If I were to write a modern educational catechism I should begin with the question "What is the chief aim of education?" and the answer I should give would be "To ennable the individual man and woman and to improve society."

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This paper was written in 1993 as a contribution to the celebrations commemorating twenty-five years of granting BSc degrees in the Department. The present version is identical except that the images have been omitted and the programming examples appear in an Appendix rather than with the relevant portions of the text.
The 1950s - Origins

Lest we think that computing at the University of Alberta began with the introduction of the first electronic digital computer, we might start with a very brief look at some of the methods of calculation used before the first computer was introduced and during the first few years afterwards. In 1929 Professor J. W. Campbell of the Department of Mathematics published a small book of mathematical tables some of which he had himself prepared on a hand calculator. These tables, which were reprinted in 1946, were subsequently replaced by Knott's *Four-Figure Mathematical Tables* which were used until the mid nineteen-sixties. There were only one or two electric desk calculators in the whole Department although students taking elementary statistics had access to small Monroe calculators which were cranked by hand. By 1962 many of the old calculators were almost worn out, and some newer types of hand calculators were purchased. (These were probably the Swedish-made Odhner calculators which weighed thirteen pounds and which accomplished multiplication and division by addition and subtraction with repeated shifting.) A little later some electric calculators and even a few electronic models were purchased.

The first use of an electronic computer at the University of Alberta was probably in the Department of Physics which in May 1957 established a link with the computer in the Department of Physics at the University of Toronto. This computer, known as FERUT for Ferranti Computer at the University of Toronto, was built by Ferranti Electric Company of Manchester using World War II vacuum tubes and occupied a large room. Input and output was by five-hole punched paper teletype tape. The machine had the capacity of one of today's programmable pocket calculators but was much less reliable. A crew of eight engineers was required for maintenance, but in spite of six hours of scheduled preventative maintenance each day, the computer could not be depended upon to run without failure for more than half an hour or so. Arrangements were made with Canadian National Telegraphs for both the loan of a teletype machine, which was installed in a closet in the basement of the Arts Building where the Department of Physics was then located, and also the free use of a telegraph line from Edmonton to Toronto one evening a week. The National Research Council paid for the computer time. The facility, which was first used on May 9, 1957, was opened officially with a ribbon-cutting ceremony attended by Dr. Andrew Stewart the President of the University of Alberta, the President of the National Research Council, the Director of the Western Region of Canadian National Railways, and representatives of the press. It was used throughout the following summer by several faculty members in the Department of Physics and their graduate students.

In the same month that the link was established with FERUT, Dr. Stewart appointed a "Committee on Electronic Equipment" to make an assessment of computing needs at the University. The Chairman of the Committee was Donald B. Scott of the Department of Physics who was to play an important role in the formation of first the Computing Centre and then the Department of Computing Science. In July the
Committee recommended unanimously that the University purchase an LGP-30 from the Royal McBee Corporation of Port Chester, New York at a price of forty thousand dollars. In September the Committee's recommendations were approved by the Board of Governors, the order for the computer was placed, and the computer was installed the following month. The University of Alberta was the third university in Canada to acquire a computer, the first being the University of Toronto and the second the University of British Columbia which acquired its computer in March 1957.

The LGP-30 was installed in the basement of the Arts Building but was moved later to the Arts Building Annex. It was soon apparent that the Computing Centre, which was initially operated informally on an open-shop basis with the users doing their own programming, would have to provide technical assistance to users. Therefore, students were hired to give full-time support during the summer months and part-time support during the academic year. One of these students was Ursula Bielenstein (later Ursula Maydell) who in 1960 became the first full-time employee of the Computing Centre, resigning a year later to begin graduate work in statistics in the Department of Mathematics. Another was Bill Adams who came in the summer of 1959 to complete an undergraduate degree begun at the University of Edinburgh. (In January and February of 1960 Bill gave one of the first programming courses at the University consisting of twelve evening lectures for the Department of Extension on programming the LGP-30.)

The LGP-30 soon attracted the attention of many faculty at the University who recognized its potential usefulness in their work. In addition to the theoretical physicists one of the early users of the LGP-30 was the Department of Soil Science which used the computer in the statistical analysis of data from fertilizer trials. A reference to their use of the LGP-30 may be found in a paper published in the August 1959 issue of the Canadian Journal of Soil Science where it was noted that "The digital computer played an important role in the study." Other early users of the computer included the Departments of Animal Science, Chemical Engineering, Chemistry, Educational Psychology, Electrical Engineering, Geology, Mathematics, Physiology, Plant Science, Political Economy, and Psychology as well as the Research Council of Alberta.

The 1960s - Formation

The LGP-30 was managed by the Committee on Electronic Equipment until November 1, 1960 when Don Scott was appointed Director of the Computing Centre with a mandate to offer computing services to the University. An article appearing in The Edmonton Journal on November 22, 1960 said that the University's computer was being used twenty-four hours a day and seven days a week. Furthermore, it stated that "the University expects shortly to launch an extensive computer training program for students, and that arrangements are being made to obtain a faster unit for the newly established centre". 
The University at first tried to purchase a used IBM 704 computer from the Toronto offices of IBM, but was unable to raise the necessary two hundred and forty thousand dollars. The Committee on Electronic Equipment, in its last official action before it was disbanded, then recommended that the much smaller IBM 1620 Data Processing System be rented at a cost of 3 126 dollars a month with part of the money coming from the National Research Council. The Board of Governors approved the Committee's recommendation, and the IBM 1620 arrived in May 1961. It was intended primarily for research while the LGP-30 was to be kept for teaching. Later in the year this system was replaced by a new 1620 with a card reader and punch. The original 1620 system was sent to the Research Council of Alberta which had been using about forty percent of the available time. The LGP-30 remained in use until the middle of 1963.

After the arrival of the 1620 the Centre continued to be operated on an open-shop basis with persons using the equipment to run their own programs. However, as the demand increased a change was begun to a closed-shop operation with Computing Centre staff operating the equipment. On April 1, 1963 a completely closed-shop operation was implemented.

In the absence of a separate department for computing, the first courses given and degrees granted were through the Department of Mathematics. The 1959/60 Calendar listed Mathematics 460 Numerical Analysis which covered a number of topics in interpolation, finite differences, linear algebra, and differential equations. The Calendar the following year listed a graduate course, Mathematics 640 Advanced Numerical Analysis. The first course devoted to computers rather than numerical analysis was Mathematics 641 Automatic Digital Computers and Programming which appeared for the first time in the 1961/62 Calendar. It covered a variety of topics in number systems, logic, computer design and organization, and programming. A prerequisite was some knowledge of elementary coding, and during the course students were required to solve several problems on the computer. These three courses were given by John McNamee of the Department of Mathematics. By the 1963/64 academic year in addition to these courses the staff of the Computing Centre gave a total of five courses to students in Mathematics, Commerce and Engineering as well as a number of non-credit courses for University staff and for the Department of Extension. Also by 1964 eight graduate students studying in the Computing Centre had been awarded MSc degrees in Numerical Analysis through the Department of Mathematics.

During the 1963/64 academic year discussions were held within the Faculty of Science about the need for a separate degree-granting academic department in which the faculty would engage in teaching and research and provide some support for persons using computers on the campus. The academic members of the Computing Centre finally convinced a sometimes doubting Faculty (Could not the computing needs of the University be fulfilled by the Department of Mathematics? What did they do at Harvard?) that a separate department was needed, and the Department of Computing Science came into existence on April 1, 1964. Don Scott was appointed Department Head, a position he held as well as that of Director of
the Computing Centre. The choice of the name "computing science" instead of the more common "computer science" was deliberate in order to indicate that computing rather than computers was to be the foundation of the discipline.

Initially there were five faculty members in the Department: Don Scott, Bob Julius who was made Assistant Head, Bill Adams, Bill McMinn who had an engineering degree from the University of Toronto and who formerly worked for IBM, and Keith Smillie who had come from the Dominion Bureau of Statistics in 1963 and who for one year had a joint appointment with the Computing Centre and the Department of Mathematics. In addition to the two courses in numerical analysis and the computing science topics course mentioned previously, there was Computing Science 300, a FORTRAN programming course for engineers. The previous year Keith Smillie had begun at the request of the Department of Mathematics Statistics 256, an elementary introduction to probability, statistics and numerical analysis. The first MSc degree granted by the Department was conferred at Fall Convocation in 1964.

During the next few years several new faculty members were recruited. These included three University of Alberta graduates, Ursula Maydell, Barry Mailloux and Wayne Jackson, and also several persons including Kellogg Wilson, Stanley and Doreen Heaps, John Penny, Wayne Davis and John Tartar who came to the University from other academic and industrial organizations. Two of the original members of the Department, Bob Julius and Bill McMinn, left, and at the end of the decade the number of faculty had increased to eighteen.

The first introductory programming course for Computing Science students, Computing Science 310 Elements of Programming appeared in the 1965/66 Calendar with the following description: "Logical structure of computers; instructions; algorithms and programs; language of computer programming; conventional computers; assemblers and compilers." The following year the BSc degree with Honors in Computing Science was listed in the calendar along with course descriptions of eight courses. By the end of the decade the Specialization and Concentration programs had been introduced and there was a total of 24 courses.

The Department made a request to the Faculty of Graduate Studies in 1967 for permission to offer the PhD degree. The report of the committee which was set up to consider this request stated that there were good Honors and MSc programs and that the senior faculty in the Department were established scholars with a significant number of publications. It also said that the Department had an excellent library which had all of the important books in computing that had been published in recent years and which was completely satisfactory for graduate study for the PhD. The recommendation for the PhD program was approved by the Faculty of Graduate Studies early in 1968.

During the early years of the Department there were many debates about the nature of computing
science and the content of courses. One controversy that developed very soon after the formation of the Department concerned the teaching of programming since there were those who believed strongly that one should start with a high-level language and those who believed with equal fervour that a simple machine language should be the first language. Differences over this problem between two of the principal protagonists were finally settled very amicably over lunch one noon in the Faculty Club. Another argument arose one year over the shortage of space for IBM keypunches, and during one lively discussion the suggestion was made to move some equipment into Don Scott's office which was larger than any other faculty office in the Department. Fortunately, reason prevailed and Don Scott retained the use of his entire office. The following year the distribution and collection of the type elements for the IBM 2741 terminals provoked another spirited discussion. The details of this argument and its outcome have been long forgotten.

The 1620 was replaced during the summer of 1964 by an IBM 7040/1401 which by September of the following year was run on a completely closed-shop operation. During the summer of 1967 this system was replaced by an IBM 360/67 which remained in use until the mid-1970s.

Both the Department of Computing Science and the Computing Centre were located for many years in what was originally the Physical Science Building. During the summer of 1968 the facilities and staff were moved to the newly opened General Services Building with the Department of Computing Science on the sixth floor and the Computing Centre on the second and third floors. During the late 1960s the role of computing began to change at the University. The Computing Centre had been formed to provide a service to the University while the Department of Computing Science was an academic department in the Faculty of Science and offered its own courses and degrees. Since Don Scott was both Director of one and Head of the other, this distinction was often blurred. The separation of responsibilities was made even less distinct since members of the Department often provided a consulting service to users of equipment in the Computing Centre and wrote some of the programs which were used. The problems were exacerbated by the conflicting demands for large amounts of computing time by the Departments of Chemistry and Physics and the Faculty of Engineering, for secure data processing by the Administration, and by the research interests of the Department of Computing Science.

In May 1966 the Administrative Data Processing Unit was formed with Bill McMinn as Director. Then in 1968 the Computing Centre began to function as an independent service organization with Bill Adams, who retained his academic appointment in the Department, as Associate Director. The stage then was being set for the complete separation of the Computing Centre and the Department of Computing Science so that the Centre could concentrate on providing a service to the University and the Department could devote all of its resources to undergraduate and graduate teaching and research.
The 1970s - Consolidation

In 1970 following recommendations made by the Computer Facilities and Policy Committee and approved by General Faculties Council and the Board of Governors, the Computing Centre became a separate organization under a Director reporting to the Vice-President (Academic). In 1971 Dale Bent, an Associate Professor of Business Analysis who had been Acting Director for a year, was appointed Director. Thus the Department of Computing Science became a user of the computing facilities as was any other department in the University. The separation of the Department of Computing Science from the Computing Centre was intended to make clear to the University the distinct functions of each organization and to improve the administration of each. Unfortunately, all of the equipment and most of the support staff were assigned to the Computing Centre. Thus one of the most urgent tasks for the Department in the 1970s was the acquisition of computing equipment to handle the teaching and research which could not be done on the computer now administered by the Computing Centre.

Don Scott was succeeded as Chairman in 1971 by John Penny who served as Acting Chairman for one year while the Department looked for a Chairman. In the summer of 1972 Arthur Wouk, a numerical analyst from Northwestern University, became Chairman of the Department. He soon became known, and liked, for his idiosyncratic mannerisms and attitude towards life, and presided over the Department with a benevolent lethargy. Arthur served as Chairman for four years, took a year's sabbatical leave, and then returned to teaching. John Tartar was appointed Acting Chairman for one year and then became Chairman for a five-year term. John filled the position with an urbane style and friendly disposition and kept an office that was always open to all members of the Department.

Very few new faculty were recruited in the 1970s. Since some of these stayed only for a few years and since some of those who had come earlier left during this period, in the 1979/80 academic year there were only sixteen faculty consisting of five Assistant Professors, nine Associate Professors and two Professors. The number of courses increased during the same period from fifty-one in the 1971/72 academic year to seventy-one in the 1979/80 year with most of the increase being in senior undergraduate and graduate courses. In addition, throughout this period there was a dramatic increase in the number of students taking not only undergraduate and graduate courses leading to degrees in the Department but also service courses intended for students in other departments and faculties.

In 1972 the first Administrative Professional Officer was appointed. By 1976 a total of three persons had held this position for brief periods. In 1976 the position was replaced by that of Faculty Service Officer and filled by Steve Sutphen who had just received an MSc degree in the Department.

During the 1970s the Department continued to use the computing equipment in the Computing Centre for teaching and research while at the same time acquiring a number of minicomputers of its own. By the end of the decade the Department was operating over a dozen computers ranging from very small
machines such as the PDP-8 to the PDP-11/45 and the Nanodata QM-1. Also a Minicomputer Laboratory with a microprogrammable computer was established to introduce students to different computer architectures. The Minicomputer Laboratory was discontinued in the early 1980s when microcomputers became available and there was much less need to study differences in computer architecture. John Tartar's association with the Minicomputer Laboratory led to his participation in the formation of the ACM Special Interest Group on Minicomputers.

The 1980s - Growth

The number of students taking courses in computing science continued to increase in the 1980s. Indeed, total enrolments in all courses increased from 2,348 in the 1977/78 academic year to 4,590 in 1981/82. Additional resources were obviously required to meet this increasing demand for courses and for the supervision of graduate students. Unfortunately, all requests for substantial assistance were unanswered, and in June 1981 John Tartar resigned with one year left in his term as Chairman feeling that it was futile to continue.

Wayne Jackson was appointed Acting Chairman for a one-year term while a search was being undertaken for a new Chairman. He took over a thoroughly dispirited Department, the staff of which could find little solace in the realization that many other computer science departments in Canadian and American universities were faring similarly. During the summer Wayne prepared a report summarizing the Department's position and the resources that would be required for the Department to meet its commitments. An ad hoc committee chaired by Bob Crawford of the Department of Chemistry expanded this report into a detailed proposal for the Planning and Priorities Committee. In December 1981 the committee produced a report of well over one hundred pages entitled Expansion of the Department of Computing Science. One graph in this report showed that total weekly student hours per term per faculty member for the years from 1970 to 1981 had increased almost exponentially for Computing Science over the last part of the range whereas the hours for the Faculty of Science and the University declined over parts of the period except for a slight increase in the last year. As a result of this report the Dean of Science gave first priority to the Department in the Faculty of Science, and later in the 1981/82 year the Planning and Priorities Committee gave the Department first priority in the University.

Wayne Jackson left the University in June 1982 to join Athabasca University, and Wayne Davis was appointed Acting Chairman until a new Chairman could be found. The situation in the Department continued to worsen, and at the end of the 1981/82 academic year all four faculty who had joined the Department in 1980 left. Although three new faculty were recruited the same year, only one was a senior full-time appointment. In 1982 the position of Administrative Professional Officer was established again and was filled first by Arnold Adam. Wayne Davis continued as Acting Chairman until March 1983 when
Lee White who had been Chairman of Computer and Information Science at Ohio State University in Columbus, Ohio became Chairman.

Lee White continued and even intensified the vigorous recruiting program begun by Wayne Jackson and Wayne Davis. Soon new faculty were being attracted to the Department, with four including Lee White coming in 1983, five in 1984, three in 1985, and seven in 1986. By 1989 there were sixteen Assistant Professors, seven Associate Professors and eight Professors in the Department.

During the summer of 1982 the newly renovated Assiniboia Hall was opened, and a few members of the Department moved from the General Services Building to the north end of the third floor. Within a year or so the Department was occupying all of the third floor except for the south end which was occupied by Pensions and Benefits Administration. The space was taken up by over a dozen faculty and Sessional Lecturers, one secretary, and a few graduate students together with two research laboratories and one conference room. In 1984 more space was found in the southeast corner of the fourth floor of the Central Academic Building for a few members of the support staff and some graduate students. By the late 1980s the Department was occupying all of the sixth floor of the General Services Building, most of the third floor of Assiniboia Hall, and a dozen or so offices on the fourth floor of the Central Academic Building. In addition, a few graduate students were accommodated in the Printing Services Building. This dispersal of staff created serious problems in communication and even some problems in morale which were alleviated somewhat by the increased use of electronic mail which provided an efficient means of keeping in touch on day-to-day matters and occasionally giving vent to frustrations.

During the 1980s enrolment in courses in the Department continued to increase. Computer science became increasing popular as a discipline, and the development of the personal computer in the early 1980s was making computer literacy the current educational fad. In 1984 the number of students entering the second year of the Honors and Specialization programs was limited to 110 a year. In 1988/89 limits had to be placed also on the enrolments in service courses. To meet the need for instructional staff Lee White hired a large number of Sessional Lecturers who took over much of the work in the introductory courses and demonstrated a high degree of technical competence and dedication in the performance of their duties.

As the Department began to recruit more staff, the amount of administrative work increased. To handle some of the academic aspects of this work Bill Adams was appointed Associate Chairman in July 1987. His main responsibilities were the undergraduate program and the newly formed Instructional Support Group, two duties for which he was very well-qualified because of his extensive experience in teaching introductory courses and organizing the associated laboratories.

Tony Marsland was the recipient of a McCalla Professorship for the 1985/86 academic year. These professorships were named in honour of Dr. A. G. McCalla, the first Dean of Graduate Studies, and came
from the sale of University farm lands to the provincial government in 1980. They enabled the recipients to devote a year to uninterrupted research. Tony spent the year continuing his research and writing on distributed computing.

Lee White's term as Chairman was marked by the recruitment of over a dozen new faculty, improved laboratory facilities for teaching and research, more technical support staff, and the beginning of more formal associations with local business and industry. During the 1987/88 academic year, the last year of his five-year term as Chairman, the Dean of Science set up a Selection Committee to select a new Chairman. Lee, who was one of three candidates and the only one to receive strong support from the Department, was offered a second term as Chairman. He declined, however, and went to Cleveland, Ohio to become Chairman of the Department of Computer Science and Engineering at Case Western Reserve University.

The Department, then, had to pick once again an Acting Chairman, and the Dean selected Bob Crawford who had also just been appointed Associate Dean (Research) in the Faculty of Science. Bob, although of course not a computer scientist, was no newcomer to either administration or to the Department. He was a former Chairman of the Department of Chemistry and had been on numerous University committees including the committee established in 1981 to make recommendations for the Department of Computing Science. Thus, Bob Crawford became the third Acting Chairman in seven years. One of his first acts was to appoint Ursula Maydell as Associate Chairman.

The summer of 1988 was one of change and even some uncertainty. In addition to having a new Acting Chairman, the Department was planning to move its staff from Assiniboia Hall to the General Services Building. It had been hoped at first to obtain sufficient space to consolidate the whole Department, but unfortunately the Instructional Support Group had to remain in the Central Academic Building. At the end of the summer and as first term was beginning the move was made even though the renovations were still in progress and the new offices were only sparsely furnished. By the end of November, however, the Department was occupying comfortably furnished offices on all of the sixth floor, and about one-half of the seventh floor and one-quarter of the eighth floor.

During the 1988/89 year a Selection Committee was again formed and the search for a Chairman was resumed once again. By March the Department had selected Paul Sorenson from the University of Saskatchewan for a five-year term as Chairman. Paul had received his first two degrees from the University of Alberta, a BSc in Mathematics in 1967 and an MSc in Computing Science in 1969. After receiving a PhD from the University of Toronto, he joined the Department of Computational Science at the University of Saskatchewan and had served as Chairman of the department. So during the long, sunny days at the end of June the Department said goodbye to Bob Crawford at a number of farewell receptions, and settled down to await the arrival of the new Chairman.
The 1990s - Challenge

One of the first tasks of Paul Sorenson as the new Chairman was to prepare for a review of the Department by the President's Advisory Committee on Campus Reviews (PACCR). Within a little over a year in October 1990 the Department issued a *Self Study Report* of approximately 125 pages which reviewed the development of the Department, its present state, and its future plans and aspirations. All of the Department - faculty and technical and secretarial support staff - participated by means of innumerable meetings, discussions, written submissions and one retreat at Lister Hall. Appropriately the report was dedicated to Don Scott and John McNamee for their "foresight and initiative in pioneering computers and computing science at the University of Alberta". The Department was duly visited by a PACCR committee which submitted their report in March 1991 to which the Department responded the following October. To summarize as succinctly as possible the result of all of these deliberations we might state that the committee was very pleased with the Department but recognized that some very serious problems needed to be addressed if the Department were to function efficiently and maintain its high standards of teaching and research. The two most important issues, to which both the committee and the Department returned repeatedly, were the administration of the undergraduate laboratories by the Department rather than by University Computing Systems, and the acquisition of adequate space to replace what the Committee referred to as the Department's present "rabbit warren". Much of the planning in the Department since the PACCR review has been concerned with these problems of computing resources and adequate space. It is encouraging to report that at the end of 1992 the Department had control of the undergraduate labs some of which had been upgraded already, and that there were very good prospects of acquiring better accommodation within the next year or so.

In July 1991 Tony Marsland was appointed Associate Chairman to replace Ursula Maydell who had finished her three-year term and who then took a year's sabbatical leave. Since the duties of the Associate Chairman were changed to include the graduate rather than the undergraduate program, two new positions of Director of Undergraduate Programs and Director of Service Courses were established. The first of these was filled by Renée Elio, and the second by Bill Adams who held it for a little over one year until his retirement on September 1, 1992.

Two new academic programs were formally introduced in 1992. The first was the Industrial Internship Program which allowed students at the end of their third year to spend sixteen months in private industry before entering their final undergraduate year. It differed from other cooperative programs at the University of Alberta and other universities in that it provided an uninterrupted sixteen-month period of employment starting with a three-month probationary period. This program has had the enthusiastic support of the private sector and provides undergraduates with valuable practical experience.
The second new program was the Master of Science (non-thesis) which differed from the MSc program in that there was more course work and an essay rather than a thesis. It is intended for persons wishing more specialized training after a first degree before entering the work force although it may be used for entry into the PhD program.

Early in 1991 a number of faculty in the Department began discussions with other University faculty and industry representatives to find ways of promoting a closer association between the University and the information technology sector. As a result of these discussions the Department issued a short report in July 1992 proposing the establishment of an Information Technology Research Institute and giving its objectives, administrative structure and an implementation schedule for the first five years of its operation.

In the 1990s the Department has put considerable effort into publicizing its activities to former and prospective students. Amongst the publications are two intended to attract students to the undergraduate program - a small brochure entitled *Department of Computing Science* and a booklet *Computing Science Undergraduate Program* which describes the undergraduate program in detail - and an eighty-eight-page booklet for prospective graduate students, *Computing Science at the University of Alberta*, which gives a detailed summary of the current research in the Department. The annual *Direct Access* is intended for alumni and gives a review of current work and profiles of selected present and previous faculty. All of these publications are produced by the Department of Printing Services and have been written under the editorial direction of Ollie Frost.

Two additional publications might be noted here. One is *The Department of Computing Science: The First Twenty-Five Years* by Keith Smillie which, in spite of its name, gives a thirty-three-year history of the Department and from which much of the material in this present account has been taken. The other is the fortnightly newsletter *DNEWS* started by Paul Sorenson which gives items about current happenings in the Department.

In January 1993 the Department held a one-day retreat in the University Extension Centre for the purpose of discussions which would contribute to a four-year plan for all faculty and staff. The departmental goals of excellence and national recognition in teaching and research with international recognition in at least two areas of research, while laudable, were considered too vague to provide a direction for the Department. Two main conclusions arose from several hours of intense but friendly discussions. The first was that communication within the Department continues to be essential for its continued well-being. The second was the urgent need for a reorganization of the duties of the support staff for an efficient and reasonable handling of the multitude of problems associated with all of the hardware and software maintained in the Department.

Finally, then, in the fourth year of the 1990s we leave the seventy or so members of the Department
of Computing Science encouraged to face a difficult but challenging future with determination and goodwill one to another.

**Teaching and research**

We have mentioned that the first credit courses given in the early 1960s by John McNamee of the Department of Mathematics were two courses in numerical analysis and a third course consisting of a selection of topics in computer logic and programming. By the time the Department of Computing Science was formed in 1964 there were five additional courses for students in other departments and faculties and a number of non-credit courses. Because of the backgrounds and interests of the persons who were in the Department in the 1960s, the emphasis in teaching and research was, in addition to programming languages, in such areas as numerical analysis, optimization, statistical analysis and algorithms, and logical design. Thus the undergraduate degree could be considered to be a major in mathematics with a minor in programming.

The undergraduate curriculum changed very little during the 1970s, although a number of new courses were added, particularly at the beginning of the decade. However, there were fundamental changes made during the 1980s. Not only did the new faculty who came during this period introduce courses in their own specialties, but the Curriculum Committee was influenced by computer science programs in Canadian and American universities and by the curricula developed by the Association for Computing Machinery and the Institute for Electrical and Electronics Engineers. By the end of the decade the curriculum covered analysis of algorithms, artificial intelligence, compiler construction, computer graphics, computer organization, data base management, data structures, discrete mathematics and logic, file management, image processing, introductory programming, logical design, numerical methods, programming languages, simulation, switching theory, systems programming, and telecommunications.

For many years the Specialization Program consisted of four streams: Computer Design, Business Applications, Scientific Applications, and Software Design. Students graduating in the program had the area of specialization shown on their diplomas. However, in 1987 the accreditation study of the Honors andSpecialization programs by the Canadian Information Processing Society suggested that these streams imposed too great a constraint on students’ programs. On the recommendation of the Curriculum Committee the Department decided to abolish the streams and relax some of the requirements to give the students more flexibility in the selection of courses.

One of the most significant developments in teaching during the 1980s was the establishment of the Instructional Support Group in 1987 to handle the increasing amount of work required to provide and maintain adequate laboratory facilities for courses. This work included the selection and training of Teaching Assistants, organization and supervision of laboratories, assistance with the preparation of
assignments and laboratory materials, and assessment of future hardware and software requirements, all of which had been coordinated informally for many years by Bill Adams. The Instructional Support Group was headed by Catherine Descheneau who had obtained all of her degrees in the Department, the last being a PhD under the supervision of Jeffrey Sampson, and who had previously been a Sessional Lecturer in the Department. The Instructional Support Group has continued to provide an invaluable service and has made a significant contribution to the quality of instruction.

During the 1980s the Department collaborated with other departments and faculties to set up joint programs. In 1980 a Computer Engineering program was established jointly with the Department of Electrical Engineering to provide students with a good background in software topics such as programming languages, data structures and file management and also hardware topics such as electronics, digital logic and microprocessors. The program has attracted a large number of students and was accredited by the Canadian Council of Professional Engineers in 1983. A Specialization program in Geo-Information Processing and Mapping was set up jointly with the Department of Geography in 1985. The purpose was to give students an expertise in the application of computer science to cartography together with the necessary background in mathematics, statistics and geography. Due to the small number of students enrolling in the program and the lack of adequate facilities the program was terminated during the 1988/89 year. In spite of considerable planning over a number of years by the Department of Computing Science and the Faculty of Business to establish a program in Management Information Systems, neither the staff nor the funding has yet been found for such an undertaking.

The first seven MSc degrees of the early 1960s before the Department was created were designated "Master of Science in Numerical Analysis" and were awarded through the Department of Mathematics. Six of the theses were on topics in numerical analysis, the exception being one by Bill Adams entitled *Probabilistic and Deterministic Aspects of Digital Computers*. Although the thesis topics for many of the first MSc degrees awarded by the Department of Computing Science were in numerical analysis, an increasing number were on topics in the implementation and use of programming languages, computer graphics, and operating systems. As more faculty were added to the Department during the late 1960s and the 1970s, the range of topics became broader, and, of course, the number of graduate degrees granted increased.

Although there was cooperation between faculty with similar research interests, there were few formal working arrangements and no visible signs in the Department of the types of research being undertaken. During the 1980s a number of research groups were established to promote cooperation amongst faculty with similar research interests and to establish laboratories where they could work with their students. The following listing of the research groups at the beginning of the 1990s together with a few notes on their research interests may give a good indication of the research being undertaken in the
**Department:**

*Artificial intelligence.* Non-monotonic and abductive reasoning systems, automated theorem proving, knowledge representation and temporal reasoning, natural language processing, logical modelling of beliefs and knowledge, learning, cognitive modelling.

*Computational complexity, algorithms and formal systems.* Complexity of sequential and parallel algorithms, combinatorial and geometrical algorithms, automatic proof-checkers, program verification.

*Computer graphics.* Automation of the design and implementation of user interfaces, computer animation, visualization environments.

*Computer vision and image processing.* Image understanding, medical image processing, high-level and stereo vision, parallel processing approaches to vision analysis.

*Database systems.* Distributed object-oriented database systems, deductive databases, distributed database management, application of neural networks to database problems, databases for software engineering.

*Distributed systems.* Distributed algorithms, sequential and graphical programming tools, multicomputers.

*Networks and distributed operating systems.* Network protocols, multimedia environments, performance evaluation, network-based operating systems.

*Numerical analysis.* Finite-element methods for three-dimensional polyhedral regions, parallel algorithms for large sparse systems of linear equations, algorithms for systems of power series.

*Programming languages and methodologies.* Object-oriented programming, functional and logic programming, programming methodologies, programming environments.

*Robotics.* Sensor-based robotics, autonomous navigation.

*Software engineering.* Automatic generation of software development environments, integration of methodological knowledge, natural language generation from requirements specifications.

The Department has received international recognition for its work in computer chess and checkers. The World Computer Chess Championship, held in Edmonton during the 1989 National Conference of the Canadian Information Processing Society, was organized by Jonathan Schaeffer and Tony Marsland. Jonathan's program *Phoenix* was in the top ten programs competing. A checkers program *Chinook* developed by Jonathan Schaeffer assisted by Joe Culbertson, Duane Szafron and a number of students came second in the United States National Open tournament in 1990 and thus became eligible to compete for the World Checkers Championship. In this forty-game match held in London, England in August 1992 *Chinook* lost to the world champion by only two points.

We shall conclude this section with a brief discussion of some recent cooperative programs with other departments and faculties in the University and with organizations outside of the University, and with
some of the contributions made by the Department to the Canadian Information Processing Society.

In the early 1980s Wayne Davis together with Terry Caelli of the Department of Psychology organized a series of monthly seminars in the areas of image processing and computer vision. From these modest beginnings evolved the Alberta Centre for Machine Intelligence and Robotics (ACMIR), formed in 1986 to promote research and development in the areas of computer vision, intelligent systems, robotics and control, and integrated manufacturing. Terry Caelli was the Director for two years and was followed by Wayne Davis as Acting Director until December 1988 when the Centre became inactive. During its period of existence the Centre prepared a number of technical reports and organized seminars by university and industry representatives.

The Department worked for several years with the Department of Computer and Information Science of the Harbin Shipbuilding Engineering Institute in the People's Republic of China, and in 1987 the two departments signed a formal agreement to provide for a better cooperation and exchange of information and staff between the two departments. Wayne Davis was one of the main participants in this program and made several visits to Harbin. Other members of the Department who have taken part are Randy Goebel, Mark Green, Ursula Maydell, Steve Sutphen, John Tartar and Lee White.

In 1988 an agreement was reached between the University of Alberta and the All-Union Research Institute for Systems Studies of the USSR Academy of Sciences for a four-year cooperative program in artificial intelligence and data bases. The main areas of research are heuristic methods of search, hierarchical data bases, and knowledge representation. Bill Armstrong, Tony Marsland, Tamer Özsu and Jonathan Schaeffer have visited Moscow as part of this agreement. One of the Russian visitors to the Department has been G. M. Adelson-Vel'skii, one of two persons for whom AVL trees were named.

Finally we may note that the Department has always taken an active part in the Canadian Information Processing Society. Participants in the Society have been Barry Mailloux, Ursula Maydell, Don Scott and Keith Smillie, and more recently Tony Marsland, Ursula Maydell, Tamer Özsu, Paul Sorenson and Lee White. The one person in the Department who has contributed most to the Society has been Wayne Davis. He was on the local Executive for three years in the early 1970s and was then on the National Board becoming First Vice-President in 1977 and President in 1978. National conferences were held in Edmonton in 1973, 1978 and 1989, and local conferences in 1986, 1987 and 1988. The Canadian Information Processing Society has established several awards to students in the Department. These are the Donald B. Scott Memorial Prize which has been awarded since 1976, and the Computing Science Award and the CIPS Scholarship which have been given since 1988. Profits from local conferences have helped support these awards since 1986.
Hardware

In this section we shall give a brief survey of the computing hardware which was available first to the Computing Centre and then to the Department of Computing Science. Most of the discussion of software except for operating systems will be deferred to the next section.

The LGP-30, which was purchased in 1957 for forty thousand dollars, weighed eight hundred pounds, occupied twenty-two cubic feet and required a floor area of eight square feet. The original installation consisted of the computer with a Flexowriter (a modified electric typewriter with a ten-character-a-second mechanical paper tape reader and punch), a photoelectric paper tape reader, a paper tape punch, and an additional Flexowriter for the preparation of program and data tapes. The computer contained 113 vacuum tubes and 1350 diodes. The recommended air conditioning was 1 1/4 tons for the equipment, and one full-time "maintainer-operator" and two observers. (It was not stated what the observers were supposed to be observing.) Storage consisted of a magnetic drum with a capacity of 4096 thirty-two-bit words. The clock speed was 120 kilocycles giving addition and multiplication times, inclusive of storage access, of 8750 and 24000 microseconds, respectively. The internal operation was binary so that all data had to be converted from decimal to binary on input and all output from binary to decimal.

The IBM 1620 Data Processing System purchased in 1961 had 20000 characters, expandable to 60000 characters, of core storage and a paper tape reader and punch which allowed input and output at rates of 150 and 15 characters per second, respectively. It was replaced later in the year by a new 1620 with a card reader and punch with speeds of 250 and 150 cards a minute, respectively, which was upgraded the following July with three IBM 7330 magnetic tape units. Arithmetic was performed on binary-coded decimal numbers of variable length. Addition, subtraction and multiplication were done by table lookup while division was by either a subroutine or an "automatic divide" feature. The times of arithmetic operations depended on the lengths of the operands, and for addition and subtraction on their signs and relative values. The addition of two ten-digit numbers took from about 1000 to 1800 microseconds and their multiplication about 17000 microseconds. The original IBM FORTRAN II compiler was soon replaced by the FORGO "load-and-go" compiler and other programs available through the SHARE library. In 1963 the University of Alberta 1620 Tape System, written by Peter Csontos, Ron Davis and Barry Mailloux, was introduced. This system included the GO monitor which allowed for job-to-job transition without operator intervention.

In order to meet the increasing demand for computing time an IBM 7040/1401 was installed during the summer of 1964 and the 1620 was phased out during a three-month period. The new system consisted of a central processing unit with 32768 words of core memory, six magnetic tape drives augmented later by more tape drives including those from the 1620 when that system was no longer used. Additional peripheral equipment obtained included a 1401 central processing unit with 4000 characters of core
memory, a 1402 card reader and punch with reading and punching speeds of 800 and 250 cards per minute, respectively, and a 600-line-per-minute 1403 printer. The 7040/1401 system was controlled by a supervisory program which handled the scheduling of jobs and the generating of accounting information.

The use of the 7040/1401 increased so rapidly that in the summer of 1967 an IBM 360/67 which allowed timesharing was installed and was upgraded several times during the next few years. By November 1969 the system had a total of 768,000 bytes of core storage, a drum, two disk units each with eight discs, eight tape drives, a CDC GRID display for interactive graphics, two printers, two card readers and punches, and fifty-six terminal ports. Several different operating systems were available for the 360/67 including IBM OS which was used together with the Houston Automatic Spooling System HASP in which input jobs were read onto a disk, then processed according to priority, and the output stored on a disk for subsequent printing. Another important system was the student-oriented batch facility SOBF developed by the Computing Centre which allowed students' programs to be processed much more efficiently and quickly than was possible before. Students were issued "SOB tickets", each valid for one run. Those who used up their allotment of tickets could purchase for a nickel each "SOB balls", each equivalent to one ticket, made of translucent plastic and dispensed by a gum-ball machine which had been bought at an auction. The SOB Facility was originally on the second floor of the General Services Building, but was soon moved to GSB 361, a large room in the northwest corner of the third floor with sufficient space to accommodate a number of keypunches. The SOB Facility was used very heavily with up to one hundred persons out of the twenty-seven hundred possible users waiting to submit program decks or pick up output at any one time.

On January 1, 1971 the Michigan Terminal System MTS was adopted as the principal operating system for both terminal and batch work, and on April 1 of the same year a charging system was introduced for all users of the MTS system. The IBM 360/67 continued to be upgraded with additional printers and tape drives and by the end of 1974 was operating at full capacity. A year later it was replaced with an Amdahl 470 V6 which itself was upgraded and then replaced with an Amdahl 580. Changes in University computing facilities during the latter half of the 1970s which had a significant influence on the Department include the acquisition of better hard-copy terminals and of display terminals, the installation of an optical mark reader and laser page printers, and the replacement during the 1979/80 academic year of the SOB facility by terminals.

The first computer acquired by the Department of Computing Science was a used Digital Equipment Corporation PDP-9 which was purchased in 1970 for 19,700 dollars. This system had 8K of 18-bit memory, an Extended Arithmetic Element to speed up multiplication, division and shifting, a teletype console and oscilloscope display, a paper tape reader and punch, and a card reader. The cycle time was one microsecond; addition required two cycles. Two 256K fixed-head disks having an average access
time of seventeen milliseconds were added shortly, and a Sykes Compucorder 100 cassette tape drive was added in 1972. The PDP-9 was used for a large number of small projects as well as for research in image processing which was moved to the PDP-11/60 in 1977. The Hour Meter, which registered 6 634 hours when the PDP-9 was purchased, was at 15 993 hours when it was sold in 1980.

In January 1973 a PDP-11/45 costing 45 000 dollars, of which 18 000 dollars represented all of Tony Marsland's research grant, was installed. The system had a 16K core memory, a removable disk of 1.2M words, card reader, and a Centronics dot matrix printer. Tony proposed replacing the DOS-11 operating system with the UNIX operating system developed at the Bell Laboratories in Murray Hill, New Jersey where he had worked before coming to the University of Alberta. One reason for obtaining UNIX was that it would enable him to match the Belle chess program developed at the Bell Laboratories on the PDP-11/45 with his own program Wita which ran under MTS on the IBM 360/67. The fourth edition of UNIX was shipped to the University in October 1973; it is believed to be the first version of UNIX used outside of AT&T. The PDP-11/45 was for some persons the most significant of the Department's computers, and was used in numerous research projects. On January 14, 1986 at 2:53 p.m. it registered one hundred thousand hours of use, an event which was marked by an appropriate celebration, after which it was formally retired. The PDP-11/45 was kept in the Department in recognition of its important role in teaching and research.

In 1974 the Department purchased at a cost of 250 000 dollars a Nanodata QM-1 which was developed at the University of Buffalo as a universal microprogrammable computer. The original intention was to use the computer to emulate each of several minicomputers so that programs developed on this computer could be run on minicomputers. However, the emulators were never developed and the QM-1 was used for research purposes, one of which did involve the emulation of the PDP-11. The QM-1 was retired in 1984, never having been used to its full capabilities, and still remains in the Department.

Late in 1975 Bill Adams and Keith Smillie took delivery of an IBM 5100 minicomputer for use in their research and teaching which involved APL. The 5100 was a small computer by the standards of the day, measuring 17.5" by 24" by 8" and weighing forty-eight pounds. The cost including a printer was 18 300 dollars. It had an attached keyboard, a small screen allowing 16 lines of 64 characters, a memory of 16K bytes expandable to 64K bytes, a tape unit for permanent storage, and a communications adapter which allowed the output to be displayed on a television monitor. The system fitted conveniently on the top shelf of an audio-visual trolley with the printer on the bottom shelf. This system was used effectively for several years both in the classroom for teaching and in the office for course preparation and research. We might note that the IBM 5100 was followed by the IBM 5150 and IBM 5160 which were better known as the IBM PC and the IBM XT.

By 1980 the computers purchased from Digital Equipment Corporation - there were several in
addition to the PDP-11/45 - were presenting serious problems due to limited storage capacities and sixteen-bit word length. They were replaced in the early 1980s by four VAX 11/780s, each with a speed of about one million instructions per second, ten megabytes of main storage and one gigabyte of disk storage. They were called Pembina, Cadomin, Cavell and Jasper. In addition a VAX 11/730 was acquired, and named Miette. Other computers obtained by the Department during the 1980s included two Sun-1 workstations which were the second and third workstations in Canada, and a MIPS M/1000 with a speed of about ten million instructions per second, thirty-two megabytes of main storage and one gigabyte of disk storage. An Imagen laser printer, one of the first in Canada, was obtained in 1982. When some of the Department moved to Assiniboia Hall, an AppleTalk network with an Apple LaserWriter was set up to accommodate the printing needs there. Another very significant event during the 1980s was the introduction of the personal computer - the IBM Personal Computer in 1981 and the Macintosh in 1984 - which had a considerable impact on all aspects of the work of the Department. Soon each faculty office was equipped with either a workstation or a microcomputer (usually a Macintosh), or both, which were used for programming, electronic mail and document preparation. Two AppleTalk networks were established for the Macintoshes, one in the General Services Building and the other in Assiniboia Hall which were connected by a fibre optic link. In addition to personal computers the Department has also purchased a large number of Sun workstations which are linked by an Ethernet.

Software

In this section we shall give a very brief survey of some of the main software packages that have been used in the Department of Computing Science, paying particular attention to the main programming languages that have been used in introductory courses. For a simple example to illustrate the similarities and differences in these languages we shall consider programs for summing the first N positive integers. We know, of course, that this sum is given simply as N(N+1)/2, but finding the sum by actually summing the integers will give more illustrative programs for our purposes.

Programming for the LGP-30 was done in machine language using an order code of sixteen one-address instructions, each with a one-character operation code followed by a four-digit decimal address. Arithmetic was carried out with one operand in the accumulator register and the other operand in the specified memory location. The introductory paragraph of the fifty-six-page programming manual was entitled "What is programming" and contained such interesting statements as "Programming the Royal Precision LGP-30 is basically simple. Understanding certain problems requires certain knowledge, however programming for the LGP-30 does not." (Many persons undoubtedly disputed these statements as they read further.) A description of the structure and programming of the LGP-30 was preceded by a discussion of organizing calculations on a hypothetical desk calculator. The remainder of the manual was
approximately evenly divided into sections on the structure of the computer, programming, number systems, input-output procedures, and a summary of the order code. There was a reference to an "LGP-30 Subroutine Manual" which presumably contained programs for input and output, number conversion and trigonometric functions. In the machine-language program for summing integers given here it is assumed that the value of N has been input and converted to binary and that the binary value of the sum remains in storage. The designation 2000, for example, refers to the location in storage with that address and (2000) to its contents, and A refers to the accumulator register.

Programming for the 1620 could be done in machine language, a Symbolic Programming System SPS, or FORTRAN. There was also an IBM library of utility routines which performed "most of the more standardized computations and routine tasks occurring in many computer problems". Since the FORTRAN language was relatively new, it was introduced in the manual as follows: "FORTRAN (FORmula TRANslation) is the term applied to another IBM programming system that translates a problem, expressed as a series of algebraic statements, into a complete machine language program, generating the step-by-step instructions necessary to solve the problem".

Some of the software packages used on the 7040/1401 system in the mid-1960s were MAP (Machine Assembly Program), FORTRAN II and COBOL compilers, an ALGOL compiler from the University of Grenoble, the LP III linear programming system, the BMD Biomedical Statistical Package, and the AGGIE student FORTRAN II compiler which was soon replaced by WATFOR from the University of Waterloo. One system implemented at the University of Alberta was a simulator for the MENTOR and MENTORSAP languages which were used briefly to teach simplified machine-language and assembly-language programming.

Although the BASIC language was first introduced at Dartmouth College in New Hampshire in 1964 as an alternative to FORTRAN as a first language for teaching purposes, it played a very minor role in the Department until personal computers came into use in the mid 1980s. The first implementation was replaced in the early 1970s by Waterloo BASIC which received only very limited use.

The FORTRAN language has been in continuous use since it first became available at the University of Alberta on the IBM 1620. FORTRAN II was soon replaced by various implementations of FORTRAN IV including WATFOR and WATFIV from the University of Waterloo and other versions more suitable for production work, and finally by FORTRAN 77 in the 1980s. FORTRAN was used for a number of years as the first conventional higher-level language in all courses, and is still used in CMPUT 251 Introduction to Programming for Scientific Applications and ENCMP 100 Computer Programming for Engineers which is taught jointly with the Faculty of Engineering.

In about 1970 FORTRAN as a first language for computing science students was replaced with Algol W, a language derived from Algol 60 and implemented on the IBM 360 at Stanford University. It
was used throughout the 1970s when it was then replaced by Pascal which is still used as an introductory language. (Students entering computing science in the 1990s must be physically as well as mentally fit since the single Pascal text used in both CMPT 114 and CMPUT 115 is a weighty hard-covered volume of over 1000 pages not counting a number of Appendices.) The similarity between Algol W and Pascal, as the programs for summing integers indicate, should not be surprising since Niklaus Wirth was one of the main designers of both. Both languages not only encouraged the use of structured programming techniques but also introduced the notion of a formal description of a programming language.

One software package introduced in the late 1970s which should be mentioned is TEXTFORM, an extremely large, complex and even cumbersome wordprocessing and typesetting package implemented by the Department of Computing Services. Although primitive when judged by today's standards for wordprocessors, it was used by countless numbers of faculty, staff and students throughout the University and provided almost all of them with their first introduction to wordprocessing. It has been almost completely replaced by wordprocessing packages on personal computers.

The introduction of the personal computer in the 1980s had a profound effect on the teaching and practice of programming. The implementation of a language became a programming environment consisting of a compiler or interpreter, or both, for the language together with an editor, debugging tools, program library, online help and tutorial. Many students purchased or had access to computers and could do many of their assignments off the campus independently of the University's computing facilities. The Department used the Macintosh labs in the Central Academic Building for CMPUT 161 and 162 using QuickBASIC and Microsoft Works, and CMPUT 325 using an implementation of Modula-2. The Macintosh labs in the Business Building were used for CMPUT 157 using first LightSpeed Pascal, MacWrite, MacPaint and Excel and then Microsoft Works and QuickBASIC.

Although programming languages and the environments in which they are used have evolved since programs were written in machine language for the LGP-30, the logic of a program for many problems is almost independent of which conventional higher-level language is used. For example, all of the programs given so far in this section for finding the sum of integers employ the same algorithm: a partial sum is set initially to zero and then incremented by explicitly adding consecutive integers starting with 1. Even the C program uses this method and is different only in appearance from the other programs. Furthermore, the overall approach to learning programming has changed not at all. In the notes on programming the LGP-30 that Bill Adams prepared for his lectures over thirty years ago we find the following comment: "This course is intended as a practical course in programming and it is of great importance that assignments should be done; otherwise nothing will be learned." Further on we read that the steps required in the solution of a problem on a computer begin with the statement of the problem, and continue through to test calculations, debugging, and finally the preparation of specifications (with this
Finally, let us note briefly two other programs for summing integers that differ significantly from those given above. If APL, which never achieved great popularity in the Department, is used as a functional language, then the program is very simple since the initialization and summing are done implicitly. A spreadsheet, which may be considered to be a declarative language, gives a particularly simple program since the sum of the first ten integers, or any other numbers, stored in, say, the first ten rows of the first column may be summed by the expression \(\text{SUM}(A1:A10)\) or one very similar to it.

People

During the years that the Department of Computing Science has been in existence there are many who have joined, stayed for varying lengths of time and have then departed. We shall mention some of these people now.

Bob Julius, one of the founding members of the Department and the first Assistant Head, went to the University of Toronto in 1967. John Penny, who was Acting Chairman in 1971/72, left in 1972 to take up the newly created chair in computer science at the University of Canterbury in New Zealand. The following year Stan and Doreen Heaps went to Concordia University and later returned to the Technical University of Nova Scotia. Wayne Jackson, Acting Chairman in 1981/82, left in 1983 for Athabasca University and later the University of Lethbridge. Lee White went to Case Western Reserve University at the completion of his term as Chairman in 1988. Of course, Bob Crawford, after being Acting Chairman in 1988/89, left the Department and returned to the Department of Chemistry and the Faculty of Science. After serving fifteen years in the Department Len Schubert went to the University of Rochester in 1989 but retained an appointment in the Department as an Adjunct Professor.

By the end of the 1980s not only had the Department matured but also so had some of its faculty to the point that they could consider retirement. First Kellogg Wilson retired in 1988, then Wayne Davis in 1991, and finally Bill Adams and Keith Smillie in 1992. The Department honoured each retiree at a dinner where his contributions to the Department and the computing profession were noted and the highlights, both real and imagined, of his career as well as his idiosyncracies reviewed. Undoubtedly, the recognition and embarrassment of future retirees by those who still labour on, as well as by those who have already retired and labour on unpaid, will be done with increasing zest and style.

Unfortunately we must record the deaths of those who have been members of the Department. Don Scott, the first Director of the Computing Centre and the first Chairman of the Department of Computing Science, left the Department in 1971, and shortly afterwards was appointed University Ombudsman, a position he held for four years. His death in 1975 ended a long career at the University of Alberta which began in 1940 as a Sessional Lecturer in Physics. His thirty-five years at the University were dedicated
not only to teaching, which he considered to be one of the most important and rewarding responsibilities of a university professor, and to departmental administration but also in service and leadership on many University committees.

Bill McMinn who left the Department in 1966 to become Director of the Administrative Data Processing Unit, left the University in 1972. He died in Toronto in 1983. K.-V. Leung died in Montreal a few years after he left the Department in 1973. John McNamee who established and gave the first academic courses in the Computing Centre in the early 1960s left the Department of Mathematics in 1967 to become Executive Director of the Canadian Mathematical Congress in Montreal. He died in 1991.

Finally, we must record the deaths of those who died while they were still members of the Department. I-Ngo Chen died in 1981, Barry Mailloux in 1982, and Jeffrey Sampson in 1985. I-Ngo Chen was known for his research in probabilistic automata, computer architecture and parallel processing, for his many papers and technical reports, and as a prominent member of the Chinese community in Edmonton. Barry Mailloux was a leading proponent of ALGOL 68, a language he worked on first as a graduate student at the Mathematisch Centrum in Amsterdam, and published many papers and technical reports in this area. Jeffrey Sampson was very active in teaching, research and administration in the Department, published many papers in a variety of areas, and was the author of two texts on adaptive systems.

To all those who have left the Department for other places and to those who have retired we extend our gratitude and best wishes. To those others who are no longer with us, we can only say that they are fondly remembered as colleagues and friends.

Acknowledgements

Technical assistance: Bill Adams, Renée Elio, Tony Marsland, Piotr Rudnicki, Jonathan Schaeffer, Steve Sutphen, John Tartar

Editorial Assistance: Donna Fremont, Ollie Frost, Brian Pinchbeck, Peternela Scharf

The quotation from Dr. Johns is from Those Tumultuous Years: The Goals of the President of the University of Alberta during the Decade of the 1960s by Duncan D. Campbell (The University of Alberta, 1977).

Keith Smillie is Professor Emeritus of Computing Science at the University of Alberta, Edmonton, Alberta T6G 2E8. His email address is smillie@cs.ualberta.ca.
Appendix 0 – Programming Examples

1000 b2001 (2001) ? A
1001 h2003 (A) ? 2003  INTEGER PROCEDURE SUM
1002 a2000 (2000) + (A) ? A    (INTEGER N);
1003 c2002 (A) ? 2002 & 0 ? A BEGIN
1004 c2004 (A) ? 2004  INTREGER TOTAL;
1005 b2004 Sum ? A FOR I:= 1 UNTIL N DO
1007 h2004 A ? 2004     END;
1007 a2001 (2001) + (A) ? A
1008 h2003 (A) ? 2003  function Sum
1010 t1003 Transfer if (A) < 0 var i,Total:integer;
1011 z0000 Stop       begin
2000 N Initially stored Total:=0;
2001 l in binary    for i:=1 to N do
2002 N + 1 Working    Total:=Total+i;
2003 i               Sum:=Total;
2004 Sum Storage     end;
LGP-30 Machine Language  Pascal

FUNCTION NSUM(N)      SumOfIntegers:
ISUM=0  Sum = 0
DO 1 I=1,N FOR I = 1 TO N
ISUM=ISUM+I  Sum = Sum + I
1 CONTINUE     NEXT I
NSUM=ISUM     RETURN
RETURN
END
FORTRAN II

10 REM Sum of
20 REM integers
30 INPUT N
40 S=0
50 FOR I=1 TO N int Sum(int N)
60 S=S+I {    int I, Total;
70 NEXT I    Total=0;
80 PRINT S   for (i=1;i<=N;i++)
90 STOP      Total+=I;
100 END      return Total;
BASIC

SUM:+=/i ω

Aałgoł W
Appendix 1 - Chronology

1957  Committee on Electronic Equipment formed; LGP-30 installed
1958  LGP-30 becoming used outside of Computing Centre
1959  First computing course
1960  *Don Scott* Director of Computing Centre
1961  Second LGP-30 rented for three months; IBM 1620
1962  IBM 1620 upgraded; first academic appointments; first MSc degrees
1963  Closed-shop operation of Computing Centre; LGP-30 retired
1964  *Don Scott* Chairman of Computing Science; IBM 7040
1965  First new appointments to Academic Staff
1966  Honors program listed in Calendar
1967  IBM 360/67 installed
1968  Dept moved to GenServBldg; first BSc degree; PhD program approved
1969  Student Oriented Batch Facility implemented
1970  Computing Centre separated from Computing Science; PDP-9
1971  *John Penny* Acting Chairman; PDP-11/45
1972  *Arthur Wouk* Chairman; first APO; Interdata 3 and 4, PDP-8 and 8/L
1973  First PhD degrees; Data General Nova 2/4; UNIX installed
1974  Nanodata QM-1
1975  PDP-11/04, IBM 5100
1976  *John Tartar* Acting Chairman; first FSO appointed
1977  *John Tartar* Chairman; PDP-11/60
1978  TI 990/4, Norpak VDP-1
1979  Terminals used instead of SOBF
1980  PDP-9 retired
1981  *Wayne Jackson* Acting Chairman; first VAX-11/780
1982  *Wayne Davis* Acting Chairman; space acquired in Assiniboia Hall
1983  *Lee White* Chairman; first Retreat
1984  Space acquired in Central Academic Building
1985  XEROX 1186 Lisp workstations
1986  PDP-11/45 retired
1987  Instructional Support Group formed; MIPS M/1000
1988  *Bob Crawford* Acting Chairman; move from Assiniboia Hall
1989  Paul Sorenson Chairman; Myrias SPS-2; Chinook wins World Computer Checkers
1990  Silicon Graphics 4D/340S; Chinook places 2nd against human players; VAX 11/780s retired
1991  PACCR; Internet connection
1992  Undergraduate labs transferred; HP 9000/720 installed
## Appendix 2 - Full-time Academic Staff

<table>
<thead>
<tr>
<th>962-1971</th>
<th>Donald B. Scott</th>
<th>1985</th>
<th>Wlodzimierz Dobosiewicz</th>
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<tr>
<td>1963-1992</td>
<td>Keith W. Smillie</td>
<td>1986</td>
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<td>1965</td>
<td>Ursula M. Maydell</td>
<td>1986</td>
<td>Piotr Rudnicki</td>
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<td>Frank Stenger</td>
<td>1986</td>
<td>Jia-Huai You</td>
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<td>1967-1972</td>
<td>John P. Penny</td>
<td>1988</td>
<td>Li-Yan Yuan</td>
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<td>Barry J. Mailloux</td>
<td>1990</td>
<td>Anup Basu</td>
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<td>William J. Meyers</td>
<td>1990</td>
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<td>1968-1985</td>
<td>Jeffrey R. Sampson</td>
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<td>1970</td>
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<td>Duane A. Szafron</td>
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<td>Duane A. Szafron</td>
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<tr>
<td>1984</td>
<td>Mark W. Green</td>
<td>1973-1980</td>
<td>Mark W. Green</td>
</tr>
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</table>

### Faculty Service Officers

| 1976 | Steven F. Sutphen |
| 1983-1983 | Daniel C. Wilson |
| 1986-1992 | Alynn B. Klassen |
| 1987 | Catherine Deschenneau |
| 1993 | Carol J. Smith |

### Administrative Professional Officers

| 1972-1973 | Graham Toope |
| 1973-1975 | Gary Albright |
| 1975-1976 | Thomas McGovern |
| 1982-1984 | Arnold Adam |
| 1984-1987 | Ivan E. Bering |
| 1987 | Brian R. Pinchbeck |
### Appendix 3 - Some statistics

<table>
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<td>-</td>
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<td>2</td>
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* Calendar year

** Data for 1964, for example, from 1964/65 Calendar
Appendix 4 - Courses 1992/93

General Interest Courses
157 Introduction to Computing for Business Applications
161 Introduction to Personal Computing
162 Introduction to Programming for General Applications
251 Introduction to Programming for Scientific Applications
252 Elements of Scientific Computing

Introductory Courses
114 Introduction to Computing Science
115 Programming with Data Structures
169 Structured Programming and Data Structures
172 Formal Systems and Logic in Computing Science

Specialization and Honors Courses
201 Practical Programming Methodology
204 Algorithms I
280 Computer Organization and Architecture I
285 Computer Organization and Architecture II
291 Introduction to File and Database Management
304 Algorithms II
311 Introduction to Computer Graphics
313 Telecommunications and Computers
321 Simulation
325 Non-Procedural Programming Languages
329 Computer Design and VLSI Implementation
340 Introduction to Numerical Methods
379 Operating System Concepts
391 Database Management Systems
401 Software Engineering
406 Introduction to Image Processing
415 Compiler Design
418 Numerical Analysis: Numerical Algebra
419 Numerical Analysis: Numerical Approximation
422 Analysis of Computer Systems I
429 Computer Systems and Architecture
451 Introduction to Artificial Intelligence
474 Formal Languages, Automata, and Computability
485 Systems Programming
495 Honors Seminar
496 Topics in Computing Science
497 Topics in Computing Science
498 Topics in Computing Science
499 Topics in Computing Science

Graduate Courses
501 Topics in Programming Languages
502 Topics in Expert Systems
503 Topics in Graphics
504 Topics in Networks
505 Efficient and Optimal Algorithms
506 Topics in Graph Theory
507 Topics in Parallel Computing
508 Topics in Computing Science
509 Topics in Image Processing or Vision
510 Topics in Computing Science
511 Computer Graphics
512 Topics in Robotics
513 Computer Networks
514 Topics in Adaptive Systems
516 Operating Systems
517 Topics in Operating Systems
518 Topics in Numerical Analysis
521 Queuing Networks
522 Topics in Performance Evaluation
525 Programming Languages
530 Topics in Compiler Design
535 Parallel and Multiprocessor Architectures
551 Artificial Intelligence: Reasoning
552 Topics in Knowledge Representation
566 Algebraic and Symbolic Computation
572 Topics in the Theory of Computation
592 Data Management
593 Distributed Database Systems
601 Seminar
602 Seminar
618 Topics in Computing Science
651 Topics in Computing Science
652 Topics in Computing Science
653 Topics in Computing Science
654 Topics in Computing Science
660 Seminar in Computer Networks
661 Seminar on Software Engineering
662 Seminar in Theory of Computation
664 Seminar in Knowledge-Based Systems
665 Seminar in Artificial Intelligence
670 Seminar in Information Retrieval