The Rise and Fall of CAI at the University of Alberta's Faculty of Education

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Abstract: In 19V2, the Faculty of Education at the University of Alberta marked its fiftieth year of operation. During the middle period of these years, beginning at about 1968, the Faculty became well known for its innovative work In the use of computer assisted Instruction (CAI). This paper Identifies the antecedents of this work as the research orientation of those who brought the Faculty into existence. This orientation provided the Impetus for the development of a research laboratory which grew to eventually encompass numerical computing as well as computer assisted Instruction. Some of the factors contributing to the decline of computer assisted Instruction at the University of Alberta are also Identified.

Resume: 1992 marque le cinquantieme anniversalre de la faculte d'FJducation de I'Universited'Alberta, Des 1968, la Faculteetait reconnue pour le travail Innovateur qu'on y accomplissait dans le domaine de l'enselgnement assiste par ordinateur (Computer Assisted Instruction [CAI]). Le present expose retrace l'historique de l'orientatlon prise par ceux qui ont contribue a mettre cetteFaculte au monde. C'est cette orientation qui a favorise l'etablissement du laboratoire de recherche qui s'est par la suite orlente vers rinformatlque numerlque et vers l'enseignement assiste par ordlnateur. Les facteurs qui ont contribue au declin de l'enseignement assiste par ordinateur a l'Unlverslte de l'Alberta sont aussl identifies.

INTRODUCTION AND ANTECEDENT DEVELOPMENTS

Although a university-based Faculty of Education did not exist in Alberta until 1942, individuals working within antecedent teacher-education institutions and programs ensured that the new faculty began with a scholarly, scientific and innovative basis both in research and in developing new methods of pedagogy. While it is rare to attribute the impetus for innovation to one individual, the direction the new faculty took was determined in large part by the first dean, M. E. LaZerte, who had been Director of the School of Education at the University of Alberta since its inception in 1929 (Chalmers, 1978). LaZerte, who obtained his doctorate in 1927, under the direction of Charles H. Judd (1873-1946) at the University of Chicago, shared Judd's views eschewing the principles of

behavioristic psychology as being appropriate for the education of humans (Judd, 1932; LaZerte, 1935). In consequence, LaZerte concerned himself with the pragmatic and practical aspects of teacher education, the scholarly concerns of analyzing how students learn and which methods of instruction are most effective. In this respect, LaZerte differed from many of his colleagues at the various Normal Schools in Alberta, whose prime concern was the rapid and consistent training of teachers for Alberta schools. The tone and the direction of the new Faculty of Education were set in large part by LaZerte, nevertheless (Dunlop, 1955).

LaZerte's theory of learning is similar to one expounded by Bruner (1961) who contends that the learning of concepts and some abstract ideas entails a hierarchical progression from concrete to abstract. In respect to learning the basic concepts of arithmetic, for example, LaZerte (1922) states,

> Before the child has experienced the need for a number, before he has used it, talked it and lived a little of it, we introduce him to a set of number symbols. A deadening process begins at once. Instead of thinking number the child tries to think in symbols; THREE now ceases to be a number idea and becomes that peculiar twisted mark, 3. (p. 30)

The use of instructional devices as aids to both teaching and learning were considered by LaZerte to be an essential element of effective instruction, therefore. Throughout his career, he both designed instructional aids and encouraged their use by students in the Faculty.

As part of his research analyzing student learning, begun in the 1920s, LaZerte developed several devices and methods to minimize instructor/tester involvement, so as to increase the likelihood of gathering data in a consistent manner. At the same time, LaZerte also discovered that some students learn new information by interacting with these devices. This discovery was important, since it provided a means by which LaZerte could address a perceived need in instruction within many schools. Before the 1950s, much rural education in Western Canada took place in one or two-room schools, where one teacher was responsible for teaching several grades simultaneously. Devices that could provide instruction without constant supervision by a teacher, could improve the instruction offered in such schools. LaZerte's discovery prompted him to develop, by 1929, a mechanical device called *the problem cylinder,* that could present a problem to a student and accept responses to ascertain whether or not the student's solution steps were correct. The problem cylinder and some of LaZerte's other instructional devices are described elsewhere (LaZerte, 1933; Buck, 1989). Although isolated individuals such as Sidney Pressey of the Ohio State University had developed similar mechanical teaching machines a few years earlier, LaZerte's efforts are described both as pioneering and comprising the spirit of innovation underlying the new Faculty of Education at the University of Alberta (Dunlop, 1955).

Developments following LaZerte

LaZerte's interest in developing and encouraging better methods both in research and teaching, led to the eventual introduction of mechanical and electro-mechanical apparatus to assist with the analysis of research data. This apparatus consisted primarily of tabulators and calculators. They were used to calculate statistics, so as to demonstrate the variability in achievement among students in Alberta schools. After LaZerte as Dean in 1950, other individuals within the Faculty of Education who shared LaZerte's concerns and aspirations, sustained the direction and research emphases he established. One such individual was G. Murray Dunlop, a Normal School veteran and, eventually, the first head of the Department of Educational Psychology.

Dunlop (1954) states that many research projects undertaken by both faculty and students were frequently hampered, or their usefulness diminished, through "the shortage of mechanical aids which take the drudgery out of the undertaking" (p. 21). In 1953, the newly-formed Faculty of Education Research Committee, through discussions with the Alberta Department of Education (now referred to as Alberta Education) began to upgrade the quantity and the quality of research equipment available to the Faculty of Education. Dunlop (1954) reports, "We have every assurance that the Provincial Government will permit the use of their I.B.M. machines [likely mechanical keypunching and/or card-sorting machines] when not otherwise required... A proper supply of computing machines and other mechanical equipment can be acquired over the years" (p. 25).

Although computers were being used at some universities for research purposes by the mid 1950s (Augarten, 1984), few were being used in Faculties of Education. Besides the scarcity and expense of such equipment, operation of these early computers required individuals possessing specialized skills in subjects such as programming and electronics, skills not usually possessed by educators at that time. It is not surprising, therefore, that a computer was not purchased for or by the Faculty of Education for several years. Dunlop (1956) notes that such purchases, "must be left to the future... At present we have access to such equipment as the university owns, and, by arrangement, may use the equipment of the departments of Education and Municipal Affairs" (p. 76).

While it appears that Dunlop appreciated the potential uses of computers in education, he did not possess much knowledge of them, nor did most members of the Faculty of Education at that time. Interest shown in computers by graduate students was encouraged, however. In the late 1950s, for example, a graduate student, Stephen Hunka, expressed interest in performing statistical calculations using a computer. While the Faculty did not possess either the required equipment or knowledge, Dr. R. MacArthur of the Department of Educational Psychology enabled Hunka to use a Royal McBee model LGP-30 minicomputer located in the Department of Physics. Hunka demonstrated that it was both possible and efficient to use a computer to calculate means, standard deviations, and correlation coefficients. This exercise also showed how the Faculty of Education could benefit through cooperating with other departments and faculties. No further applications were made of this computer since there were no

computer programming languages available, such as Basic or Fortran, to permit easy development of programs. In subsequent years, following the development of computer technology, members of the Faculty of Education began to use and acquire computers both for research and instructional purposes.

To be sure, the economic growth of the early 1960s contributed to the ability of the Faculty to obtain computing equipment. Another factor leading to the Faculty of Education's eventual acquisition of computing equipment, was the progressive attitude and supporting actions of the University's president of the time, Walter H. Johns. A subsequent President, Harry Gunning (1974) states, "Under the dynamic leadership of Walter Johns, this University gradually emerged from the chrysalis of parochialism into a fully developed centre for creative education" (p. 3).

Teaching Machines and Programmed Instruction

While interest in adapting computers for uses in education developed among some members of the Faculty of Education, another group was developing interest in the largely American phenomenon, rising from Skinnerian behaviorism, of using teaching machines and *programmed instruction* (PI) methods as the primary means of instruction in primary, secondary and post-secondary classes. In spite of being interested, most faculty were reluctant to join the bandwagon advocating a wholesale adoption of PI and teaching machines. The slowness with which teaching machines and PI were investigated at the University of Alberta was due in part to prudent caution. Many teaching machines and much programmed instructional material were not readily available in Canada for several years following the initial surge in interest shown in the United States (Rutherford, 1961; Sorestad, 1963).

Several experimental uses of teaching machines and PI methods were undertaken by staff of the Faculty of Education. Rutherford (1961) reports that some individuals were, "preparing a program in statistics but little progress yet; has bought two programs and planning to buy two machines" (p. 116). Some work was done evidently, since a Rheem-Califone model 501 *Didak* teaching machine, designed by B. F. Skinner, containing the remnants of an introductory lesson in statistics has survived.

Clarke (1961) likely reflecting the enthusiasm of educators subscribing to the teaching machine bandwagon, predicted that teaching machines would become an integral part of most classrooms, and that "one prediction is safe: they [teaching machines] will be present in classrooms within ten years" (p. 72). In spite of this prediction, it does not seem that the teaching machine(s) used in the Faculty of Education operated in the manner anticipated, since use was soon discontinued and no further research with teaching machines is reported. This point is corroborated by J. D. Ayres, a professor emeritus of the Department of Educational Psychology, who states, "I did not consider teaching machines, which were really very primitive, and not much more advanced than Babbage's 1800's computers, a suitable vehicle for research" (personal correspondence, December 5, 1988).

Other individuals within the Faculty seem to have conducted some research with teaching machines, but no evidence has been located to suggest that prolonged or extensive instructional use was made of teaching machines. While many initiatives using PI techniques were developed and used by faculty members, a greater impact and innovation was the more widespread and varied use of computers by the Faculty during the 1960s and 1970s.

COMPUTERS FOR EDUCATIONAL RESEARCH

General Research Applications

By 1960, spearheaded by the need for research as part of the development of a doctoral program supported by the Carnegie Foundation, the Faculty had established a research laboratory for the processing of numerical data primarily from surveys and achievement testing. A major goal of this laboratory was to demonstrate the wide variability in achievement within given grade levels of Alberta schools. As noted previously, ready-made computer programs were essentially non-existent, so the Faculty had little choice but to use unit record equipment and electro-mechanical calculators. The unit record equipment consisted of an IBM card sorter-counter and a keypunching machine. Calculators were still required, since the card-sorter could perform no arithmetic operations other than counting. It was Dunlop's plan that the research laboratory would perform a valuable service both to the Faculty and to the field in the analysis of data, and that this service would provide some of its financial support.

By 1961 the University of Alberta had acquired an IBM 1620, a small mainframe computer system, and shortly thereafter an IBM 7040 system. The processing of research data became more routine, especially for the more numerically inclined graduate students. With the move of the Faculty of Education from the old Normal School building (now called Corbett Hall) to the new Education Building in 1963, the research laboratory was expanded, and additional equipment for data analysis was obtained.

With the rapid growth of interest in research, particularly in the general area of measurement and evaluation, the Division of Educational Research Services (DERS) was formed in 1967, and equipment was consolidated under its jurisdiction. The DERS acquired the University's first electronic optical examination scoring machine, as well as the first IBM magnetic tape typewriter for the production of research manuscripts authored by faculty members. Also in 1967, the University acquired an IBM 360/67 computer system, access to which enabled DERS to prepare a package of computer programs for statistical analysis which were extensively used on campus and also distributed to other universities. A remote computer terminal located in the Faculty also permitted the use of Iverson's APL language for data analyses (Iverson, 1962). During the next few years, research demands of the Faculty used about 10% of the University's computing resources each year, with so many jobs being processed that the University's first delivery service of computer input and output was established

in the Faculty of Education on a six days per week schedule. To provide some students in public schools an opportunity to use computers as adjuncts to classroom instruction, four remote printing terminals connected by telephone modems to the IBM 360/67 and accessing APL, were placed into an elementary, a junior high school, and two senior high schools in the Edmonton area. By sharing a common file accessed by both high schools, the students developed a simple system of electronic-mail.

INSTRUCTIONAL USES

Training Computer

The first purchase and use of a computer for instructional purposes specifically by the Faculty of Education, appears to have been made by the now dismembered Department of Industrial and Vocational Education. Under the direction of H. R. Ziel, a Fabritek transistorized training computer was purchased in 1965, as an instructional adjunct to the electronics courses offered to students intending to become industrial arts teachers. The unit, which occupied most of the surface of a sturdy table or large desk, was designed so that component panels inside the cabinet could be withdrawn for maintenance and to facilitate the observing of discrete parts of the system such as the core memory and the resistor-transistor logic gates. Input to the computer could be achieved either by pressing illuminated switches on the front of the cabinet, or by means of a two<ligit octal keyboard, connected to the computer by a length of cable. Although only simple arithmetic operations could be carried out by this computer, it did function according to the same principles of operation as larger computers of the day designed for other purposes. While the newer computer technology of the 1970s made the Fabritek computer obsolete as an instructional device for illustrating current computer technology, it continued to be used until 1987 to show some examples of early computer technology. Although replaced by the Department of Adult, Career and Technology Education, the old Department of Industrial and Vocational Education was at the forefront in other areas of using computers for instructional purposes.

DECPDPs

By the time the Department of Industrial and Vocational Education had ordered the Fabritek unit, minicomputers were beginning to be marketed. Two standard model PDP-8s were purchased in 1967 (personal communication with Dr. M. Petruk, February 1992). The standard PDP-8s use toggle switches rather than a keyboard to enter data. Although intended primarily for instructional purposes, the DEC minicomputers were not designed for presenting instruction, so they did not possess a user-friendly interface and were not used as extensively for instruction as some other computer systems designed subsequently. The DEC minicomputers continued to be used for instructing programming skills until the purchase of microcomputers in the late 1970s. For teaching programming skills

and techniques, and for the development of experimental instructional paradigms, the department purchased a Digital Equipment Corporation model PDP-8 Classic minicomputer in 1975. This unit, about the size of a small desk, contained an integral keyboard, an 8.5 inch floppy disk drive and a small monochrome monitor.

APL

Although most of the computer applications of the late 1950s and the early 1960s were of a numerical nature, interest in using computers for instructional applications was growing. Because APL is an interactive language, the potential existed to use computers for interactive exploration of mathematical concepts and direct instructional functions. The first CAI application, made in 1967, was an arithmetic drill program. This program automatically adjusted its level of difficulty as a function of the student's rate of success.

In cooperation with J.A.L. Gilbert in the Faculty of Medicine, an interactive simulation of the management of a medical patient with hypertension was created using APL, as a basis for the development of more valid medical examination procedures. The approach kept the logic of the simulation distinct from the medical content, and foreshadowed the development, within the Faculty, of VAULT (a Versatile Authoring Language for Teachers) by Romaniuk (1970). VAULT allows teachers to use pre-defined models of instructional logic for their own specific subject matter needs. APL had also been used earlier by Romaniuk for the development of an interactive vocational guidance program. Thus, through the use of the interactive APL language designed for numerical applications, the Faculty and campus were introduced to what is known today as computer-assisted instruction (CAI).

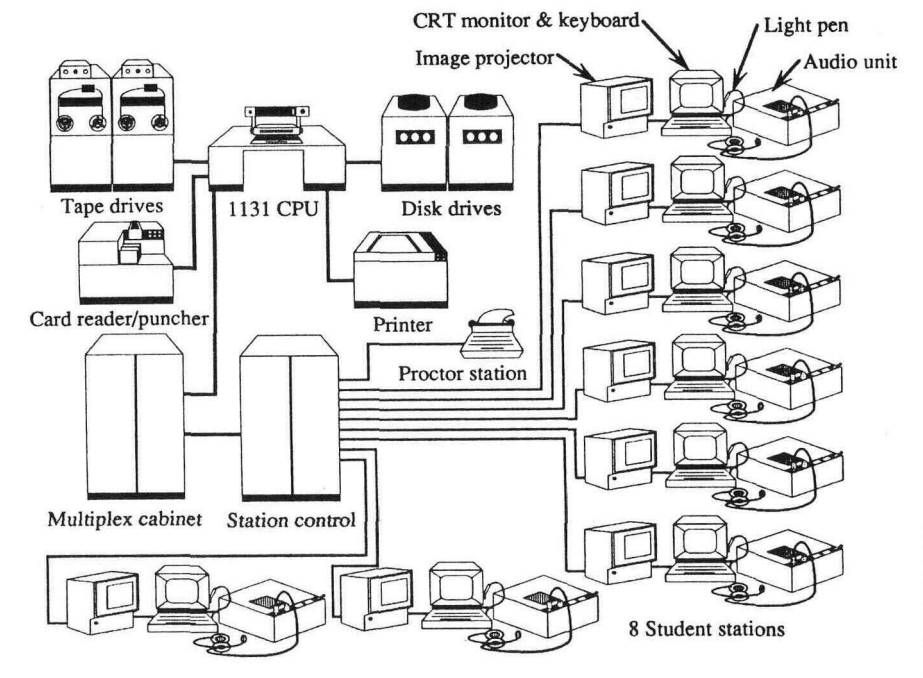
IBM 1500 System

In 1968 the Faculty in cooperation with the Department of Computing Science, received an IBM 1500 CAI system, initially prototyped at Brentwood school in California by Patrick Suppes of Stanford University. Shortly thereafter, the Donner Foundation (Canada) through a grant of $52,000, supported graduate students interested in researching the use and effectiveness of CAI. While other CAI programs were started at about the same time at other universities in Canada, most were largely experimental, and none used an integrated computer system designed specifically for providing instruction. Although the Quebec Ministry of Education was the only other Canadian organization to obtain an IBM 1500 system, it was a short-lived installation. The University of Alberta's installation survived as the only such system in Canada, and one of the longest-lived IBM 1500 systems in North America.

The IBM 1500 system was the first fully integrated instructional multi-media system (graphics, sound, and single-frame 16mm film projection) supplied by a single manufacturer. Its initial configuration at the University of Alberta consisted of eight student stations each having a monochrome CRT display with keyboard accessing different font sets, a light pen, a magnetic tape-based audio

system (record and play), and a rear screen projection system. The IBM 1500 system has received little formal documentation in the research literature, and most employees of IBM hardly know that it ever existed, since only about 25 such systems were produced. Figure 1 illustrates the basic components of a 1500 system and their functional relationships.

Figure 1.
Typical Configuration of an IBM 1500 System.



The CPU was an IBM 1131 processor with 64K of memory, which in comparison with today's microcomputers would hardly qualify as being useful at all. Through system software, the CPU operated in a time-sharing mode. System software was stored on a 250K disk drive located with the CPU. Four additional disk drives of 250K each were configured to hold the courseware code. Since only one copy of courseware existed on the system, the location of the course code to be executed for each student had to be maintained. In addition to the CPU being used for execution of course code, it also controlled the film projection and audio system for each student station. Information resulting from the execution of a specific sequence of courseware for a given student was written to a large video buffer which continuously refreshed the appropriate screen display. This method of maintaining the screen displays for each student, because of the high volume of information being transmitted, required coaxial cables and prohibited the

location of student stations at more than about 1,000 feet from the CPU. As with any small CPU used in a time-sharing mode, poor programming techniques could cause unacceptable response time delays for all students. To appreciate the quality of the software design of the system, one only needs to consider that in spite of the diminutive size of its CPU (compared with the capacity of current microcomputers) the IBM 1500 system could control up to 96 peripheral devices, that is, 32 stations multiplied by 3 for control of the primary student station, audio, and the projection system. The magnetic tape drive system was used for storage of performance records and graphics information, which was required to produce hard copy documentation. The documentation of graphics was done through the University's Calcomp plotter, located at the University's Computing Center.

Of course, hardware alone does not make a CAT system. Effective procedures for the creation of courseware, its execution, and support services for the instructor are also required. The authoring language used was COURSE-WRITER II, supplied by IBM, which had a command syntax requiring the definition of numerous parameters. COURSEWRITERII was executed through an interpreter rather than a compiler. It was soon learned that CAI computation was quite different than numerical computation, especially in determining whether a CAI program ran correctly. To facilitate determining the technical correctness of courseware, a list processor using Fortran was developed, into which the course logic was automatically abstracted and then traced to identify logical inadequacies, infinite loops for example (Flathman,1969). The software could also simulate students using the courseware, with various probabilities being assignable to different response categories. Other early uses of the system included: administration of individual intelligence tests (adaptive testing), Boyle (1973); examination of the relationship between intelligence and achievement using CAI (Brown, 1969); the development of an interrogative authoring system (Paloian, 1971). In anticipation of studying eye movements by students using CAI, Petruk (1973) designed and built a computer controlled oculometer system, likely the first such system ever developed in Canada.

The instructional operating environment of the IBM 1500 system provided many features required of an instructional environment, such as a registration system for authors, proctors, and students, provisions for restarting the course at an appropriate location for each student, authoring support services, and progress reports. Although more powerful systems exist in todays microcomputers, operating in a stand-alone mode or on a local area network (LAN), these do not provide necessarily for the instructional operating systems requirements of CAI.

The IBM 1500 system in the Faculty was rapidly expanded to 16 terminals, and eventually reached a configuration of 23 terminals. The academic and technical staff of the CAI facility participated actively in the IBM 1500 Users Group, which eventually became known as the Association for the Development of Computer-based Instructional Systems (ADCIS) which currently publishes the *Journal of Computer-Eased Instruction.* CAI programs as well as specialized

functions developed in support of the instructional courseware were shared with members of the IBM Users Group. A particularly important development, facilitating the interactive creation of graphics using the light pen instead of specifying graphics on punch cards, was designed by N. Margolus (then an undergraduate student working part-time for the CAI facility and who later was to graduate with a Ph.D. in computational physics from M.I.T.) and N. McGinnis.

An unusual characteristic associated with the operation of the CAI facility from its inception, was that graduate students from fields other than education became involved either as students in the Faculty of Education, or as students of other Faculties. Together with graduate students in Educational Psychology, graduate students trained in other fields provided a truly interdisciplinary approach to CAI research within the Faculty of Education.

Uses and Further developments of the System

By the middle 1970s, the Faculty of Education was well on its way to making extensive applications of computers both for numerical and instructional processes. In one form or another, it had explored avenues of computation which foreshadowed many more recent developments. For example, some of the firsts included the creation and use of statistical program packages before commercial packages such as SPSS were developed, test scoring and item analysis, remote access to computers via telephone lines, interactive computing, e-mail, educational uses of computers in the areas of instruction, testing, and simulations, and the study of eye movements as it relates to learning. At least one graduate student, in a rather unofficial manner, used the IBM 1500 system's capability for handling text to produce a thesis, thus anticipating the local use of computers as word processors.

In addition to the Faculty of Education, the IBM 1500 CAI system was used by other Faculties at the University of Alberta. Although the Faculty of Education was the largest user, the Faculty of Medicine made extensive use of the system by scheduling all its second year students (108 students) for a CAI course in cardiology developed by R. E. Rossall of that Faculty. Today, this course is the only currently operational CAI course originally developed on the IBM 1500, transferred to the University's PLATO installation, and then to IBM PCs using the Infowindow system and videodiscs. This course, which today has been operational for over twenty years, is likely to be recognized as possessing the longest continuous history of operation of any CAI course. The Faculty of Medicine also developed many patient management problem simulations for its own use, and for use by the Royal College of Physicians and Surgeons of Canada. Individuals in other areas of medicine such as anassthesiology, and individuals in areas related to medicine, including pharmacology, microbiology, nursing, and obstetrics also developed CAI courseware on the Faculty of Education's IBM 1500 system. The work of the Faculty of Medicine attracted considerable interest worldwide, attracting visitors from over 20 countries, including a visit from a Chinese medical delegation which made a special trip to the University of Alberta after their tour of the United States.

The initial use of the CAI system by the Faculty of Education was for teaching an introductory statistics course for graduate students, written by three staff members in the Department of Educational Psychology. This course was newly developed, and was not a transcription of the course designed for the Didak teaching machine. In this instance, the CAI system comprised the primary source for most of the instruction for the course. Eventually, the course grew to provide about 90 hours of instruction, and was used for over ten years on the IBM 1500 system, after which time it was converted for operation for another six years on a Digital Equipment VAX system. In cooperation with Pennsylvania State University, a special education course named "CARE", developed by P. Cartwright, was made available in the Faculty. A course in electrical theory, initially obtained from the U.S. Signal Corps at Fort Monmouth, New Jersey, was revised and extended to include a mathematics component, and made available to classes in the Department of Industrial and Vocational Education as well as to electrical apprenticeship students at the Northern Alberta Institute of Technology. The course included a practical laboratory component, for which the responses to the assignments were checked by the CAI system. At the time the 1500 system was decommissioned and returned to IBM in 1980, the system was providing about 27,000 student hours of instruction annually, calculated on the basis of actual time logged by students. Over the 12 years of operation, courses were developed in the following areas: introduction to COURSEWRITERII (the programming language of the CAI system); introduction to the use of APL using learner control; measurement for elementary school children at the Alberta School for the Deaf; introduction to beginning reading for kindergarten children; introductory French; introduction to IBM 360 (for students at the Northern Alberta Institute of Technology); Accident Reporting (Edmonton City Police Department); introductory statistics in Educational Psychology; fundamentals of data processing (for Library Science); and micro and macro economics (for the Department of Educational Administration).

The work of the Faculty in CAI was featured in a video series produced by the London Life Insurance Company, titled The Human Journey, broadcast nationally in 1973, as well as in an IBM advertisement in *Time* magazine. A close liaison with practicing teachers and the classroom was maintained by permitting students from local schools to visit the IBM 1500 system and to learn from it. Over 2,000 children per year visited the CAI installation. In addition, elementary and junior high students participating in a special program for gifted students operated by the public school system made use of the Faculty's CAI facility. Visitors from outside the University of Alberta, interested in exploring the use of CAI applications, were also accommodated. Representative examples include instructors from the Canadian Armed Forces, instructors from various technical schools, and academic staff from universities in the U.S.A., United Kingdom, Germany, China, Cuba, and Australia. The success of the CAI operations was such that demand for time on it increased. In response, the system was operated ten hours per day Monday to Friday, eight hours on Saturday, and four hours on Sunday.

During the late 1970s, budget cuts began to jeopardize the operation of the CAT facility. Fortunately, IBM agreed to grant the use of some student stations without charge. The Faculty of Medicine, through efforts of Dean W. MacKenzie and R. E. Rossall, also contributed some financial support. Additional hardware in the form of surplus equipment and cables, was obtained from the Pennsylvania State University following the closure of their IBM 1500 facility as the result of budget cuts at that university.

CDC PLATO/DEC VAX 11-785

In 1978 IBM gave notice that it would withdraw the 1500 system, despite having pressure placed on that company by a number of users, including the University of Alberta, at a meeting with IBM officials at the Pentagon in Washington, D.C. Although the option existed to purchase the system, there was no assurance that spare and replacement parts would be available from IBM. The University, especially through Computing Services, sought a replacement system to accommodate the considerable amount of courseware that had been developed for the IBM 1500 system. In 1980, the final solution was to acquire a Control Data Corporation PLATO system (a commercial variant of the PLATO system developed by D. Bitzer at the University of Illinois) for campus-wide use. The Faculty of Education was provided with funds to purchase a Digital Equipment Corporation VAX 11/785 system. Some courses from the IBM 1500 system were rewritten by the staff of the University of Alberta's Computing Services, to function on PLATO. The funds from the operation of the IBM 1500 system, which were transferred from the Faculty to the Computing Center for support of PLATO, and the commensurate loss of technical support, prevented DERS from employing the same technique of transferring courses from the IBM 1500 system to the VAX 11/785 system. Because of this, a decision was made to develop a new computing language called Elf (Davis, 1989) which would be used to develop authoring languages (by first developing the interpreters for these languages) so that program code from the IBM 1500 system could be run directly on the VAX system.

The transfer of courseware to the VAX 11/785 system allowed for some enhancements of the courseware, since the new system had terminals consisting of the DEC Gigi microprocessor as well as color display monitors. The Elf language was used to create a COURSEWRITERII interpreter. However, no equipment was available for accommodating the 16mm projection and sound system used by the 1500 system. Drawings previously on 16mm film were converted to digital form by developing an interactive graphics interpreter using Elf, specifically for handling the conversion task, as over 350 drawings were required for the statistics course. By 1981, the statistics course was operational on the VAX system. Since Keyano College in Fort McMurray, Alberta, also had an identical computer system configuration, the statistics course was used there during 1988 to provide instruction to students unable to attend the University of

Alberta. Thus, distance education was instituted using the computer installation at Keyano College, although insufficient funds precluded the establishment of computer-to-computer communication. Further developments entailed refinements to the instructional environment of the VAX. Changes included an enhanced system of student registration which also contained specifications as to how modules of the course were to be sequenced for each student, a facility to report examination marks for students and instructors, and an interactive authoring system, the development of which was supported by a grant from Social Sciences and Humanities Research Council (Hunka, 1988). By using the interactive authoring system, which included a graphics component, a 19 hour matrix algebra course was developed. The interactive authoring system used a menu of commands rather than icons found in some later operating systems and authoring programs, but it did allow for advanced features such as the definition of instructional model sequences which, once defined, would interrogate the author for input, and a simple visual representation of the course logic would be created.

Changes in Direction

By the late 1970s, the rapid development of microcomputers was evident and departments within the faculty began to use microcomputers rather than minicomputers and mainframes. In 1978, through the impetus of H. Ziel and M. Petruk, the Department of Industrial and Vocational Education became the first in the Faculty to purchase microcomputers for instructional use. Three models were obtained initially, a Compucolor, a Commodore and an Imsai. The Compucolor and the Commodore both possessed keyboards for data entry, and cassette tape drives for storage. Only the Compucolor could display colour images.

At first, the three initial microcomputers were used to teach programming in BASIC. Later, using the BASIC language, undergraduate and graduate students in Industrial Arts programs designed simple CAI programs for these microcomputers. The CAI lessons were administered to two classes of local junior high school pupils who came to the Faculty of Education's Industrial Arts laboratories twice a week for instruction. The apparent success of these three microcomputers in providing instruction led to the purchase, in 1980, of 15 Commodore PET microcomputers as well as a number of Radio Shack TRS-80s, Texas Instruments and Cromenco microcomputers. Subsequent acquisitions, largely the result of efforts by M. Petruk, included 40 Commodore Super PETs in 1981, 40 Monroe-Litton microcomputers in 1982, as well as the first appearance of Apple microcomputers in the Faculty in the form of 36 Apple 11+ models (personal communication with Dr. M. Petruk, February 1992). The lead established by the Department of Industrial and Vocational Education, and the demonstrated success of the microcomputer as an instructional device, contributed to acquisition of microcomputers by other departments in the Faculty.

In 1980, through the efforts primarily of E. W. Romaniuk, several Radio Shack model TRS-80s were purchased. These machines were used to develop an

extensive arithmetic drill program which was distributed to Alberta schools via tape cassettes. Other departments in the Faculty soon followed suit by acquiring numbers of several types of microcomputers. During this period, there was not only an infusion of new computing equipment, but a rapid growth in the variety of computing. By 1981 two academic staff members had been able to acquire over two million dollars worth of computing equipment for the Faculty of Education, with the help of the Provincial Government's matching grant program and without impinging on the Faculty's capital allocations from central University sources.

With microcomputers providing access to a very wide range of applications, most of which were not of a CAT nature, the interest of faculty in large part shifted away from CAI to using computers for other functions, such as word processing, spreadsheets, instruction in simple graphics and page-layout packages, and teaching of simple programming languages like BASIC and LOGO.

To be sure, individuals within some of the Faculty's departments had been working with common audiovisual technologies while others were working with the Faculty's computer systems. Such technologies included: television, radio, film formats, overhead projection equipment, photographic apparatus and recorded sound. Instruction is still provided to students in the theories and methods of using such apparatus in schools, however, major implementations of the methods tend to be most prevalent in the audiovisual courses themselves. Elements of instructional technology e.g., computer managed learning and testing, were, nevertheless, incorporated into audiovisual developments by members of the Faculty of Education using PLATO and microcomputers.

IBM Microcomputer Project

Although IBM's support of the 1500 CAI system was terminated by 1980, that company's interest in educational applications of computers had not. Directed by M. Petruk of the Department of Industrial and Vocational Education, a collaborative project was instigated with IBM, with funding coming largely from IBM. A special microcomputer laboratory was constructed containing 27 IBM model XT microcomputers with monochrome displays and two 5.25 inch floppy diskette drives each. No hard drives were supplied initially, but hard disks and a local area network file server were added later. The laboratory subsequently came under full control of the Faculty of Education, and the original equipment has been replaced with IBM PS2/55 microcomputers, using Faculty of Education funds. The IBM microcomputer project also included the equipping of six other laboratories containing a total of 125 additional microcomputers. These laboratories are located at: Harry Ainlay High School, Edmonton; University Elementary School, Calgary; Gilbert Paterson Junior High School, Lethbridge; Province of Alberta, Department of Agriculture; and the Department of Mechanical Engineering in the University of Alberta (personal communication with Dr. M. Petruk, February 1992).

Recent Developments

With little support by faculty and administration for the work being done on the VAX CAI system, both the system and DERS were quietly shut down in 1989, and two system development programmers, who started with the IBM 1500 system, were released because of budget cuts. After 21 years of operation, the centre of control for instructional computing was shifted from academic staff and turned over to the Instructional Technology Centre (ITC) by the administration of the Faculty of Education. Although some departments within the Faculty contain small microcomputer laboratories, such as one located in the Department of Adult, Career and Technology Education, budget priorities and limits have so far prevented such facilities from becoming as extensive and research-oriented as earlier endeavors. It is hoped by some individuals, that by combining the audiovisual skills of the educational technology staff with the expertise of those staff working with microcomputers, pioneering results can be obtained in the areas of multimedia presentation and other alternate instructional delivery systems.

Using the facilities operated by ITC, two CAI courses at the undergraduate level are run in the IBM laboratory. One course is an extensive special education course developed by P. Cartwright of the Pennsylvania State University. With the assistance of personnel of the ITC, two additional modules authored by G. Kysela of the Department of Educational Psychology at the University of Alberta have been added to this course. The second course, developed entirely by faculty and ITC staff, takes an average of about 40 hours to complete, and is in the area of developmental psychology. One lecture/laboratory-based undergraduate course, an introduction to computer assisted instruction, is operated by the Department of Educational Psychology using a Macintosh laboratory equipped and operated by the ITC. Courses introducing novices to microcomputer uses in education are offered by the Department of Adult, Career and Technology Education (ACTE), and in the 1991-92 academic term this Department initiated a graduate program in the area of computer-based instruction. The graduate courses presently use the facilities operated by ITC, although it is anticipated that when funding for additional computers is provided, ACTE will be able to use their own computer laboratory for instruction and research purposes.

Through a contract with the Department of Education and the Apple Innovation Support Centre (under the directorship of M. Petruk) Petruk and his staff have completed the development of a CAI course covering the Grade XII Mathematics 30 curriculum as used by the Correspondence Branch of Alberta Education. This course, prepared using Authorware Professional, and distributed as a CD-ROM suitable for Macintosh microcomputers, is currently being field tested in some Alberta high schools for possible general use. Plans are also underway to broaden its use into Saskatchewan and Manitoba. Resident visitors to the Apple Innovation Centre, housed within the Faculty, have access to the Centre's advanced microcomputer and video equipment for courseware development congruent with its goals.

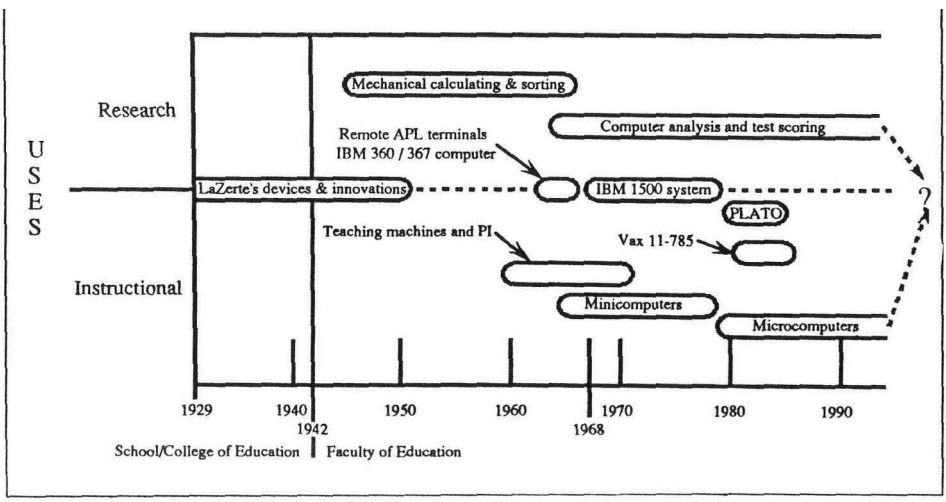
With the excellent technical expertise and TV experience resident among the professional, but non-teaching staff in the Instructional Technology Centre, tremendous strides are expected to be made in the development of CAI courseware and in the melding of audio visual capabilities with those of the computer to bring the Faculty to a new level in the use of computer technology for instruction.

SUMMARY AND CONCLUSIONS

We have examined the development of computer assisted instruction in the context of the prominence given research at the time the Faculty of Education was formed fifty years ago. The emphasis on research is identified as the basis for the initial development of a research laboratory concerned with statistical analysis primarily. Hardware advances led to the incorporation of unit record equipment initially, then calculators and finally computers. Computer assisted instruction, rather than being developed from an interest in teaching machines and programmed instruction, was found to be a spin-off of the use of computers for statistical computations. The decline of CAI as a primary source of instruction began with the introduction of microcomputers, and budget restrictions, which eventually led to a loss of support from administration and faculty for the CAI facility and to lesser extent the use of computers for statistical computations. The following chart is included to assist the reader's comprehension of the chronology and association of events and developments.

The arguments of a better quality of instruction at lower cost being provided by CAI have faded away in light of the current protracted period of economic

Figure 2.
Chronological Chart of Events and Developments.



decline and restraint. Perhaps if accurate accounting systems existed it would be found that graduate students and sessional instructors can provide instruction at far less cost than that required for the development of courseware, and the capitalization and maintenance of *a* computing facility. It will remain to be seen what effects hybrid instructional delivery systems will bring to the next fifty years of the University of Alberta's Faculty of Education.

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