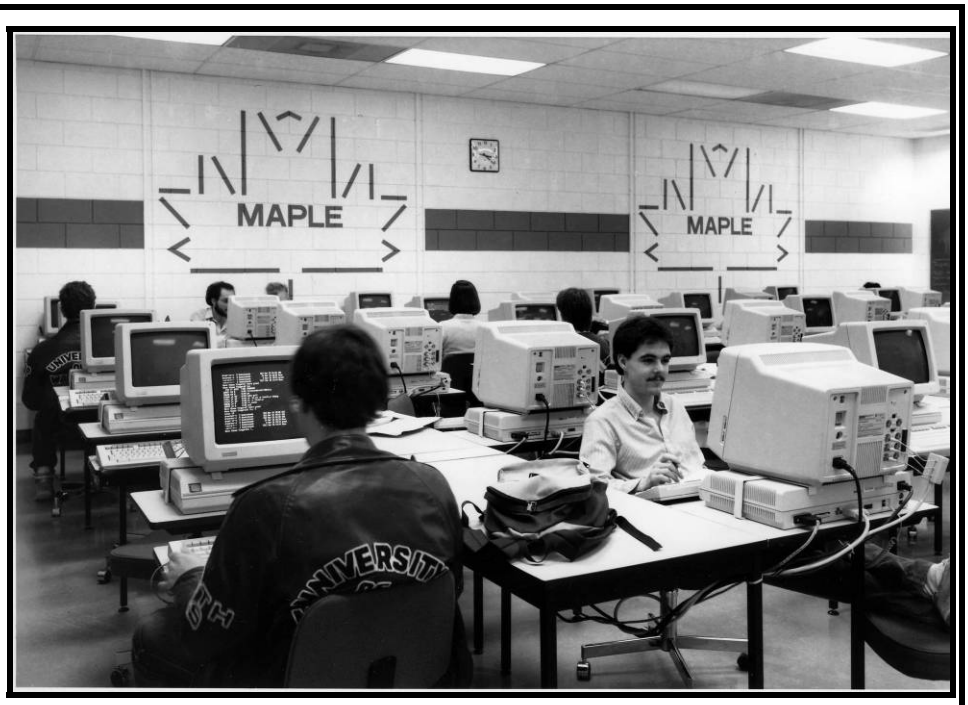
MacJANET

In 1985, the CSG designed a version of JANET for Macintosh hardware. The network was used in the CS 100 course (Introduction to Computer Usage). The MacJANET network was ideal for the academic environment because it provided security through password logon. It also minimized hardware and paper costs, because assignments were available online. In addition, teaching time was maximized because course administration could be handled through the network. Shortly after it appeared, MacJANET started to be used in courses beyond CS 100.

UW Special Collections. GA 133-59. Wes Graham Fonds. Series 1.2: Biographical Articles. Carl Durance and Shirley Fenton, "Waterloo MacJANET," Minds in Motion. (Winter 1988), 27-34.

As a result of CSG's work on the project Apple donated the forty-eight computers that were used to run the course. In 1989, MacJANET was modified to include Ethernet and multi-server support so it could be used to support all core courses in CS (Ponzo 93).

Maplesoft	Maplesoft is a leading developer of advanced mathematical and analytical software. Its innovative products provide industry and academia with advanced mathematical tools that have integrated numerics and symbolics. Maplesoft, (currently) a division of Waterloo Maple Inc., was founded in 1988, with its core intellectual property developed as an advanced research project at the University of Waterloo in the early 1980's. Its tools are used at advanced research institutions and universities worldwide, and over three million people use Maplesoft technology. Academic and commercial organizations have applied Maple in nearly every technical field, including physics, engineering, aerospace, finance, telecommunications, data analysis, quantum mechanics, and many others. Maplesoft is a privately held company, headquartered in Waterloo. This material has been adapted from Maple's Website: http://www.maplesoft.com/company/about/index.aspx Some of the earliest documentation on the creation of Waterloo Maple comes from a grant proposal for a pilot project authored by UW Professors Keith Geddes and Gaston Gonnet in September of 1983. Their proposal described Maple as a compact system with efficient data structures that could handle a broad range of mathematical problems. Geddes and Gonnet asked the Mathematics Faculty for a lab with fifty to sixty 32-bit microprocessor systems that would serve roughly 300 first year students. The long term goal of the project was to serve the entire first year class of 800 students. The idea of commercializing Maplesoft developed from this early success. UW Special Collections. GA 133-1333. Wes Graham Fonds. Series 4.1: UW Post-1973 Files. The Maple Systems and Undergraduate Education: A proposal for a pilot project. Keith O. Geddes and Gaston Gaston H. Gonnet, Symbolic Computation Group-University of Waterloo.



Students work in the Maple lab at UW circa 1985. Maple, later Maplesoft, a major software company in Waterloo, started as a pilot project within UW's Faculty of Mathematics, and was first proposed by Professors Keith Geddes and Gaston Gonnet of the Symbolic Computation Group. Photo Courtesy of UW Special Collections/Don Cowan.

Micro Computers	Micro Computers were the forerunners to today's Personal Computers (PCs). They included the Commodore PET and the IBM PC, both of which were limited in power and function. UW's CSG first began developing software for them in 1979. The Micro Computers have led to a revolution in computing.

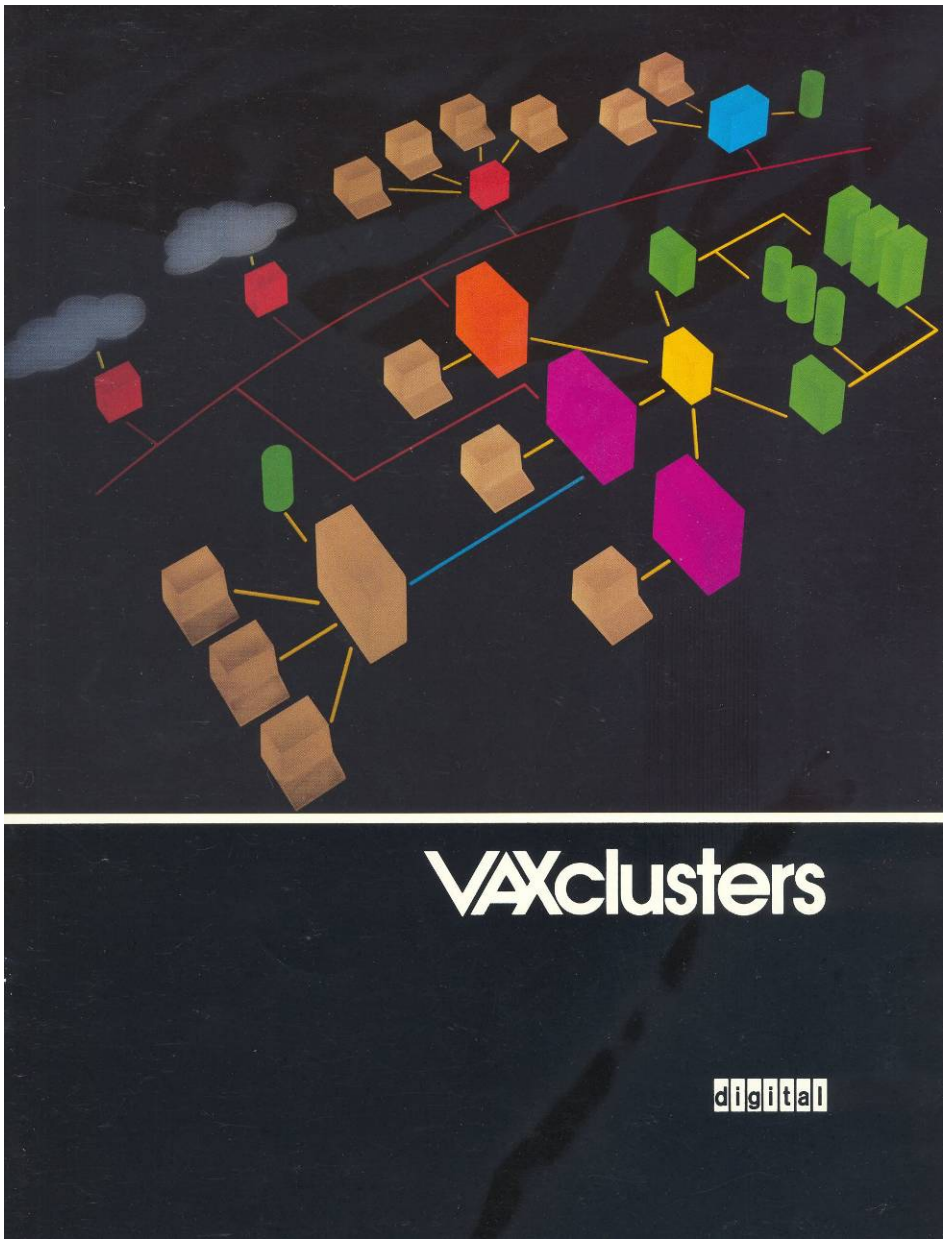
Commodore PET microcomputers in use during a WATCOM hardware design seminar given by WATCOM in 1983. Photo courtesy of UW Special Collections/Don Cowan.

MicroWAT	In 1980, the MicroWAT computer system was developed. It had a memory of one megabyte and was suitable for networking. MicroWAT software included language interpreters for APL, BASIC, COBOL, FORTRAN, and Pascal (Ponzo 92). The project produced many corporate partnerships for UW and helped advance the state-of-the art in personal computing. MicroWAT used bank-switch memory which later appeared in microcomputers as Expanded Memory Specification (EMS). The SuperPET and NABU PC also used EMS circuitry. In the course of the MicroWAT project, SuperPETS and NABU PCs made their way into many UW courses. In 1989, the SuperPET was still being used to teach CS 230 (Cowan, Graham, Mackie et al. 30). The MicroWAT was produced for UW by Northern Digital Inc., a UW spin off company. The Volker-Craig Division of the NABU Corporation also produced a version known as HITS (Highly Intelligent Terminal System). Finally, BMB Compuscience of Milton, Ontario produced a MicroWAT computer that used a two megabyte system. UW Special Collection. GA 133-734. Wes Graham Fonds. Series 3.1: Works: Manuscripts. MicroWat – A Personal Workstation of Modular Design, 1982).

Minicomputer

Minicomputers were a class of stored program digital computers suitable for general purpose applications, but smaller and less expensive with less capacity than general purpose mainframe computers.

E.B. Ogle, Long Distance Please: The Story of the TransCanada Telephone System (Toronto: Collins Publishers, 1979), 282.



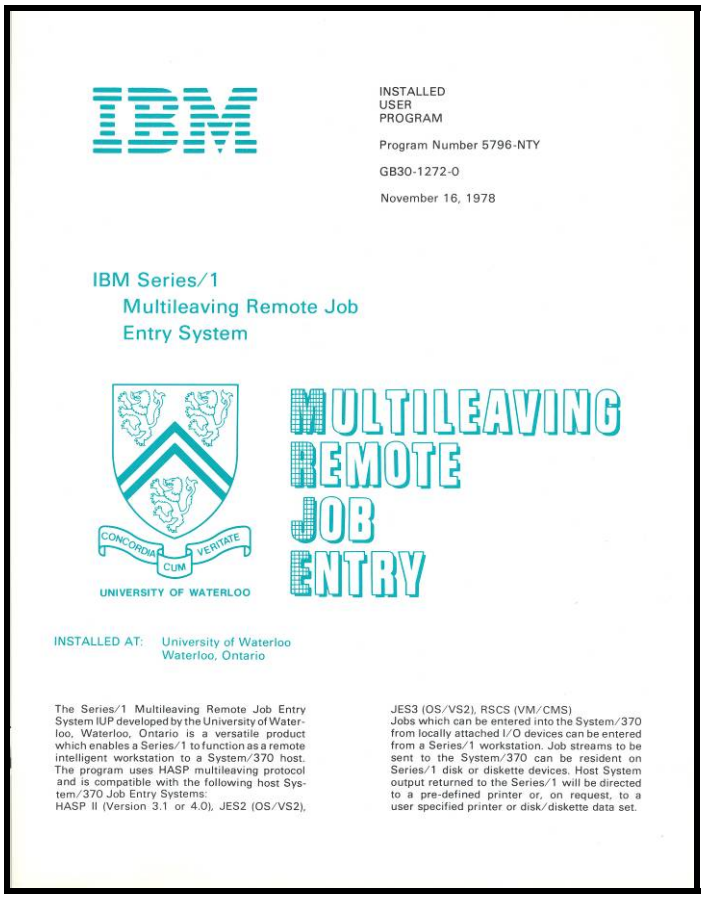
Starting in late 1970s and early 1980s, UW began to depend on computer networks in order to allow students access to computers. Networks, however, depended largely on minicomputers as the workhorses within their systems. Minicomputers like the IBM Series/1, DEC's PDP models, and later DEC's VAX line were generally the computers of choice at UW. Above is an advertisement from 1984 for VAXclusters, which refers to networking equipment available through the DEC company.

MRJE

MRJE is an acronym that stands for “Multileaving Remote Job Entry,” which was a system that was developed by UW in the late 1970s. (IBM began to market the system in November of 1978). It allowed IBM Series/1 micro-computers to function as remote intelligent workstations with the IBM 370 System mainframe serving as a host. Computer jobs could be submitted through a Series/1 terminal and executed by the 370 computer. The system also allowed student printing from remote locations.

MRJE was originally intended for use in academic settings, but IBM soon realized that this early networking technology had many potential applications in business and government. At UW the work on the MRJE project allowed members of the CSG and other UW staff members to experiment with portable software which quickly became the basis of the success of ventures like WATCOM.

UW Special Collections. GA 133-1411. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. IBM Series/1 Multileaving Remote Job Entry System (MRJE) (November 16, 1978), passim.



IBM

INSTALLED
USER
PROGRAM

Program Number 5796-NTY

GB30-1272-0

November 16, 1978

IBM Series/1
Multileaving Remote Job
Entry System

CONCORDIA VERITATE CUM

UNIVERSITY OF WATERLOO

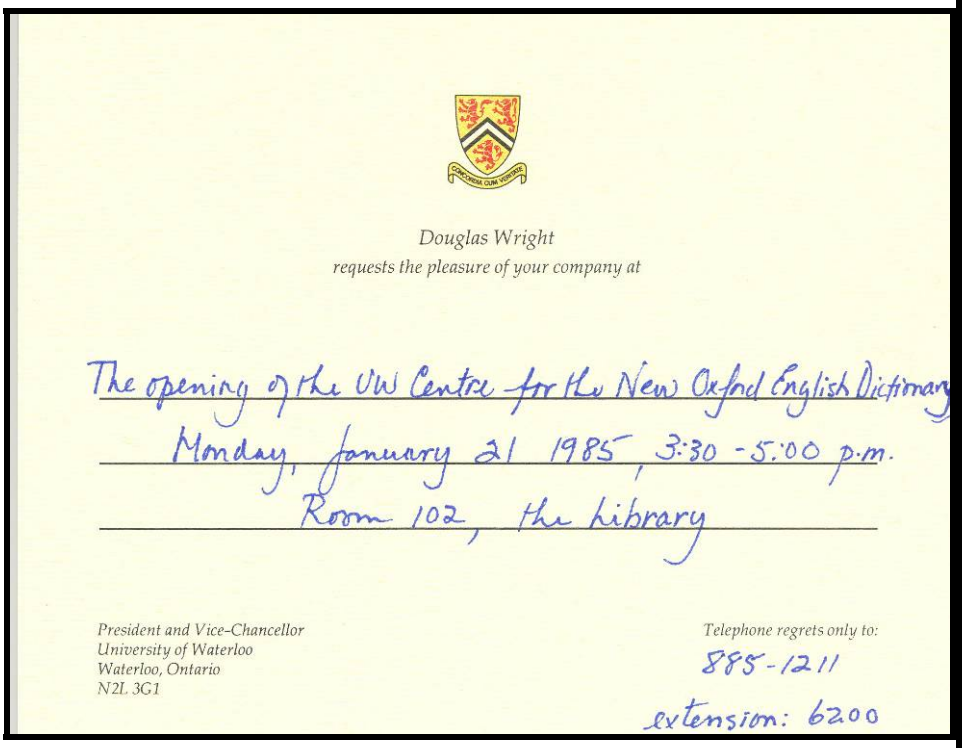
MULTILEAVING
REMOTE
JOB
ENTRY

INSTALLED AT: University of Waterloo
Waterloo, Ontario

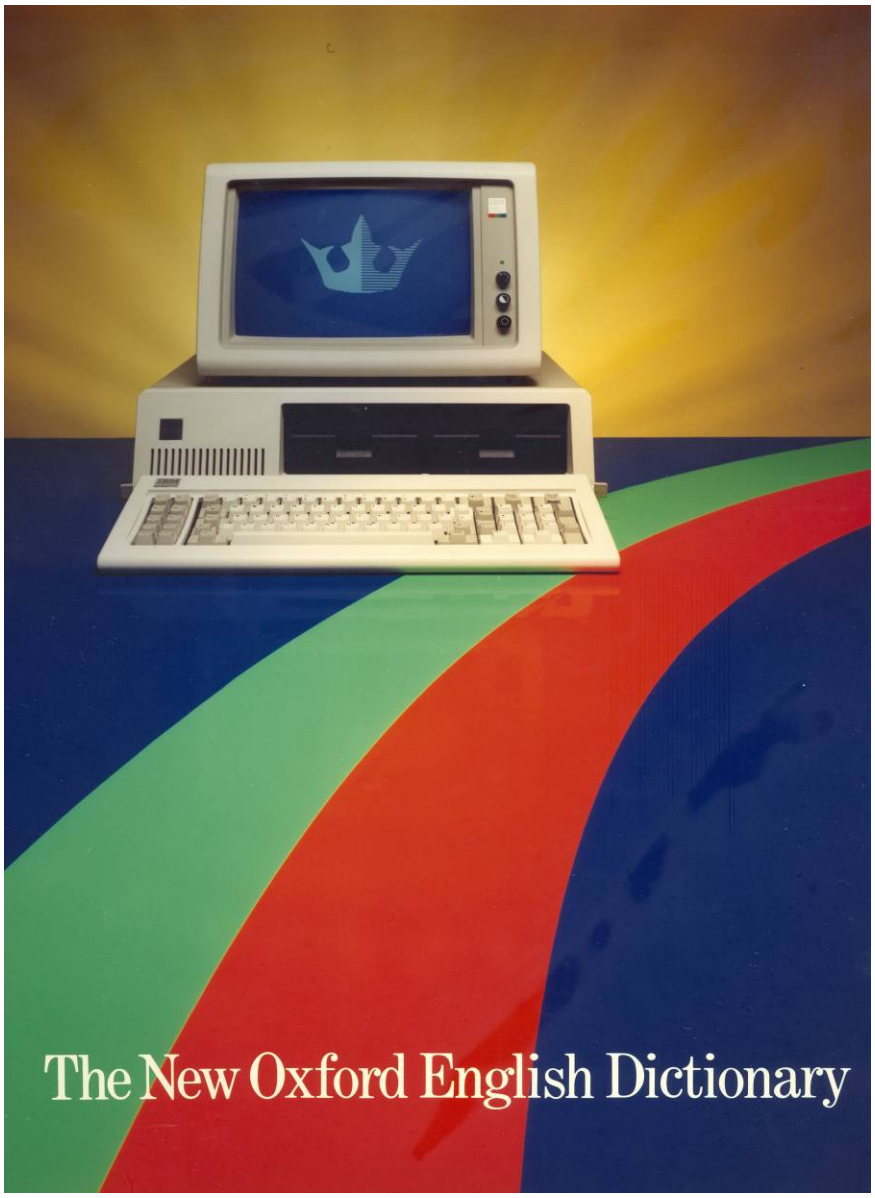
The Series/1 Multileaving Remote Job Entry System IUP developed by the University of Waterloo, Waterloo, Ontario is a versatile product which enables a Series/1 to function as a remote intelligent workstation to a System/370 host. The program uses HASP multileaving protocol and is compatible with the following host System/370 Job Entry Systems:
HASP II (Version 3.1 or 4.0), JES2 (OS/VS2),

JES3 (OS/VS2), RSCS (VM/CMS)
Jobs which can be entered into the System/370 from locally attached I/O devices can be entered from a Series/1 workstation. Job streams to be sent to the System/370 can be resident on Series/1 disk or diskette devices. Host System output returned to the Series/1 will be directed to a pre-defined printer or, on request, to a user specified printer or disk/diskette data set.

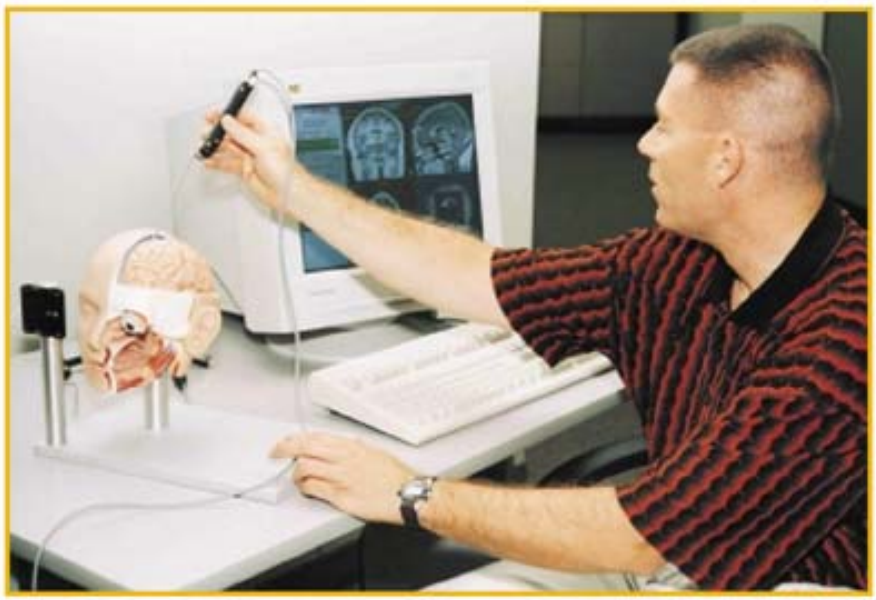
In 1978 IBM began marketing the MRJE system on UW’s behalf. It was one of many co-ventures between IBM and the university. This brochure is IBM’s description of the system, it includes order information.

NFS	An acronym that stands for "Network File System." NFS is a client/server application. In the early stages the technology was slightly unreliable, but Sun Micro-systems designed a useable commercial version in the mid-1980s. The application allows all users to access shared files through an interface called the Virtual File system (VFS) that runs on top of TCP/IP (Transmission Control Protocol/Internet Procol—TCP/IP is the basic communication language, or protocol, of the internet). Users can manipulate shared files as if they were stored locally on the user's own hard disk. With NFS, computers connected to a network operate as clients while accessing remote files, and as servers while providing remote access to local shared files. The NFS standards are publicly available and widely used. (This definition comes from www.webopedia.com).
New Oxford English Dictionary (NOED) Project	 *Douglas Wright* *requests the pleasure of your company at* The opening of the UW Centre for the New Oxford English Dictionary Monday, January 21 1985, 3:30 - 5:00 p.m. Room 102, the Library *President and Vice-Chancellor* *University of Waterloo* *Waterloo, Ontario* *N2L 3G1* *Telephone regrets only to:* 885-1211 extension: 6200 Wes Graham's invitation to the opening of the NOED Project Centre on UW's campus on January 21, 1985. Image courtesy of UW Special Collections. GA 133-1445. Wes Graham Fonds. Series 4.2: UW Post-1973 Files.

New Oxford English Dictionary (NOED) Project	In May 1984, Oxford University Press announced that it would computerize the Oxford English Dictionary, a vast work contained in twelve large volumes with four supplementary volumes. (Together the Oxford English Dictionary (OED) and its supplements comprised over 21,000 pages and 60 million words. The original OED took 50 years to prepare and its supplements almost 30 years). Not surprisingly, the OUP felt it could update the dictionary more quickly and economically if the OED and its supplements were captured in electronic form. UW joined IBM, REED International, and OUP as the only non-profit organization in the project. It was UW's responsibility to conduct a survey of the major potential users of the computerized NOED and to design an advanced database that could successfully capture the data for the NOED. OUP estimated that 1.2 million British pounds would be spent in computer costs in the course of the project. UW Special Collections. GA 133-1444. Wes Graham Fonds. Sries 4.2: UW Post-1973 Files. Project Description. The Heads of Agreement (i.e. the contract) between OUP and UW allowed Waterloo to keep the rights to any original database designs discovered in the course of the project, which lasted from 1984 to 1989. OUP, for its part, retained the rights to the content of the NOED and the right to use UW database designs for the purpose of marketing its dictionaries and other purposes internal to the company. Ultimately, the agreement proved very favourable to Waterloo because the NOED database designs were later incorporated into the product lines of Open Text Corporation, which became a highly successful spin-off company from UW. The search engine, which was the first of its kind, was the original product of Open Text and was developed even as the Internet was first becoming available. UW Special Collections. GA 133-1446. Wes Graham Fonds. Series 4.2:UW Post-1973 Files. Sixth Draft, 24 August 1984, Heads of Agreement between Oxford University Press (OUP) and the University of Waterloo (UW). For more information please see Open Text's Website at: http://www.opentext.com/corporate/our_history.html
NOED Project Centre	In January 1985 UW opened a centre to deal with the various tasks that the university had to complete in order to fulfill its responsibilities in the NOED Project. Ultimately the endeavour spawned academic and technical developments that few could have anticipated at the outset.



A brochure produced by the OUP in 1984 to describe the scope and objectives of the NOED project. UW Special Collections. GA 133-1444. Wes Graham Fonds. Series 4.2: UW Post-1973 Files.

Northern Digital Incorporated (NDI)	NDI, a UW spin-off company created in 1981 by Jerry Krist a former member of CSG, is now an international company, with offices located in Waterloo, Hong Kong, and Germany. The company designs, develops, and markets advanced optical and electromagnetic measurement technology. NDI's products are used in medicine to aid intricate surgical procedures and facilitate Computer Assisted Therapy (CAT). In industry, NDI's technologies are used in applications that range from automotive manufacturing to robotics and aerospace. In research, NDI is currently involved in studies of ergonomics, gait and posture analysis, human growth, development, and rehabilitation. NDI's website is: http://www.ndigital.com  David Ristau, project team leader at Northern Digital, demonstrates the company's Polaris System, which keeps track of surgical measurements during medical procedures. Photo and descriptive text from: www.ontariocanada.com/.../OBR-2000-May_EN.html

Numerical Analysis	Numerical analysis is the study of algorithms for the problems of continuous mathematics (as distinguished from discrete mathematics). This means that Numerical Analysis deals mainly with real variable or complex variable questions, numerical linear algebra over the real or complex fields, the solution of differential equations, and other related problems arising in the physical sciences and engineering. Former UW professor Ralph Stanton was one of the first mathematicians in Canada to do advanced work in Numerical Analysis, a study that became important to Computer Science. Stanton's textbook on the subject in the early 1960s was one of the first in Canada to identify the importance of this field of mathematics. It was particularly appropriate at Waterloo where numerical analysis became an integral part of the Engineering curriculum, assuring the new university of a prominent position in engineering practice in Canada.
Object Code	Object code is also known as machine language or low-level language. It is the only form in which a computer can read, interpret, and execute instructions. (This definition comes from www.webopedia.com).

Open Text	In June 1991, Open Text was incorporated under the Business Corporations Act of Ontario. The company's indexing and string search technology evolved out of the New Oxford English Dictionary Project (NOED) undertaken at UW. One of the results of that project was a search engine that could search any number of user-defined document structures without loss of performance. Initially, Open Text focused on marketing this software and its early derivatives. In 1995, Open Text acquired Odesta and its key technology Livelink. Using Livelink, Open Text started marketing its first internet-based product, Latitude Web Server, later known as Livelink Web Server. Largely on the strength of this technology, Open Text became a publicly traded company and generated $61 million in its first offering of shares. By 2002 Open Text had over 15 million customers in 10,000 companies and thirty-one countries around the world. For Open Text's full corporate history please see: http://www.opentext.com/corporate/our_history.html  Frank Tompa (left) and Gaston Gonnet (right) are co-creators of the technology that became the basis of the success of OpenText. Frank Tompa Photo: www.cs.uwaterloo.ca/people/snaps/small/fwtompa.jpg&imgrefurl Gaston Gonnet Photo: http://www.inf.ethz.ch/news/focus/res_focus/mar_2004
Operating System	The operating system is the most important program that runs on every general purpose computer. Operating systems perform basic tasks, such as recognizing input from the keyboard, sending output to the display screen, keeping track of files and directories on the disk, and controlling peripheral devices such as disk drives and printers. (This definition has been adapted from www.webopedia.com).
Parser	A program that dissects source code so it can be translated into object code. (This definition has been adopted from www.webopedia.com).

Pascal/Modula-2

Pascal is a high-level language developed by Niklaus Wirth in the late 1960s. The language is named for Blaise Pascal, a seventeenth century French mathematician who constructed one of the first mechanical adding machines.

Pascal is best known for its affinity to structured programming techniques. For this reason, it is a popular teaching language. Despite its success in academia, Pascal has had only modest success in the business world. Part of the resistance to Pascal, by professional programmers, stems from its inflexibility and lack of tools for developing large applications.

To address some of these criticisms, Wirth designed a new language called Modula-2. Modula-2 is similar to Pascal in many respects, but it contains additional features – which are additional properties, devices, and software applications. (These definitions are drawn from webopedia.com).

Blaise Pascal and Niklaus Wirth. Wirth named his popular educational programming language after the seventeenth century mathematician. Photo: http://www.at-mix.de/pascal.htm.

PET/SuperPET

PET was an acronym that stood for “Personal Electronic Transactor.” This microcomputer was a home/personal computer produced by Commodore starting in the late 1970s. Although it was not a top seller outside the Canadian, US, and UK educational markets, it was Commodore's first full-featured computer and would form the basis for their future success.

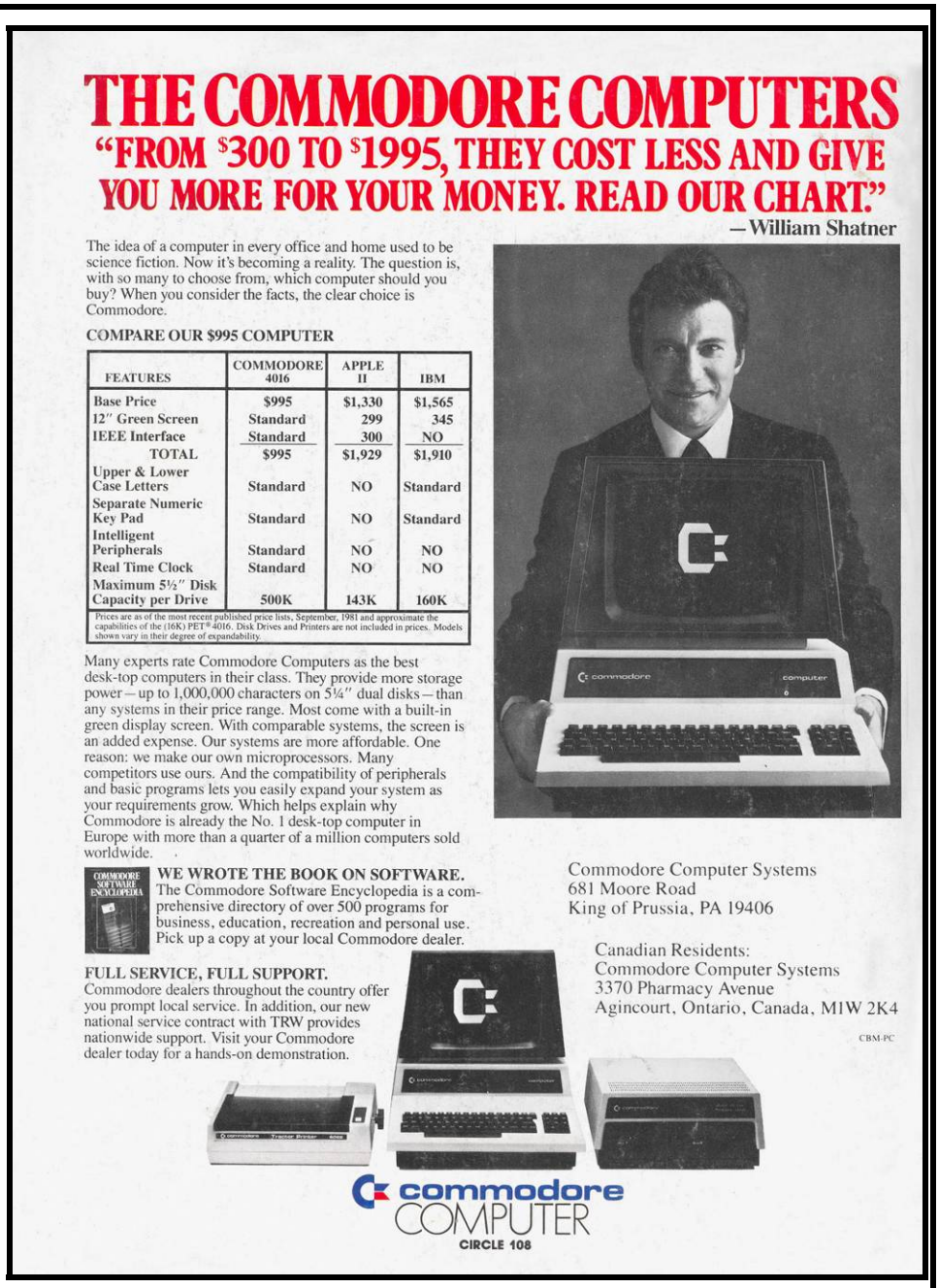
Beginning in the early 1980s, Commodore added many improvements that originated at UW to the PET. CSG researchers added virtual memory to boost the storage capacity of the PET. RS232 interfaces were installed for data sharing, and new software was created to increase the number of applications available on the PET. Interpreters with advanced error diagnostics for APL, FORTRAN, BASIC, PASCAL, and COBOL were also put in place by the CSG staff. UW’s contributions helped to create a new product known as the SuperPET. In July of 1981, thirty-five of these devices were donated to UW and were used for teaching.

Students working with PETs in a UW classroom. Photo courtesy of the UW Special Collections/Don Cowan.

UW Special Collections. GA 133-679. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. Wes Graham, History of the SuperPET, 1981.

UW Special Collections. GA 133-1272. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. Letter: April 4, 1982, From Joe Ferrari, To Don Cowan.

PET/SuperPET



THE COMMODORE COMPUTERS

"FROM $300 TO $1995, THEY COST LESS AND GIVE YOU MORE FOR YOUR MONEY. READ OUR CHART."

—William Shatner

The idea of a computer in every office and home used to be science fiction. Now it's becoming a reality. The question is, with so many to choose from, which computer should you buy? When you consider the facts, the clear choice is Commodore.

COMPARE OUR $995 COMPUTER

FEATURES	COMMODORE 4016	APPLE II	IBM
Base Price	$995	$1,330	$1,565
12" Green Screen	Standard	299	345
IEEE Interface	Standard	300	NO
TOTAL	$995	$1,929	$1,910
Upper & Lower Case Letters	Standard	NO	Standard
Separate Numeric Key Pad	Standard	NO	Standard
Intelligent Peripherals	Standard	NO	NO
Real Time Clock	Standard	NO	NO
Maximum 5½" Disk Capacity per Drive	500K	143K	160K

Prices are as of the most recent published price lists, September, 1981 and approximate the capabilities of the (16K) PET®4016. Disk Drives and Printers are not included in prices. Models shown vary in their degree of expandability.

Many experts rate Commodore Computers as the best desk-top computers in their class. They provide more storage power—up to 1,000,000 characters on 5¼" dual disks—than any systems in their price range. Most come with a built-in green display screen. With comparable systems, the screen is an added expense. Our systems are more affordable. One reason: we make our own microprocessors. Many competitors use ours. And the compatibility of peripherals and basic programs lets you easily expand your system as your requirements grow. Which helps explain why Commodore is already the No. 1 desk-top computer in Europe with more than a quarter of a million computers sold worldwide.

WE WROTE THE BOOK ON SOFTWARE.
The Commodore Software Encyclopedia is a comprehensive directory of over 500 programs for business, education, recreation and personal use. Pick up a copy at your local Commodore dealer.

FULL SERVICE, FULL SUPPORT.
Commodore dealers throughout the country offer you prompt local service. In addition, our new national service contract with TRW provides nationwide support. Visit your Commodore dealer today for a hands-on demonstration.

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3370 Pharmacy Avenue
Agincourt, Ontario, Canada, M1W 2K4

CBM-PC

commodore COMPUTER

CIRCLE 108

William Shatner as the Spokesperson for the Commodore 4016 in the 1980s.
Photo: www.commodore.ca

PET/Super PET

Why the SuperPET was developed.

By Professor Wes Graham
Director, Computer Systems Group
University of Waterloo, Waterloo,
Ontario, Canada

We needed to unburden our large mainframe from the crunch of processing 25,000 student jobs each day. Clearly, microcomputers offered many advantages such as economy, reliability and flexibility. But the software available was not suitable for our use. In addition, the addressable-memory of micro systems was too small to house the software and leave a meaningful work area. Finally, applications could easily outgrow the micro, causing extra problems for professors.

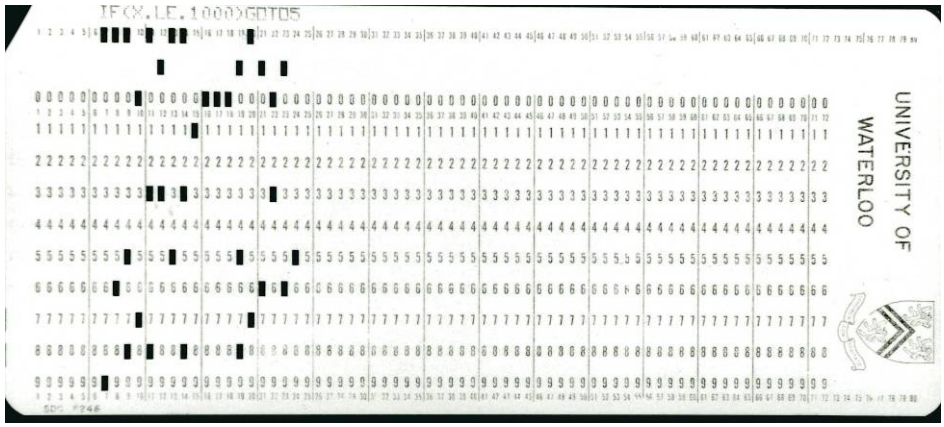
Waterloo liked the advantages of micros and set out to bridge the gaps. With software systems written to meet our needs, the software problem was solved. Then we introduced a virtual memory concept with hardware and resolved the addressable-memory size problem. By using an RS232 interface, the micro could communicate with a shared data base. And by duplicating the software system onto a mainframe, the same program could be run using large memories at high speed. Thus a student could begin to solve his problem on the micro and, if necessary, complete it on the mainframe.

Commodore adopted these ideas and created the SuperPET. We installed 35 such systems at Waterloo in July, 1981 and they have proven as effective as expected. We look forward to future applications of this technology.

*MUPET is a product of BMB Compuscience

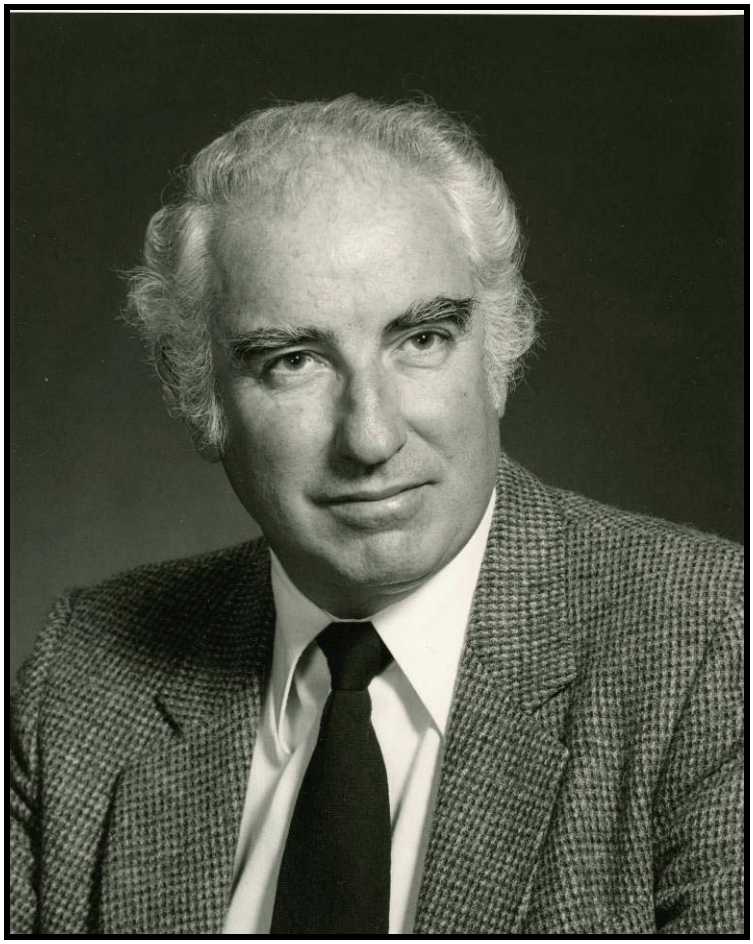
This excerpt from a Commodore advertisement shows Wes Graham as the spokesperson for Commodore circa 1982. Initially, the Commodore Company planned to have Shatner give the quote introducing the new SuperPET. Unfortunately for UW Science-Fiction fans, the two “legends” did not appear together. Graham’s brief stint as a Commodore spokesperson is, however, evidence of his wide influence in the 1980s. (As the ad makes clear, Graham became Commodore’s spokesperson because of CSG’s central role in designing the SuperPET Personal Computer). Photo: http://www.commodore.ca/gallery/brochures/SuperPet/SuperPet.htm.

PDQUISH	Completed in 1968, PDQUISH was a program which compressed partitioned data sets without copying them. This process allowed for more effective use of disk storage space on the IBM 2314 magnetic disk storage unit which tended to become quickly saturated. PDQUISH also eliminated obsolete files and eliminated any unusual memory segments created by the IBM 360/75's operating system. The program was designed at UW by Mike Doyle and first presented to other programmers working outside UW at the SHARE Conference held in Houston, Texas in February, 1968. UW Special Collections. GA 133-944. Wes Graham Fonds. Series 4.1: UW Files to 1973. J.P. Sprung (ed.), "Research and Development." The Computing Centre Newsletter. (Issue 2 March 11-2, 1968), 4.  At the Share Conference held in February 1968, UW introduced PDQUISH and three other significant programs to North America's major IBM users. Photo:http://www.srcf.ucam.org/~hmw26/join-the-dots/2004/11/page/2/ (web discussion group).
Porting	Porting is the process of moving a program from one type of computer to another. To port an application, you need to rewrite sections that are machine dependent and recompile the program on the new computer. Programs that can be ported easily are said to be portable. (This definition is adapted from www.webopedia.com).
Processor	A processor is the logic circuitry of a computer that responds to process basic instructions. (This definition has been adapted from www.whatis.techtarget.com).
Program	A program is a set of order operations for a computer. (This definition has been adopted from www.whatis.techtarget.com).

PROLOG	Prolog is short for "Programming Logic." It is a high-level language based on formal logic. Unlike traditional programming languages that are based on performing sequences of commands, Prolog is based on defining and then solving logical formulas. Prolog is sometimes called a declarative language or a rule-based language because its programs consist of a list of facts and rules. Prolog is widely used in artificial intelligence applications, particularly expert systems. (This definition is from www.webopedia.com).  *An illustration from the website of AI expert Christopher Chabris and programmer Gene Weiss. Please visit their cite at: http://www.atarimagazines.com/startv2n5/prolog.html*
Punched Card	A Punched Card was a data recording medium consisting of a stiff-paper card in which holes were punched to represent data in machine-readable format. In some systems each card contained one or more related data elements and was referred to as a unit record. E.B. Ogle, Long Distance Please: The Story of the TransCanada Telephone System. (Toronto: Collins Publishers, 1979), 285-6.  This is a punched card of the type used at UW between 1960 and 1975.

Punched/Paper tape	Punched tape is an old-fashioned form of data storage, which consists of a long strip of paper in which holes are punched to store data in a machine-readable format.  Bendix G-15 *multi-code, high-speed* PAPER TAPE READER Punched paper tape from almost any device or system equipped with a punch can now be read directly and at high speed into the Bendix G-15 computer. The unique Model PR-2 photoelectric reader accepts paper tapes *punched in any numeric* code by cash registers, accounting machines, adding machines, typewriters, analog-to-digital converters, and similar devices, whether operated manually or as part of an automatic data collecting system. Applications of the G-15 and PR-2 accessory cover a broad range of data sources. For example, in research there are wind tunnels and engine test stands, telemeter equipped missile and experimental aircraft, and strain gauge and other types of laboratory test systems. In industry there are process monitors and data loggers, production line test and measuring devices, and inventory recorders. In business there are point-of-sale recorders and office machines of many types. The PR-2 accepts paper tapes of 5, 6, 7 or 8 channels. It reads unidirectionally at 400 characters/second, allowing rapid input of data collected by one or many devices, regardless of their punching speed. It stops on one character, eliminating the need for special spacing following a stop code. A plug-in matrix may be quickly replaced or rewired, enabling the user to change external codes at will. This matrix transforms the external code into standard G-15 codes and enters the information into the computer. Reel-less tape winding and unwinding facilities accept tapes from most punching devices with minimum handling. With this new Bendix Computer development, flexible communication between computers and their sources of data reaches a new peak. Rather than modify the data originating equipment to fit the requirements of the computer, the computer can now be adapted in a few short seconds to the characteristics of its data source. The Bendix G-15, used at UW in early 1960, is a good example of a punched tape machine. Image: UW Special Collections. GA 133-863. Wes Graham Fonds. Series 4.1: UW Files to 1973. POGO Automatic Programming for the G-15 Digital Computer. Bendix promotional material.
PWAP	At the request of CSD, CSG converted the PWAP parser generator to produce Pascal for use in CS 240. PWAP was also ported to Macintosh for use in the new MacJANET lab. CSG completed both these tasks within the 1985 calendar year (Cowan, Graham, Mackie et al. 31).

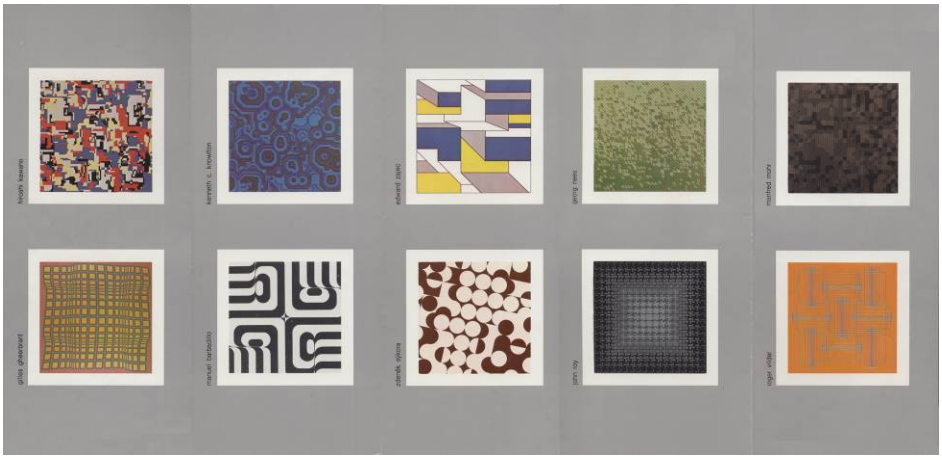
Quantum computing	First proposed in the 1970s, quantum computing relies on quantum physics by taking advantage of certain quantum physics properties of atoms or nuclei that allow them to work as quantum bits, or qubits, to be the computer's processor and memory. By interacting with each other while being isolated from the external environment qubits can perform certain calculations exponentially faster than conventional computers. Quantum computing is thought to be less well suited for tasks such as word processing and email, but ideal for tasks such as cryptography, modeling and indexing very large databases. Additionally, quantum computing has been very important to the recent development of computer research at UW. In 2002, UW established the Institute for Quantum Computing (ICQ). That same year Mike Lazaridis, founder and Co-CEO of Research In Motion (RIM), donated $6 million to the organization and the Ontario government added an additional $3 million to this amount. In 2004, Lazaridis and his wife, Ophelia, made a contribution of $33 million to the institute, in order to attract researchers to the university and to establish and equip a new building. The Ontario government matched the donation two-to-one to create a massive $100 million initial fund for the IQC. (Lazaridis has served as UW Chancellor since 2002.)  Mike and Ophelia Lazaridis on the occasion of their 2004 donation to the IQC. http://www.bulletin.uwaterloo.ca/2004/may/03mo.html http://www.bulletin.uwaterloo.ca/2002/nov/19tu.html

RIM	"Research In Motion" is arguably Waterloo's most successful high-tech firm. It became a multi-billion dollar corporation on the strength of innovations beginning with its world-famous 1998 BlackBerry portable messaging system. RIM's website: http://www.rim.net/
SHARE Conferences	SHARE Conferences were joint meetings between the major users of IBM hardware for the purpose of presenting and discovering new software, hardware, and applications as well other developments for IBM machines. Academic and business installations were both well represented in these meetings. It was at these conferences that UW popularized its software, especially the WATFOR and WATFIV compilers.  Wes Graham and his colleagues were much sought after at Share Conferences as they oversaw the development of some the best software available for IBM machines. (Graham had recommended that UW join the IBM user group in 1961 after the university decided to purchase an IBM 1620 computer.) Photo courtesy of UW Archives/Don Cowan '83-12-4.

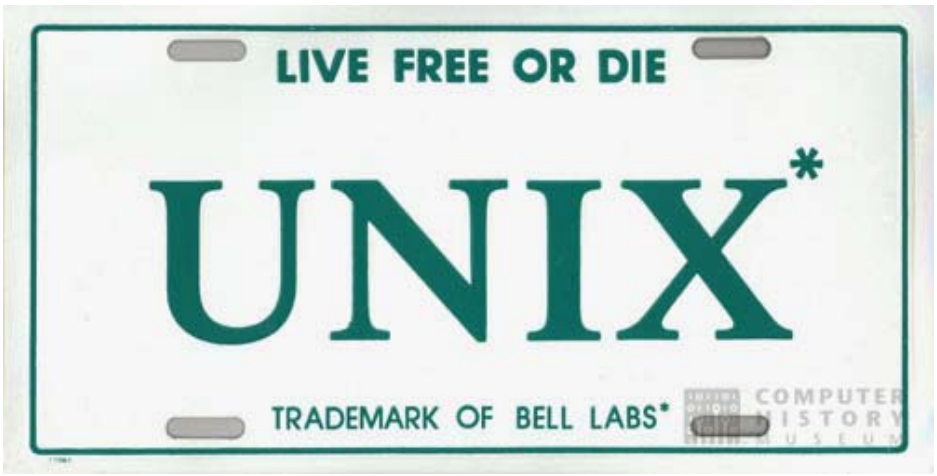
Source code	Source code is a set of instructions written in their original format. Source code is readable to an experienced programmer, but generally needs to be translated into object code so that it can be read by a computer. Source code is also known as high-level language. (This definition is adapted from www.webopedia.com).
SPECTRE	SPECTRE was a hypothetical computer developed in order to teach machine structure and machine language programming to mathematics students at UW (Cowan, Graham, Mackie et al. 27). The original SPECTRE program had 1000 words of memory and contained error diagnostics similar to WATFOR to help student programmers. UW Special Collections. GA 133-1140. Wes Graham Fonds. Series 4.1: UW Files to 1973. SPECTRE I.-[1966]. In 1965, Professor Wesley Graham, and students Robert Zarnke, and Gus German wrote assembler and simulator programs that made it possible to run SPECTRE programs on the university's IBM 7040 computer. At that time, J.H. Vellinga also authored a user's manual entitled "SPECTRE and SPECTRE MAP a User's Guide." In 1967, Paul Dirksen corrected minor errors in the program and added problem sets at the end of the SPECTRE documentation notes. In addition, Mr. R. Charney wrote new assembler and simulator programmes for the SPECTRE computer so that SPECTRE programs could run on UW's new IBM 360/75 computer. UW Special Collections. GA 133-744. Wes Graham Fonds. Series 3.1: Works: Manuscripts. Wes Graham, Spectre 1968, Preface. From 1982 to 1983, M.P. Graham, a UW Co-op student, created an implementation of SPECTRE that could be run on the Commodore PET and used in a high school setting. UW Special Collections. GA 133-745. Wes Graham Fonds. Series 3.1: Works: Manuscripts. Wes Graham, SPECTRE Specbook, 1983: ii. SPECTRE was written by Mr. R. Charney and was first presented outside UW at the SHARE conference held in Houston, Texas in February, 1968. The program was based on the imaginary computer described in T.E. Hull's textbook "Introduction to Computing." UW Special Collections. GA 133-944. Wes Graham Fonds. Series 4.1: UW Files to 1973. J.P. Sprung (ed.), "Research and Development." The Computing Centre Newsletter. (Issue 2 March 11-2, 1968), 4.
SPECTRE MAP	SPECTRE MAP was also created in 1965 as the assembler for the SPECTRE hypothetical computer (Cowan, Graham, Mackie et al. 27).

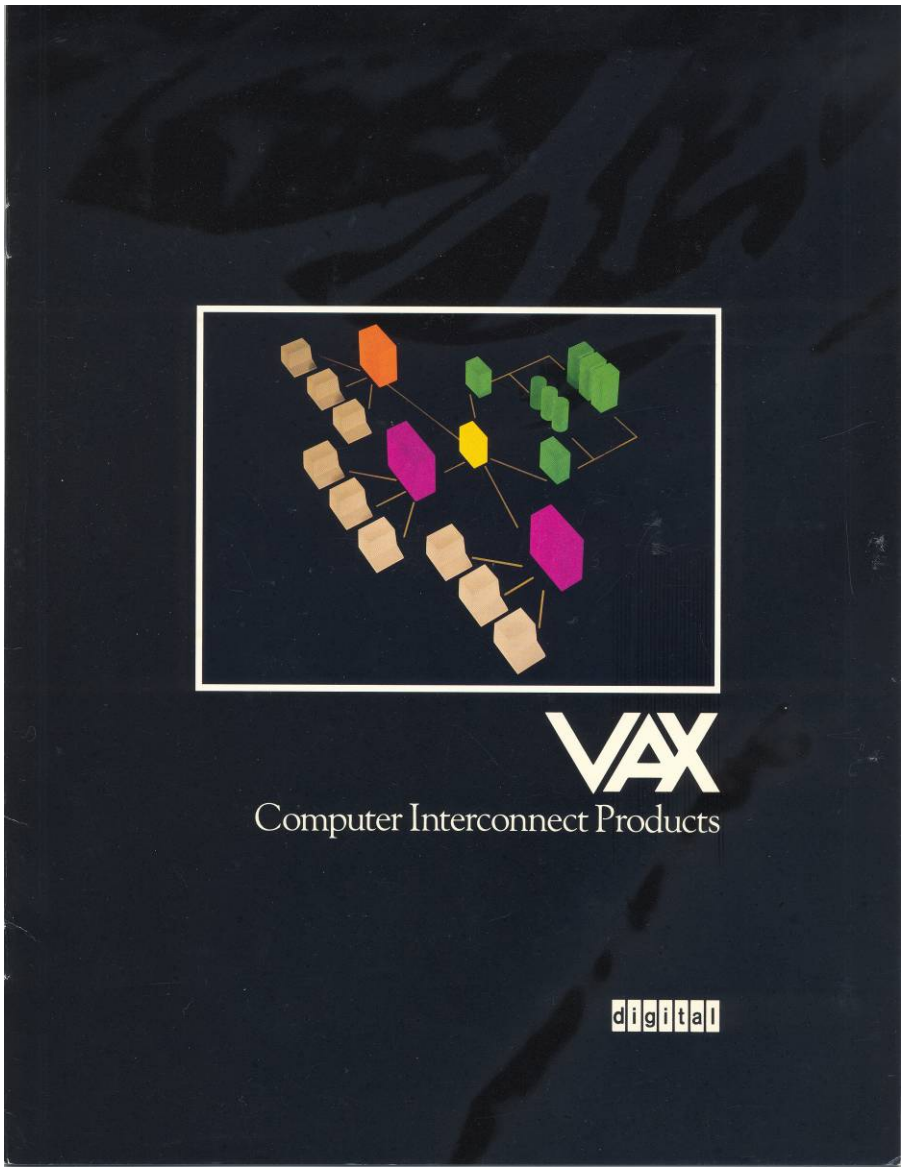
Spin-off	A spin-off is a company created using technology developed at a university as the basis for some or most of its patented products. UW's Intellectual Property policy allows for the creation of such companies.  UW President David Johnston at an open-air ceremony, held on September 22, 2004, in which the president announced that Open Text, a UW spin-off, would open a new facility in the university's North Campus Research Park. Photo: http://www.bulletin.uwaterloo.ca/2004/sep/22we.html http://www.newsrelease.uwaterloo.ca/news.php?id=4151 https://mailman.uwaterloo.ca/pipermail/uw-news-release/2004-September/000150.html
Start-up	A start-up is a company that involves university graduates and/or personnel in its operations in some way. A *start-up* company generally does not use patents from a university in its product lines; therefore, the relationship between the university and the company is thought to be less close than in the case of a spin-off company.

Student Lap Portable Computers Project	On October 23, 1985, the UW Gazette announced the arrival of the first thirty portable computers donated by Hewlett-Packard (HP). In total HP committed to giving UW 300 portable computers worth almost $2 million for experimental use. The project gave strong impetus to the ARIES portable computer network undertaken in 1986. Some of the longer term goals of the project are only starting to be seen today—a cross-campus wireless network and data filling and dumping stations for portable computers, for example. UW Special Collections. GA 133-1493. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. "'Lap' Project is underway." UW Gazette, October 23, 1985.  This photo shows one of the 300 UW students fortunate enough to receive an HP lap portable computer from CSG. To the student's right are the more traditional IBM PCs.  Wes Graham, Shirley Fenton, Eric Mackie and Don Cowan experiment with an HP laptop portable computer.

Systems Dimensions Limited (SDL)	Systems Dimensions Limited (SDL) was a company founded by George Fierheller and his associates, John Russell and Guy Morton, in March of 1968. As founding President, Fierheller secured a contract to continue the Agriculture Rehabilitation and Development Agency (ARDA)'s computerized land mapping project, which the federal government had begun with IBM. That year, Fierheller and his colleagues also began preparations to create Systemcenter, a multi-user computer service centre that operated on advanced IBM hardware and used state-of –the-art timeshare technology. All told the project cost more than $17.5 million. After Systemcenter became operational in June of 1969, SDL soon established itself as a major corporation within the Canadian computer service industry and expanded its operations into Quebec and the United States. Two important connections to UW present themselves in SDL's history. Paul Cress, one of the authors of WATFOR 360, worked on the Supercenter project in its development phase. In addition, Wes Graham sat on the company's board of directors. Graham and Fierheller were long-time friends who had first met while working at IBM in the 1950s (Fierheller 50-62). In the Fall of 1978, SDL was acquired by Datacrown to form one of North America's largest computer services companies with sales of over $80 million in 1981. During the 1970s, SDL had been one of Canada's largest independent computer services companies. It was also one of the country's leading centres of innovation (Fierheller 71).  The inside of a brochure for a special collection of computer generated art sponsored by SDL. The SDL Collection brought together internationally renowned artists and gave them a chance to display their work. Image courtesy of UW Special Collections.

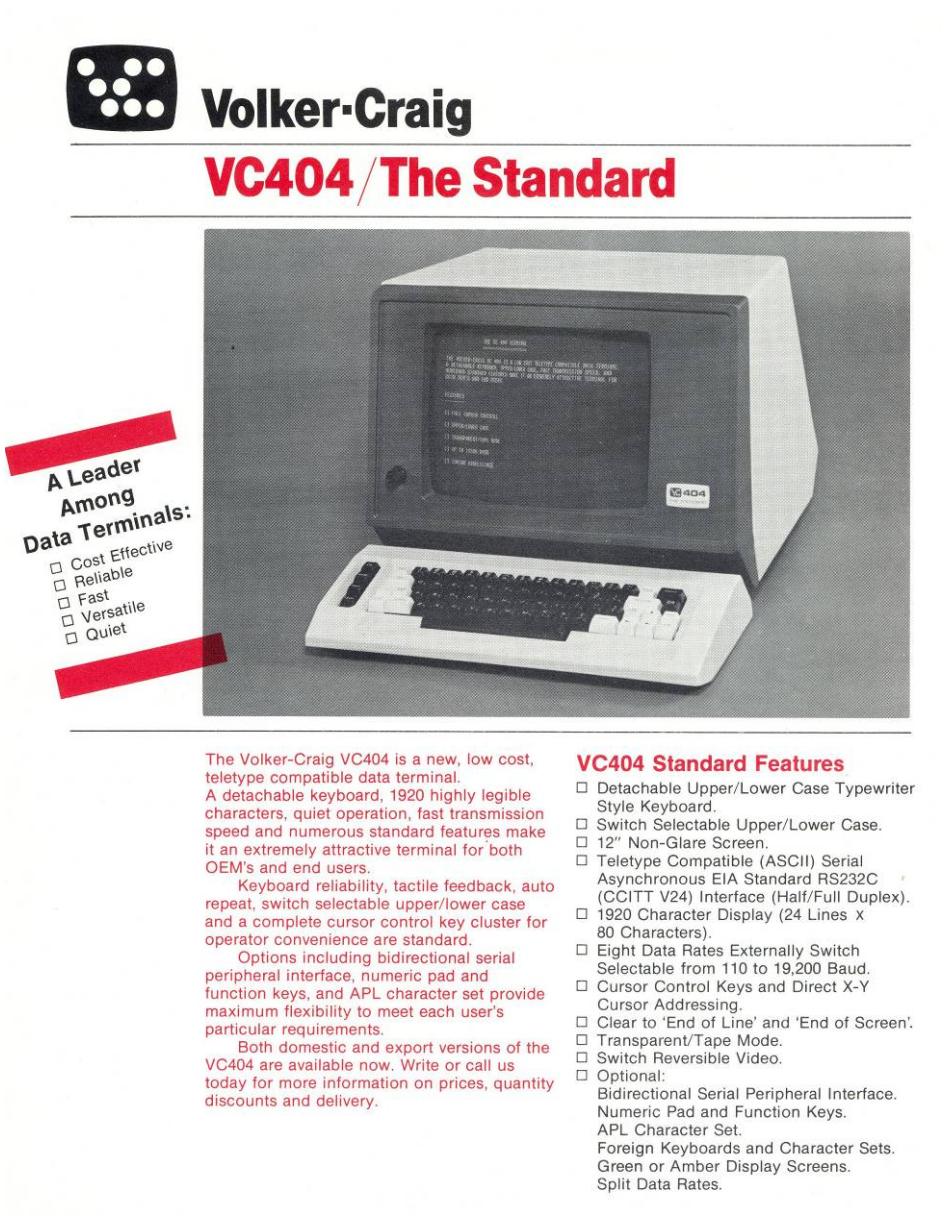
Time Share/Time Sharing	A method of operation in which a computer is shared by several users for different purposes at (apparently) the same time. Although the computer actually services each user in sequence for a short period of "time slice," the high speed of the computer makes it appear that all users are being handled simultaneously. E.B. Ogle, Long Distance Please: The Story of the TransCanada Telephone System. (Toronto: Collins Publishers, 1979), 286.  From 1968 to 1978, George Fierheller was President of the time share company SDL. In his family memoirs, Fierheller points out that SDL's accounting software was so efficient that it went well beyond the time sharing methods of other utilities. The charge that a customer received from SDL was based as much on the amount of computing power and number of systems used as it was on the amount of time spent using the machine.
TRACE	TRACE was a program developed in 1967. It provided increased debugging facilities for machine and assembly language programs. (Until that time, octal and hexadecimal dumps, printouts consuming large amount of paper, were the most common debugging tools). TRACE allowed programmers to debug by following the computer's actions line-by-line as it ran their programs. TRACE was designed by Mr. R. Milne and first presented to IBM users at the SHARE Conference held in Houston, Texas in February, 1968. UW Special Collections. GA 133-944. Wes Graham Fonds. Series 4.1: UW Files to 1973. J.P. Sprung (ed.), "Research and Development." The Computing Centre Newsletter. (Issue 2 March 11-2, 1968), 4.

UNIVAC	The American company UNIVAC began as the business computer division of Remington Rand formed by the purchase of the Eckert-Mauchly Computer Corporation (EMCC) in 1950. The most famous UNIVAC product was the 1951 mainframe computer. The machine gained notoriety when it successfully predicted the 1952 US election.
Unix	Unix is a portable, multi-tasking and multi-user computer operating system. It is one of the more popular ones available. It was developed by AT&T Bell Labs employees Ken Thompson, Dennis Richie, and Douglas Mcllroy. The machine was produced by the Digital Equipment Corporation (DEC). DEC was founded in 1955 and was one of the first corporations in the computer business. It was also one of the computer companies that bid against IBM to sell its hardware to UW.  A Unix enthusiast's license plate. Image: http://archive.computerhistory.org/resources/still-image/UNIX/unix.license_plate.102623933.lg.jpg

VAX	VAX is short for “Virtual Address eXtension,” DEC’s successor to its PDP-11 line of minicomputers. As its name implies VAX systems featured an operating system—VMS—that supported virtual memory. The VAX was introduced in the late 1970s and reached its pinnacle of success in the mid-1980s. VAX systems could be equipped with Digital System Interconnect, High-Speed Computer Interconnect, as well as special adaptors and connectors for networking and data sharing applications. UW Special Collections. GA 133-1232. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. VAX Computer Interconnect Products: Digital Advertising.  After the WATDEC agreement of 1984, the VAX systems became a mainstay at UW. Image Courtesy of UW Special Collections. See above for exact reference numbers.

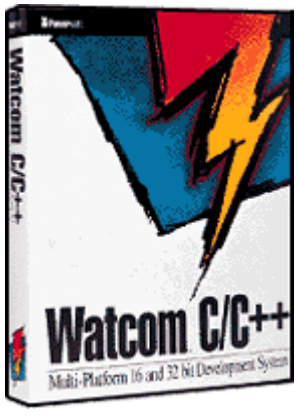
VM/CMS	The IBM VM (Virtual Machine) operating system and its CMS (Conversational Monitor System) timesharing interface played a key role at Waterloo from about 1975 until about 1995. This new virtual timesharing method of computing replaced the old batch processing method, which was used on the Model 75 for development and academic work. Batch computing continued in virtual machines largely for administrative applications until mainframes disappeared from UW completely in 2002. (This definition was provided by Bruce Uttley, a Senior technologist with IST). VM/CMS was but one of many IBM programs used with the 360 line of IBM mainframes. (Above) IBM's corporate logo. Image: http://www.cs.cf.ac.uk/ccgrid2005/
VMS	VMS stands for "Virtual Memory System," a multi-user, multi-tasking, virtual memory operating system that runs on DEC's VAX and Alpha lines of minicomputers and workstations. VMS was introduced in the late 1970s along with the first VAX minicomputers. (This definition comes from www.webopedia.com). Above is the DEC Corporate logo. UW used VAX minicomputers and many of the basic operating systems produced by DEC for that system including VMS. Image: http://www.cs.uiowa.edu/~jones/pdp8/logos/

Volker-Craig	Volker-Craig Ltd. was a Canadian manufacturer of computer terminals and microcomputers. The company was founded in 1973 by two University of Waterloo graduates, Michael C. Volker and Ronald G. Craig. The monitors that the company produced were known simply as "Volker-Craigs." These "dumb terminals" allowed users to access mainframe computers from various locations to submit requests and receive results from specified programs. Volker-Craig dumb terminals figured heavily in the WIDJET system used at UW. Link to Volker-Craig Users Manual, in .PDF format: http://vt100.net/volker-craig/vc4404-um/vc4404-um.pdf. Much of this information can be found at: http://vt100.net/changes/volker-craig/history. In 1980, the CSG began developing software for Volker-Criag's VC 2900. The CSG equipped the VC2900 with a BASIC programming system and a 64K memory. Overall, CSG's modifications gave the VC 2900 capabilities similar to the Commodore PET. In exchange for their work on the VC 2900 project, CSG was to receive a $10 royalty on every unit shipped that contained their software. In addition, CSG retained ownership of all new technologies, if any, designed in the course of the project. For their part, Volker-Craig gained access to the relatively new microcomputer market. UW Special Collections. GA 133-1213. Wes Graham Fonds. Series 4.1: UW Files to 1973. Volker-Craig – 1980.  A detail of Volker-Craig's distinctive "VC" logo. Image courtesy of UW Special Collections. See above for reference number.

	 This is an advertisement for Volker-Craig's standard Personal Computer, at the beginning of the PC era. In 1980, UW and Volker-Craig began cooperating to deliver microcomputers that had memory and versatility adequate for that time.
WATBOL	An acronym that stands for "WATerloo COBOL." WATBOL was created in 1972 by Ron Hurdal and Rod Milne; it was a high-speed compiler written for use with COBOL, the primary language for business computation. It was designed for co-op students who needed a background in COBOL programming. The compiler had operating characteristics similar to WATFOR (Cowan, Graham, Mackie et al. 4). For addition information on WATBOL, please visit this website: http://csg.uwaterloo.ca/sdtp/watbol.html

WATCOM	WATCOM was a company specializing in educational software for personal computers. It was founded in 1981 by Wes Graham and associates from CSG and heralded the beginning of a generation of high-tech UW spin-off companies. Recognizing WATCOM's value, the Powersoft Corporation acquired it in 1994 before merging with Sybase Inc. in 1995.  James W. Welch, President of WATCOM Products Inc. (left) with K. Ian McPhee, President of The WATCOM Group (right). Jim Welch (left), President of WATCOM's Products and Ian McPhee (right), President of the WATCOM Group. Image courtesy of UW Special Collections. Copyright WATCOM, May 1984.
WATCOW	WATCOW, a portable computer system on wheels was created by the CSG. It consisted of a DEC PDP-11 processing unit, a printer and a card readers that read mark-sense cards and these units were all mounted on a single cart about 30" on each side. Mark-sense cards were cards that could be marked with a pencil instead of the more traditional approach of punching holes. The computer was often taken to schools where the students could run programs on the spot (Ponzo 54). WATCOW was short for "Waterloo Computer on Wheels."

WATDEC	The "WATDEC deal" was the informal term for a joint research agreement between UW and the Digital Equipment Corporation (DEC). This was a research partnership from 15 June 1984 to 31 December 1987. DEC and UW staff had worked on many initiatives prior to 1984, however. In 1974, WATFAC, a charitable foundation headed by Professor Wes Graham, used a PDP-11 minicomputer donated by DEC and designed implementations of WATFOR and WATBOL for that computer. DEC received new software for their PDP-11 computer, and WATFAC got to keep DEC's hardware. UW Special Collections. GA 133-1321. Wes Graham Fonds. Series 4.2 UW Post-1973 Files. Amendment to the Joint Research Agreement as Executed June 22, 1984 between: University of Waterloo and Digital Equipment of Canada Limited ('Digital"). Ten years later, both parties were willing to build on their previous cooperation. In the 1984 agreement, DEC donated $25 million worth of equipment to UW which took the form of 2000 workstations for student use and 10 VAX Systems. The University of Waterloo contributed roughly $40 million in order to maintain the initiatives stemming from the project over a five year term. Most of the money was to come from government sources and was to take the form of grants to the Institute for Computer Research (ICR). In addition to finding new sources of revenue to keep the project going, UW also had to provide DEC with cutting edge research in diverse areas like networking, computer graphics, artificial intelligence, and office automation. Not without controversy, this arrangement benefited both the company and the University of Waterloo. UW Special Collections. GA 133-1321. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. Institute for Computer research University of Waterloo. Proposal to Digital Equipment Corporation for a Joint Research Program in Open Computing Using Fourth Generation Systems. Pg.7.  UW President Doug Wright (centre) shakes hands with DEC executives as he (symbolically) takes delivery of equipment donated by the company. Photo courtesy UW Special Collections/ Don Cowan.

Waterloo BASIC	Waterloo BASIC was a portable implementation of BASIC, which was completed and debugged in December 1978. The final program, however, was not available for distribution until new features were added and some remaining bugs were removed. The program itself was augmented by structured programming constructs and compatible with the IBM Series/1 and 370 families of computers. Many of the structured programming ideas used in the creation of the Waterloo version significantly influenced the ongoing development of the BASIC standard (Cowan, Graham, Mackie et al. 29). Many of CSG's younger programmers gained valuable experience by helping to produce Waterloo BASIC, which was much sought after by IBM's Boca Raton Development Lab. The team was headed by Eric Mackie and included Ian McPhee, James Welch, and David Boswell to name but few. UW Special Collections. GA 133-1257. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. Memorandum: December 8, 1978, To: BASIC Development Team (12 individuals), From: J.W. Graham. UW Special Collections. GA 133-1259. Wes Graham Fond. Series 4.2: UW Files Post 1973. Letter: March 16, 1979, To Mr. Rich Anstette, From Jim Welch.
Waterloo Capture	Waterloo Capture was a program designed to allow screen images from microcomputers to be easily incorporated into documentation, lecture notes, and textbooks. Waterloo Capture was created in 1989. (Cowan, Graham, Mackie et al. 32.)
Waterloo C/System	Created in 1984, the Waterloo C/System was produced because of a need to write portable software which would operate on both mainframes and microcomputers. At the time that the project began, there were no effective C compilers available on IBM mainframes and operating systems (Cowan, Graham, Mackie et al. 30).  Many of Watcom's programmers first had experience writing programs in C at UW. By the end of the 1980's, much of Watcom's reputation was based on the fact that their versions of C helped programmers write tight, error-free code. Will Watts, "Review of Watcom C (vers. 7)." EXE (October 1989, Vol. 3, Issue 8) Photo: http://www.integra.co.yu/p-watcom.gif.

Waterloo Draw	Waterloo Draw was a program designed in 1989. It allowed diagrams to be easily incorporated into documentation, lecture notes, and textbooks. (Cowan, Graham, Mackie et al. 32).
Waterloo Modula-2	Waterloo Modula-2 was a compiler for the Modula 2 programming language with excellent debugging characteristics. This compiler was originally designed because of Modula-2's strong data typing and its ability to support teaching of development techniques. The novelty of the language caused CSG to examine several research questions dealing with compiler design. The Waterloo Modula-2 compiler was completed in 1986 (Cowan, Graham, Mackie 31).
Waterloo PC Network	Developed in 1984, the Waterloo PC Network was a network consisting of microcomputers, minicomputers and/or mainframes. The minicomputers and mainframes acted as file and print servers for the microcomputers. This network was developed to create an effective teaching environment using microcomputers and resulted in a donation of over $7.5 million in equipment from IBM to UW (Cowan, Graham, Mackie et al. 30).  The Waterloo PC Network allowed multiple users access to computer terminals at the same time. In many ways this solved many of the problems associated with shared computer time and other limited resources. Improved access, however, also increased demand for computer services.
Waterloo Pascal	In 1979, CSG wrote a Waterloo Pascal compiler at the request of the CSD to support the teaching of mathematics and CS students. This system was a debugging-oriented, load-and-go compiler that could be used in a time-sharing environment (Cowan, Graham, Mackie 29).

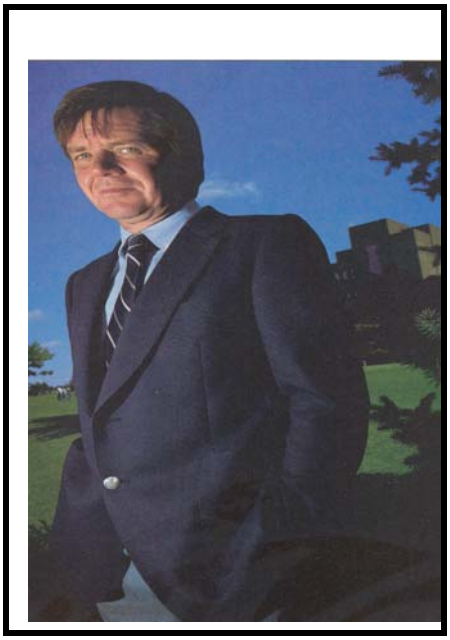
Waterloo SCRIPT	Waterloo SCRIPT was an early text formatting program developed at UW (Cowan, Graham, Mackie et al 29). Waterloo took responsibility for the Script project from MIT in 1974. The SCRIPT processor eventually supported the most commonly available typesetters and laser printers. For much of the 1970s Waterloo SCRIPT was the most practical way to produce documents. It was so widely used that its popularity beyond UW rivalled that of WATFIV. In 1979, Waterloo Script received the Datapro Award of Merit (Ponzo 92). The initial implementation of SCRIPT at UW was documented in the May 1975 Issue of the Computing Centre Newsletter which noted some the advantages of using SCRIPT: "a) Footnotes are handled easily. b) Page numbers can be in Arabic or Roman numerals, and can appear at the top or bottom of the page, in the centre, on the left or on the right, or even-numbered pages and on the right for odd-numbered pages. c) Underscoring or over striking can be made a function of SCRIPT, thus uncomplicating Editor functions. d) SCRIPT files are regular OS databases or CMS files. e) Output can be obtained on the printer, or at the terminal…" The article also pointed out that SCRIPT had over 100 commands to assist in formatting documents, though 8 to 10 of these commands were sufficient to complete most formatting jobs. Thus SCRIPT had many of the capabilities that computer users generally associate with contemporary word processors. UW Special Collections. GA 133-949. Wes Graham Fonds. Series 4.1: UW Files to 1973. Carol Vogt, "SCRIPT." Computing Centre Newsletter (May, Issue 1975-4, Shirley I. Melen, ed.), 4.

	 Bruce Uttley the author of SCRIPT seated right beside Bruce Hay accepts the award of merit from Datapro/Datamation for his work on the program. Back are Rod Mine, Paul Dirksen, Sandra Ward, Roger Watt and Ron Hurdal
Waterloo System Language (WSL)	In 1979, WSL was introduced as a simple and small systems programming language that allowed portability across machines and operating systems. At the time, WSL addressed the portability needs of many operating system users (Cowan, Graham, Mackie 29).
Waterloo Rita	Waterloo Rita was a structured editor designed as a front end, or user interface, for text formatting systems which used tags from a document description language to indicate document structure and ultimately document appearance. The user did not have to learn the tag set for the language as they were guided through document preparation. The software system was developed as the result of a PhD thesis by Riel Smit a student associated with CSG. The program was completed in 1988. (Cowan, Graham, Mackie et al. 32).
Waterloo Word Processor	The Waterloo Word Processor first appeared in 1986. The software package was designed to introduce students to word processing and to avoid many of the complications present in professional word processing that existed in the 1980s. The program was designed to be easier to use than a typewriter (Cowan, Graham, Mackie et al. 32).

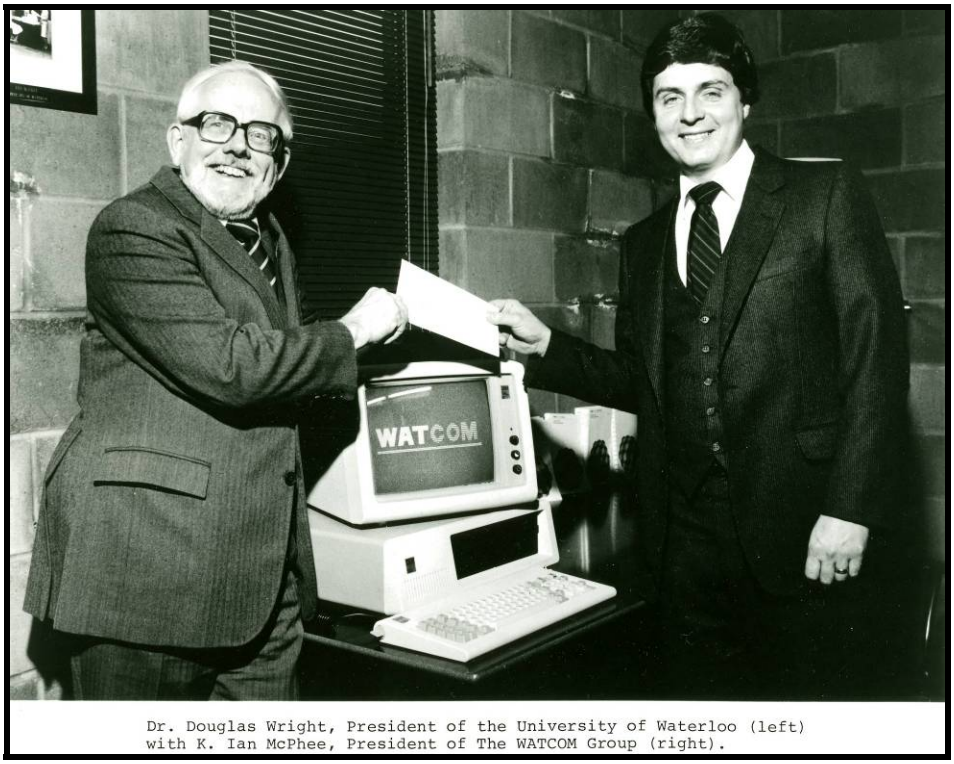
WATFAC	This acronym stood for "**Waterloo Foundation for the Advancement of Computing (WATFAC).**" WATFAC was established in 1974 by Wes Graham, Paul Dirksen and Don Cowan. According to the Computing Centre Newsletter, the non-profit, charitable organization had a threefold purpose: 1) The preparation and distribution of student-oriented software for small computers: software that is of particular interest to high-schools, community colleges, and small universities. 2) Publication and printing of books related to computing. 3) Presentation of seminars and workshops to business and industry on the subject of structured programming. The seminar and publication functions of the organization provided much of the revenue needed to pay the team of three programmers. In addition, because it existed outside the regular, political structures of UW, WATFAC could also receive donations more readily than a university department. This fact allowed WATFAC to take delivery of a PDP 11 Model 45 from DEC Canada in 1974. Once the computer facilities were in place, the team of three programmers proceeded to write an advanced compiler for the DEC machine—the PDP 11 WATFOR compiler. UW Special Collections. GA 133-949. Wes Graham Fonds. Series 4.1:UW Files to 1973. Carol Vogt and Shirley Melen, "PDP 11 WATFOR—or How to Write a Compiler on a Shoestring." The Computing Centre Newsletter. (May, Issue 1975-4, Shirley I. Melen, ed.), 2-3.  The "bank" building, on Phillip and University in Waterloo, was WATFAC's first and only headquarters.

WATFILE	WATFILE (WATerloo FILE system) was developed between 1973 and 1983 by Prof. J.W. Graham and associates. It was developed to assist the Director of Computing Services at UW with the manipulation of large amounts of data (i.e. service records, costs, mailing lists, etc.). The many suggestions of WATFILE's users resulted in changes and additions and led to the creation of WATFILE/Plus, a powerful, easy-to-use data manipulation system. WATFILE was designed for professional people with advanced data management needs, but little or no programming experience. The program was to be a file processing calculator, and was similar to a paper filing system. It stored data, and allowed the user to search for, update, and use stored information to produce reports. WATFILE/Plus was manipulated through commands that did exactly as they suggested. (eg. SORT, TOTAL, SELECT, etc.). UW Special Collections. GA 133-1280. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. WATFILE/Plus Workshop: Computer Science Days—University of Waterloo, 1991. Throughout the 1980's, WATFILE/Plus was one of WATCOM's most versatile and popular products. The program had many educational and administrative applications. It was even used by the Molson Indy in 1987 to keep track of basic race-related information. Terry Wilkinson, "Away to the Races with WATFIEL/PLUS," WATCOM News. (1987, Vol. 5, J.E. Carter ed.), 1.  This is a contemporary image from the Molson Indy. In the late 1980s, WATFILE was a mainstay for administrators of the race. The program was also popular with educators and at UW. Photo:http://www.roadauthority.com/database/company/mcasphalt/image12.gif&imgrefurl=

WATFOR	WATFOR was a compiler for the FORTRAN IV computer language created for the IBM 7040 computer. It was developed in the summer of 1965 by four UW undergraduate students. The program created by Gus German, Jim Mitchell, Richard Shirley, and Robert Zarnke increased the 7040's processing speed by 100 times, so that a job that had once taken an hour could now be processed in under a minute. It also had diagnostic capabilities superior to most of its contemporary counterparts so that users could find and correct errors. The program greatly expanded the potential for using computers in undergraduate instruction, and it put the fledgling university on the map internationally. WATFOR was acquired by institutions in Canada, Great Britain, France, Italy, India, Sweden, Switzerland, and the United States.  The original WATFOR development team. (standing, left to right: Gus German, Richard Shirley, Robert Zarnke, seated: Jim Mitchell) The original WATFOR development team (standing left to right: Gus German, Richard Shirley, Robert Zarnke, seated Jim Mitchell). Photo courtesy of UW Special Collections/Don Cowan.

WATFOR 360 / later WATFIV	Waterloo's most successful compiler designed for the IBM 360 by Paul Dirksen and Paul Cress. It was first known as WATFOR and later as WATFIV when FORTRAN language extensions presented at a SHARE conference were added to the program. The acronym WATFIV literally stands for "Waterloo (WAT) FORTRAN (F) 4 (IV)." WATFOR 360 was developed in 1967 and it greatly enhanced the speed and ease of use of the IBM 360/75. The program was essentially WATFOR for the IBM 360 series, the latest in computing technology at the time. It was also the early student-friendly variant of FORTRAN IV. The group leaders of the team that created the compiler, Paul Dirksen and Paul Cress, won the Grace Murray Hopper Award in 1972 for their efforts. In 1973, WATFIV was augmented with structured programming constructs and character variables to create WATFIV/S (Cowan, Graham, Mackie 28).  Paul Dirksen was one of two project leaders in charge of writing the WATFOR 360 program. Here, Dirksen is photographed by PC magazine in 1985. At the time, Dirksen was the director of computer services at UW. For full the article please see: UW Special Collections. GA 133-57. Wes Graham Fonds. Series 1.2: Biographical: Articles. John Helliwell, PC 4, no. 7 (April 2, 1985), 204-209, ill.

WATIAC	An acronym that stands for "Waterloo Instructional Automatic Computer." It was a hypothetical computer designed as a convenient way to teach assembly language programming and machine architecture to large numbers of students. (This definition has been adapted from www.whatis.techtarget.com). WATIAC and WATMAP were developed in June 1973 and succeeded SPECTRE and SPECTRE MAP. The system was surpassed itself in 1980 by Micro-WAT (Cowan, Graham, Mackie et al. 28, Ponzo 91). UW Special Collections. GA 133-599. Wes Graham Fonds. Series 3.1: Works: Manuscripts. R.H. Copper, D.D. Cowan, P.H. Dirksen, J.W. Graham, R.B. Penton, and S.W. Treadwell. An Introduction to WATIAC and WATMAP, (Waterloo: UW Computer Systems Group, 1974), iv-v.  UNESCO fellow Dr. J.O. Sonuga of Nigeria in the 7040-1401 is seen visiting the computer facility ca. 1966.
WATMAP	WATMAP was the assembler for the WATIAC computer. (This has been adapted from www.whatis.techtarget.com). A WATIAC simulator and the WATMAP assembler were designed and programmed by Rick Penton and Steve Treadwell during the summer months of 1973. UW Special Collections. GA 133, File 599. Wes Graham Fonds. Series 3.1: Works: Manuscripts. R.H. Copper et al. An Introduction to WATIAC and WATMAP, iv.
WPROLOG	In 1986, the CSG ported Unix at the request of the CSD to allow the execution of PROLOG programs on large IBM mainframes (Cowan, Graham, Mackie 32).

WATSOFT	On February 1, 1982 WATSOFT was incorporated as an organization dedicated to marketing software produced by UW's CSG, WATFAC, and WATCOM. The most difficult political issue that WATSOFT had to deal with was the question of university involvement in its commercial ventures. Eventually WATSOFT Products, as it was known by 1983, became part of the WATCOM and took on the name WATCOM Products. With the addition of WATSOFT products, WATCOM started to become an extremely successful software marketing firm. The sale of WATSOFT to WATCOM also put an end to any questions of propriety regarding the university's involvement in the commercial licensing of software products, even though UW retained a ten percent share in the new company and the CSG continued its work on campus with WATCOM handling the licenses for its products. Many critics were probably silenced by the fact that WATCOM paid $252,000 to the university for the purchase of WATSOFT. UW Special Collections. GA 133 File 1710. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. Articles of incorporation for WATSOFT, February 1, 1982, Harper, Haney & White (Law Firm). UW Special Collections. File GA 133 1719. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. WATSOFT Proposal 1983-06-17.  Dr. Douglas Wright, President of the University of Waterloo (left) with K. Ian McPhee, President of The WATCOM Group (right). Dr Douglas Wright, UW President, and Ian McPhee, WATCOM President, on the occasion of WATCOM's purchase of the WATSOFT Products.

WATSTAR	WATSTAR was a local area network that consisted of SuperBrain workstations and was developed to provide a general-purpose, graphics-capable computer environment for Engineering. WATSTAR predated the JANET network which used IBM microcomputers. By 1984, there was one WATSTAR lab with thirty-one workstations and six JANET labs with seventy microcomputers at UW. UW Special Collections. GA 133-1321. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. Institute for Computer Research-University of Waterloo. Proposal to Digital Equipment Corporation for a Joint Research Program in Open Computing Using Fourth Generation Systems. February 1, 1984, p. 21.  A student and instructor log on to the WATSTAR network. Photo courtesy of UW Archives/Don Cowan.
WATSYS	Created in 1981, WATSYS was a message-based portable operating system originally designed for the IBM Series/1 minicomputer. Later, the operating system was ported to the IBM 370. It used lightweight processes and was one component of the Waterloo PC Network. WATSYS also contained a distributed file system that allowed multiple file systems to appear to the user as a single image (Cowan, Graham, Mackie et al. 3).

WIDJET	WIDJET stood for "Waterloo Interactive Job Entry Terminal System." This computer system operated on PDP-11 terminals and IBM machines. The system allowed students to submit jobs to mainframe computers from remote workstations. The creation of the CSG, this development eliminated punch cards, paper tape, and cafeteria style computing. WIDJET first appeared in 1975. It stayed in use until 1984. The system saved Waterloo a great deal of money by reducing paper costs and by using student computing time more efficiently. UW Special Collections. GA 133-1412. Wes Graham Fonds. Series 4.2: UW Post-1973 Files. IBM Series/1 Waterloo Interactive Direct Job Entry Terminal System (January 4, 1978), passim. In April 1979, Digital News magazine announced the introduction of Waterloo Package for Education, or WATPAC/E, an educational software package that ran on the WIDJET network. The software package included multiple job control terminals, printing facilities, as well as public and private student files, along with many other built in systems. UW Special Collections. GA 133-60. Wes Graham Fonds. Series 1.2 Biographical Articles. K. Ian McPhee and Terry A. Wilkinson, "Feature Report: Waterloo Package for Education—WATPAC/E," Digital News. (Vol. 1, No. 4, April 1979).  The WIDJET job entry system as it appeared in 1975. These students are accessing WIDJET using Volker-Craig terminals. Volker-Craig was a spin-off company started by two UW graduates, Mike Volker and Ronald Craig.

Z1	Z1 was created in 1966 as a systems programming language to assist in the development of compilers and other systems software. It is likely that Z1 was one of the first, if not the first, systems programming language (Cowan, Graham, Mackie 27). Later, Z1 was used to write the program COMASS which, was in turn, used to write WATBOL. In this way the Z1 systems language proved to be a valuable addition to computing at UW. The original author of the Z1 program was Bob Zarnke. UW Special Collections. GA 133-917. Wes Graham Fonds. Series 4.1: UW Files to 1973. Personnel Status, September 1972, 7.  Bob Zarnke (centre), the author of Z1, retrieves a computer printout as two other students look on. A gifted programmer, Zarnke was also part of the teams that solved the Archimedes Cattle Problem and wrote the first WATFOR compiler. Obviously, Zarnke did a lot to build UW's reputation in computing. Photo courtesy of UW Special Collections/Don Cowan.

Frequently Cited Sources and Primary Research	D.D. Cowan, J.W. Graham, E.W. Mackie, Computer Systems Group (CSG) A Brief History. (Waterloo: University of Waterloo—CSG, 1989). George A. Fierheller, Finni's Family: The Fierheller's: A Canadian Story. (NP/ND: Draft). Peter Ponzo, Computer Science at Waterloo: A History to Celebrate Twenty-five Years. (Waterloo: University of Waterloo—Computer Science Department, 1992). Note: the pagination in Ponzo's original copy is different from the citations given here. The picture under the definition of the Computing Centre contains the following people from left to right Lothar Kesselhut, Paul Cress, Sandra Ward, Rod Milne, Lynn Williams, Derek Meek, Elizabeth Schmidt, Paul Dirksen, Bill Kindree, Mike Doyle The primary research for this project was conducted by Harold Alkema, a graduate student in the Public History Program in the Department of History at the University of Waterloo. The series of Oral History Interviews conducted under the auspicies of the J.W. Graham Information Technology Trust is also an extremely useful source of information. (The complete list of these oral history interviews is available in the Special Collections Department of the Dana Porter Library at the University of Waterloo.) The photos from the Don Cowan Collection, as yet uncatalogued, are housed in the Special Collections Department.

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