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COMPUTER LEARNING:

The Policy Imbroglio

by

Teresa Plowright

Institute for Research on
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COMPUTER LEARNING:
The Policy Imbroglio

a study of the policy environment
for computer learning and its
effects on industry

Teresa Plowright
Wescom Ltd.
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EXECUTIVE SUMMARY

COMPUTER LEARNING: THE POLICY IMBROGLIO

This study examines a major new area of computer useage: the application of the computer as a learning tool. Computer learning (CL) industrial activity includes the manufacture of both hardware and software, and will expand rapidly in the next few years in education, training and consumer markets. The development of CL however is impacted by government policies in numerous ways. This study maps the policy environment for computer learning, so that the ways in which government now affects CL development can be better understood; and in order that new actions can be taken to promote Canadian industrial advances in CL.

As part of a wave of computerisation occuring today, the use of computers for learning is at a point of rapid growth. After years of slow gestation, CL is becoming commercially feasible. Three markets are emerging: in educational institutions; in industrial training; and in a consumer or retail market for micro-computers or smaller handheld devices. The industrial implications of this prospect of growth are twofold: will Canada be a largely passive market for foreign products, or can Canadian industry attain gains in CL, in both domestic and export markets?

This report discusses CL in three sections: Technology, Industry, and Policy. It concludes with recommendations on strategies to advance CL. There are numerous points of interface between government and computer learning, as government players act either from the education/training perspective (to use or set policy for CL), or from the industrial development perspective. In general, although Canada showed instances of advanced development of CL in the past, the state of computer learning is weak in Canada today. Weak support for CL becomes more significant now that a time of accelerated growth has arrived. Without supportive conditions for industry, Canada will meet domestic needs through imports, while international markets unfold with little benefit to Canadian firms.

The report begins with two basic descriptive chapters. Chapter Two introduces computer learning itself. It discusses the hardware associated with CL at present, and explains the special software needed, such as authoring languages which are used to create actual learning applications themselves. This chapter also describes various forms of CL, ranging from simple drill and practice programs to sophisticated artificially intelligent systems. Increasingly intelligent or knowledge-based applications are the future of computer learning; in comparison, the use of CL has been rudimentary to date.

Chapter Three is a description of the kinds of technology that can be used to deliver CL content to users: microcomputers and videodiscs, which have "standalone" or self-contained capabilities; and a variety of forms of telecommunications as well which can link units or distribute content. While the standalone microcomputer is in the public eye at the moment, the importance of telecommunications as a convenient means of delivering content to users remains.

Chapters Four and Five deal with computer learning markets and industry. Chapter Four discusses the three market areas for CL which are evolving at present: education, at both elementary/secondary and post-secondary levels; industrial training, as it is carried out by both government programs and industry itself; and a consumer or retail market for CL. The industrial training market is considered most opportune within the CL industry today. Despite a proliferation of microcomputers in schools, the school market is fraught with a number of problems that reduce its attractiveness to Canadian industry. The consumer market is most speculative, and may include informal learning and training, practical instruction, and "freeform" conceptual learning for children that is also fun.

Much more information is needed to estimate market sizes for CL. For example, there is little information available about training in industry as it is carried out by traditional means. A second major point about CL markets is that the institutions of the past for education and training are changing today. Post-secondary institutions, for instance, are straining under new demands for part-time and continuing education. Education and training is being used and acquired by individuals for their own self-development--for interest, to improve work skills, to shift occupations, and so on. Informal education and training, outside of structured degree-granting programs, is on the increase. Such trends represent a new demand for flexibility in time and place of study that computer learning could potentially meet.

Chapter Five is a discussion of the CL industry at present. It introduces a number of major CL systems: PLATO, TICCIT, NATAL, CAN, LOGO and Smalltalk. It also notes other centres of activity in computer learning, and discusses the growing interest among publishers in producing CL software. To date, the CL community has been a relatively small one; as commercial opportunity increases, interest in CL can be expected to grow among hardware and software firms, publishers, and others.

Chapter Five also discusses the international context for CL. International trade is especially important for Canada, with a small domestic market and extreme permeability to foreign products which must be offset by exports.

The remainder of this report is devoted to policy concerns. Chapter Six identifies a set of critical problems in CL development which are encountered in planning for its advancement: (1) the cost of content development; (2) problems in micro-computer content supply; (3) incompatibilities; (4) r&d funding conditions; (5) detrimental treatment of software as a product; (6) weak export market capability; (7) shortage of expertise. The first three subjects are functional problems which prohibit CL activities and which are immediately felt. These matters have tended to attract policy attention in the past. The remaining subjects, however, are also of critical importance to CL industrial success and should be addressed by policy to promote CL.

Chapter Seven identifies the main policy players whose actions influence CL and describes their respective roles. From the viewpoint of education and training, the principal actors are as follows: provincial ministries of education and the Council of Ministers of Education, Canada; CEIC (Canada Employment and Immigration Commission), which supports substantial amounts of training both through programs which give funds to industry to train and which purchase seats for trainees in institutions; and finally the federal government itself with its internal training needs, in the military and public service.

From the viewpoint of industrial development, one finds: the federal department of Industry, Trade and Commerce (now the Department of Regional and Industrial Economic Expansion); Ontario's BILD industrial development program, which stands out as a provincial initiative with emphasis on the "high-tech" sector; and the National Research Centre which has a long-standing interest in CL. The federal Department of Communications had a branch dealing with educational technology in the past, but this has since been dismantled.

The policy environment for computer learning is complex, even if one considers only the major players involved. Not only are numerous parties involved from both the viewpoint of user (in education/training) and industrial strategist, but both federal and provincial levels of government are concerned. Split jurisdictions complicate the policy setting for CL--in the case of manpower training, for example, where a considerable federal role exists despite provincial jurisdiction over education.

Thus as interest in CL awakens, it is dispersed among numerous government players--federal and provincial, users and industrial planners-- and cooperation is difficult.

In general the support for computer learning has been weak despite CL's potential from either the educational or the industrial viewpoint. Only in Ontario have procurement policies attempted to combine educational needs with industrial advancement in CL. In training, government has not acted as a "catalyst user" to support CL, as the military has in the U.S. R&d has been scarce, and CL fails to fit the funding frameworks of either of the two federal councils which give research grants to universities. CL is almost invisible at the university level, where expertise must be built if CL industries grow.

The weak support for CL reflects a number of factors: the relative newness of commercial viability for CL, which in industrial development circles has been overshadowed by higher-profile industries; a split federal/provincial jurisdiction in education and training (which leads to a blind spot in funding for educational technology projects); and also a narrow understanding of major changes which are now occuring in education and training. The need for a re-modelling of training in Canada has become a policy issue in itself, and at the same time the educational system is struggling to meet new demands for both informal learning and informal training. In particular, new demands for computer-related skills are exerting pressure on the old institutions. Yet there is no real vision of the changing needs in education and training, or the ways in which the computer as a learning tool can fit into this transition.

There are three facets, then, to the matter of policy to advance CL:

i) a need for increased attention to computer learning among government players who undertake or set policy for education and training;

ii) a need for increased attention to CL among industrial strategists;

iii) a need for improved mechanisms for liaison and cooperation in planning for CL.

Chapter Eight discusses various policy strategies which can be chosen to promote computer learning. These can be broadly grouped into three approaches:

i) Organize the Marketplace
  - -build up knowledge about computer learning
  - -organize content supply
  - -organize the hardware market

ii) Give Financial Support
  - -provide catalyst use of CL
  - -fund r&d
  - -support exemplary projects
  - -give subsidies: grants to nurture high-tech firms; support for user markets

iii) Create Favourable Conditions for CL Business
  - -provide supportive financing and tax conditions
  - -encourage the software industry
  - -encourage r&d supported by industry
  - -encourage expansion into export markets

Chapter Eight also discusses areas of emphasis in CL planning. Policies may variously address hardware, software, educator support, learner awareness or telecommunications in efforts to promote CL. The contention here is that emphasis should be placed upon software, especially applications software, which is lacking at present and which is the substance of CL. Software should no longer be considered a lower priority than hardware manufacturing, which has dominated industrial development attention.

Chapter Nine summarizes the conclusions of this report and provides a list of recommendations. In the past, the provincial ministries of education have been the main actors in CL policy, responding to pressures from teachers to organize aspects of the use of microcomputers in schools. Their efforts have concentrated on organizing the marketplace, solving problems in marketplace conditions where immediate problems are felt, through such solutions as clearinghouses.

A more forceful position is required. From both the educator and the industrial viewpoint, it makes little sense to organize the marketplace for the distribution of poor quality material, or (as is likely) for imported U.S. material balanced by few Canadian-made products. Financial support is needed, for content development and for exemplary projects. To date, only Ontario has supported content development in a major way.

Financial support for computer learning is also recommended in several other ways: through catalyst use of CL, particularly by the Canada Employment and Immigration Commission, with its roles in manpower training; through r&d grants to universities, especially for long-term r&d; and through exemplary projects funded at federal as well as provincial levels.

Industrial development programs which give grants to CL firms will quickly evoke responses from industry. Industrial development policies, however, should focus also on the creation of favourable conditions for business generally. Rather than attempt to select a few firms who benefit from a granting program, the task is to form a favourable framework in which CL companies can operate. R&d should be encouraged within industry (by tax policy, for example); the software industry should receive favourable treatment; and financing conditions are particularly important in software development. Finally, export market support is critical. A variety of means can be used to encourage expansion into export markets--financing aid, trade agreements, market intelligence, and so on.

A specific recommendation is also made regarding the need for a coodinative mechanism in CL planning. In the complex policy environment for CL with its many players, divergent and disjointed actions may not only be detrimental to industry but may prove inefficient if incompatibilities are entrenched. More opportunities for coordination should exist. A strengthened version of the National Research Council's Associate Committee on Instructional Technology appears as the most likely candidate to fulfill a coordinative role., and to promote CL interests among the many policy-makers whose decisions affect CL development.

CHAPTER ONE THE POLICY INTEREST IN COMPUTER LEARNING

The computer is everywhere. Shedding its image as an intemperate number cruncher, its appearance is changing: robots are taking over on assembly lines, and workstations blink deferentially on office desks. And after years of slow progress, computers are proliferating as learning tools. They act as teachers' aides in schools and they automate training courses in industry; they simulate equipment and experiments for students to practice; they can act with expert knowledge to judiciously guide the learner; or they may silently express a microworld for the learner to explore.

Computer learning is part of a wave of computerization brought on by advances in microelectronics. Computer costs have dropped, microcomputer power has grown, and computer learning systems have gotten better. Meanwhile, in the training world rising labour costs have made training increasingly costly, while at the same time the workplace is changing and more and more training is becoming required. The computer is becoming a cost-effective means to train. In the educational world, interest in computers is causing a diffusion of microcomputers in schools. And finally computer power is becoming more and more common in homes.

Three broad markets for computer learning (CL) are now evolving: in education (where microcomputers are being bought by schools at prodigious rates); in training (where the computer saves time and time equals money through employee wages); and in a consumer market for microcomputers and special handheld computer learning devices. Computer learning has reached the moment of commercial success.

As these markets evolve, they will represent massive expenditures in hardware and software. This prospect raises certain questions from the industrial viewpoint. The first is defensive: is this hardware and software to be largely imported? Canada could be a passive market, buying Japanese or US hardware and stocking it with US content. The other questions are more spirited: can Canadian companies get some share of the domestic market? And going further, are there opportunities for Canadian industry in the international marketplace?

Computer learning calls for a spirited attitude and for thinking in international terms. There is no established market hegemony in this area--no giants dominate in either hardware, software, or content, and no country has advanced to the point where any field of schooling or training is flush with well-developed CL material. Both CL products and expertise are in short supply. Canada has been a leader in computing learning in the past, before the market was ready. The aim now is to provide favourable conditions for industry as CL markets expand.

As is the case with a number of opportune high-technology areas, questions of industrial policy exist, both to attain industrial gains and to avert balance of payment problems. Computer learning is remarkable, however, for the number of ways in which its development is affected by policy. The influence of government dates back to CL's earliest days: any computer learning system in use today is likely to have been nurtured by public support during long years of r&d.

This study examines the policy environment for CL and its effects on industry: how policy affects the prospects of Canadian firms offering hardware, software and assorted services for computer learning. Industry activity includes special software (such as specialized authoring languages to create CL content), learning applications software itself, and enterprises which connect and deliver content to users, such as clearinghouses, networks and telecommunications systems. Multiple facets of the high technology sector are involved.

Policy now impacts computer learning in four major ways:

(1) the public education system is a major market for CL. The ways in which equipment and content are acquired have direct industrial effects;

(2) government itself supports a large amount of training, and could be a primary user of computers to train;

(3) r&d (a kind of lifeblood for development in fast-evolving technologies), can be supported by government funds or encouraged by incentive policies;

(4) firms making CL products are part of a high-technology sector that is in the limelight of current industrial development strategies, where a variety of measures (grants, financing aid, etc.), are being applied to nurture "high-tech."

There are a score of policy actors involved, but a few main players stand out. Provincial Ministries of Education are under pressure to organize the chaotic spread of microcomputers purchased by schools. Ontario has been most ambitious, funding a major CL content project and fostering the development of a CEM (a Canadian Educational Microcomputer). There are federal government departments which support extensive training: the military and the Public Service Commission train for internal purposes and the Canada Employment and Immigration Commission spent over $800M this year in manpower training programs across Canada. Next are the ministries responsible for industrial development at both federal and provincial levels, who view CL as a potential high-tech growth area. Finally, there are federal research funding agencies who either have supported CL in the past or could potentially do so.

The scene is complex, with players at federal and provincial levels, some viewing CL from the perspective of use and some from the perspective of high-tech development. Provincial education planners are taking different and at times divergent approaches towards the use of microcomputers in schools and while some coordination is occurring it happens almost by chance. Also, over the decades since the provinces were assigned responsibility for education, considerable federal involvement has evolved and manpower training, for example, occurs as a mix of federal and provincial activity. Split federal/provincial responsibilities in education and training lead to complicated overlaps and can create certain blind spots as well.

A focus on industrial development, however, is neither federal nor provincial. The roles of both levels of government in education and training must be considered because they are potential users of CL. However, industrial development is a national question--whether with the advent of computer learning imports will proliferate, or whether opportunities can be had by Canadian firms. Both levels of government can act to encourage industry.

With few exceptions, at present the situation shows an absence of action detrimental to the industry. The education market appears to be too fragmented to provide a base for Canadian industry; government has not served as a "catalyst user" of CL (as it has in the US through the military); and CL has received little encouragement in industrial development policy (where the ability to fund software development in general has only recently been mobilized). Furthermore, the r&d setting is spartan: little research money is available, and research within the federal government has been concentrated on a single project for nearly ten years.

Though it seems all but forgotten, national policy for CL was the subject of considerable scrutiny by the federal government some seven years ago.[1] Several recommendations of that time are still apt, such as support for r&d and for developmental projects to foster a competitive Canadian CL industry. Moreover, cooperation between federal and provincial governments was achieved in plans for several CL projects. The state of CL in Canada today--if it had been energetically developed since 1975--can only be pondered; a full-fledged effort in r&d and exemplary projects over seven years would have built up expertise and experience that could be brought to bear now that rapid CL growth has begun. One finds instead that the policy machine examined the situation, identified opportunities and needs, and called for action--but that this came to nought. Like a half-made gesture, a few reports remain.

The policy history for computer learning has had more than one such weak moment, but as a period of accelerated growth in CL continues, the failure to encourage industry becomes more significant. Computer learning is an area where Canada has been ahead of its time. However, without supportive conditions for industry Canada will meet domestic CL needs through imports, while international markets for education and training unfold with comparatively small benefit to Canadian firms.

Computer learning is a major new area of computer useage, and apart from the industrial matters considered here CL entails broad social issues as well. For example, the spread of computers will change the institutions of education and training built for the past. In schools today, there is a mood of enthusiasm among educators who see a positive side to CL. Early fears of job replacement by computers have dwindled, and computers are now viewed as a resource rather than a substitute for teachers themselves. Teachers appreciate the computer's ability to suit the student's own pace; to undertake rote teaching chores (punctuation, grammer, and so on); and to "individualize" learning by reflecting different student responses. Teachers may view themselves more as managers of the learning process, able to give more time to help with difficulties and special cases.

At present, the computer is used in the classroom less for its capabilities as a teaching tool than for the chance it gives students to learn about the computer itself. Many teachers look upon exposure to the computer as a valuable part of a student's education, and computer literacy is a motivating factor in much of the use of microcomputers in schools. Eventually more use of the computer in the curriculum is expected, as is the use of information retrieval resources by students themselves.

However the way such developments will impact schools and teachers is largely left undiscussed. What will be the effect of the computer on such pillars of the established system as the division of the day into standard time periods? Are there health hazards associated with prolonged use of video screens?[3] Will computers eventually reduce the need for teachers--or will more teachers be required in the future because of new demands for education and training? Also there is soul-searching to be done about the role of the teacher and the school system, which are responsible for much more than the transmission of knowledge itself. Educators are beginning to ask themselves questions. Does the school system maintain a common social meaning in our society?[4] What will be the effect of computers on human relations in schools?

Already there are concerns about equity of access. Computers tend to be found in schools in affluent areas.[5] As one US observer put it: "Power is not distributed evenly now, and computers will broaden that gap." Or, put more bluntly, "If computers are the wave of the future, a lot of [the country] is being washed out."[6] The need for schools to acquire computers quickly thus becomes a larger question of social opportunity.

At higher education levels, old institutions are feeling new strains. Post-secondary institutes are pressed by new demands for informal learning and training. More and more people are viewing learning as leisure, or are seeking work-oriented training on their own. The computer will change the way courses are given within institutions, and offer a new means to acquire knowledge and instruction outside their walls.

Some observers suggest that public education will fail to cope with new changes and that private education (commercial training courses for adults, in-house corporate training, and even "computer camps" for kids) may be more responsive than the public system to new education needs. A shift from public to private education is predicted. Will an advantageous education, even at the school age level, belong to only those who can pay for it? New and major issues in education may be faced.

The focus of this report, however, is upon how policy (within public education systems and within government) is affecting the industrial development of CL. Computer learning development is closely tied to policy through procurement (in provincial education systems and in government-supported training), through r&d support, and through high-technology industrial development measures. The latter includes grants, financing assistance, conditions to encourage r&d within industry, encouragement of the software industry, and export marketing support. Given that the debut of commercial success for computer learning is near, and that government in many ways sets the stage for its development, what kind of conditions for industry are created by the current policy setting? and how might these conditions be improved?

This report is structured in three parts, dealing with Technology, Industry, and Policy. Part I introduces computer learning in Chapter Two, and describes a number of delivery technologies in Chapter Three. Part II discusses three broad markets for CL in Chapter Four: the education, training and consumer markets. Chapter Five discusses the industrial setting for CL—the major computer learning systems and centres of activity, a growing interest in CL software on the part of publishers, and the international context of opportunity and competition. Part III on Policy begins with a delineation of a number of issues critical to CL development, in Chapter Six. Chapter Seven describes the policy environment for computer learning, discussing the major players and their various roles. Chapter Eight analyses the approaches and strategies taken in developing computer learning and Chapter Nine offers recommendations for specific policy moves to encourage the CL industries.

FOOTNOTES: CHAPTER ONE

[1]A Working Committee on computer-communications in education (spearheaded by a now-defunct Educational Technology Branch at the Department of Communications in Ottawa), reported in 1975.

[2]The Ontario Teachers' Federation Submission to the Cabinet, 1981 (1981), p. 11.

[3]Ibid., p. 15.

[4]British Columbia Teachers' Federation (1981), p. 30.

[5]A US survey found that 80% of the country's largest and most affluent public high schools had computers in 1982, while 60% of the 2,000 poorest schools had none. Time, Nov. 15, 1982 (Market Data Retrieval Inc. survey).

[6]Ibid. Quotation from Andrew Molnar, computer education specialist at the National Science Foundation.

[7]Ibid. Quotation from Market Data Retrieval Inc. president, Herbert Lobsenz.

PART I

TECHNOLOGY

CHAPTER TWO INTRODUCTION TO CL

The computer is being used for learning for many reasons. In training settings, its main value is that it teaches more cost-effectively by reducing the time required by employees to train. There are also gains in convenience: trainees may have flexibility in time and place of instruction. And simulations allow students to practice without the use of actual equipment during training sessions.

In businesses, in addition to training employees in job functions, computer learning can be used to instruct in the use of new equipment, which will be encountered in many occupations in the next few years as automation in the workplace takes place. Also, as micro-computers diffuse into small businesses and homes, markets will evolve for practical instruction, and in the home market informal learning and free-form applications such as LOGO will appear.

In schools today the main purpose in using computers may simply be computer literacy, to expose the student to computers in some way. When it is used to teach material or to provide learning environments, the computer can become increasingly interesting and powerful, using simulation and animation, or acting as an intelligent tutor. Some see the computer as an intellectual tool whose purpose is to expand creative thinking, rather than simply to improve the learning curve. Many see it as eventually a ubiquitous and all-purpose learning tool.

How effective are computers in teaching? Where evaluations have been done, the computer has appeared to be at least as good as traditional methods in conveying knowledge.[1] In some cases, (with handicapped learners, for instance[2]), the computer has been outstanding. In training situations with adult learners, training time is typically reduced by some thirty per cent.

There are many complexities to ponder concerning the use of computers to teach and train--the need for the human touch, the role of peer interactions, and the degree to which computerization is possible or desired for different types of learning. Still the computer has proved itself as an able teacher and it has almost always been well-liked by students and trainees. Its performance can be expected to improve as more sophisticated forms of CL appear.

As a learning tool, the computer can take various appearances, including the use of graphics, videodisc, simulations, animated games, or artificial intelligence. Without a daunting amount of technical detail, this chapter provides a sense of the diverse ways in which computers are used for learning.

From "Drill and Practice" to Expert Systems

As early as 1963, researchers at Stanford University were using computers for instruction, quizzing students in elementary and high school math through computerized drill and practice routines. Drill and practice was the earliest and simplest form of CL, essentially automating the sort of exercises one might find in a textbook.

In the following years, research in computer learning clustered around the development of a few major systems (described in Chapter Five). At the same time as work on these projects got underway, a simplified programming language (BASIC) was developed that could be learned in a few days. Countless teachers have written programs in BASIC on their own, to supplement their classroom instruction.

Tutorials, that present instructional material along with interactive questions and answers, have been the common form of CL, and have often been quite simple. More sophisticated variations of CL tap the resources of the computer in more powerful ways, but require more effort and expertise.

Simulations replicate a set of conditions, which can then change dynamically in response to the learner's actions. The learner can practice in simulated flight conditions, for example, or conduct standard scientific experiments without the use of actual lab resources. There is also a trend to enliven learning with *animation*. In animated problem-solving, the kind of anecdotal math problem commonly found in textbooks is portrayed in using cartoon-like pictures (or "icons"). The learner tries out different solutions and watches the results. For instance, in a program called TRIP, developed at Xerox Corporation's research centre, the student manipulates variables of time and speed, by sending two trains racing on a collision course across the screen.

Individualization uses the resources of the computer to provide responses that vary with an individual learner. The simplest application of CL presents material almost mechanically, in a standard fixed sequence, using the computer essentially as a textbook that has an electronic screen. Instead of such fixed sequences, CL can incorporate conditional branching: a number of alternative sequences are included in the computer program, and depending on the individual's response, different sequences are entered. More advanced systems (less commonly found outside of lab examples) build up "learner profiles" through testing and monitoring, that can take complex individual learning patterns into account.

More sophisticated systems are being developed that incorporate *artificial intelligence (AI)* approaches to CL. Two concepts are involved in these systems. The first is that of the "expert system,"[3] in which the computer is programmed with a substantial amount of knowledge in a particular domain. The SOPHIE system tutors in electronic troubleshooting, while SCHOLAR is an expert on world geography. Secondly, intelligent systems expand the "learner profile" idea into a more complex "student model" representing the hypothesized knowledge state of the student. Based on this student model, the computer selects the best procedures to present material. The BUGGY system, for example, can diagnose student problems (or "bugs") in doing simple arithmetic.

In advanced intelligent systems, the learner probes in a knowledge environment, trying out ideas and interacting with a responsive program. The learning process can be a dialogue with an expert problem solver, and in fact the model of a "socratic dialogue" has been used.

The trends in CL applications that stand out at this time are as follows:

- individualization in learning is becoming more sophisticated;
- visual environments are increasingly interesting, with graphics, animation, and the use of full video with videodiscs;
- applications are more involving, using simulation, animation, "socratic dialogues," and so on;
- the use of intelligent systems is advancing.

Instructing, Coaching and "Learning Without Teaching"

As a learning tool, the computer has largely been used in educational and training settings in a didactic or *directive* manner, to convey a specific curriculum of knowledge and skills.

Typically, the material in a CL application has been arranged as *sequential instruction*. The learner works his or her way through an ordered curriculum. Branching sequences that reflect individual responses, animated problem-solving, simulations, video narratives and other enhancements may appear, but the process of learning remains a defined and ordered one.

A contrasting approach exists, that uses the computer in a non-directive way for "learning without teaching" or *free-form learning*. In this model, learning is conceptual in nature and occurs as it does in the natural world, without curriculum. A young child learns much without being taught. Similarly, the computer can provide a domain of knowledge for the learner to explore, serving as a learning environment in which concepts and skills can be built up. The LOGO system, and particularly its world of "turtle geometry,"[4] exemplify this approach, which is termed "Piagetian learning" by the LOGO creators, after the Swiss child psychologist Jean Piaget.

A third broad type of learning through computers can be called *coached learning*. Using knowledge-based systems (that have a domain of expertise plus the intelligence to monitor the learner's progress), the individual may learn by exploring a domain of knowledge with the aid of an intelligent coach or guide. Learning is "directive", as the coach assures that a set curriculum of knowledge and skills is mastered. But rather than follow a sequence of of instruction, the student explores in a less structured way. While sequenced instruction leads the learner down paths in a domain of knowledge, with coached learning the student covers the ground independantly with the help of a guide.

Components of CL

Putting the computer to educational use requires a number of components: hardware systems of various kinds; authoring tools to create content; content or learning applications themselves; and in some cases telecommunications links. Telecommunications is discussed in Chapter Three, as are two major sorts of hardware equipment, microcomputers and videodisc systems. This section briefly discusses hardware, systems software (particularly authoring tools), and applications.

Hardware:

The main kinds of hardware being used to provide computer power in CL at present are minicomputers and microcomputers. As is the case with computing generally, the trend in hardware has been towards shrinking size that holds increasing capacity. *Mainframe* examples in computer learning still exist: the PLATO system, an early CL giant, continues to rely primarily on a timeshared mainframe computer model. However, prospective customers face either a price of some $2M for a CYBER mainframe, or substantial ongoing charges to connect to PLATO centres. At the other end of the size spectrum, developmental work is inching towards microcomputers the size of a book.

Minicomputers today fit most requirements for substantial computing power, where, for instance, a CL language demands large computer resources, and the system has to support a large number of users. Prices vary but are always a considerable expenditure, ranging from $30,000 up to a half-million dollars.

The low costs of microcomputers has caused a rush of buying in elementary and secondary schools, and micros are also spreading steadily in the home and small business personal computer ("perscom") market. The cost for a typical "micro" for student use in schools skips from $1600 to $2000, $2500 and $3700, for Commodore, Tandy Radio Shack, Apple and IBM products respectively. Perscoms usually have more resources and capabilities and are higher priced. For teachers, systems with more resources may be preferred, so that costs may be closer to perscom levels. A well-equipped Apple II costs nearly $5000 in Canada, plus a further $1000 if a printer is desired. Much lower prices are expected within a few years, and a figure under $1000 is generally considered essential for any real consumer market growth.

The micrcomputers being bought today can be embellished with a number of features. Most are now highlighting colour graphics. Also, a variety of input devices besides keyboards can be found ("joysticks" which one rotates to move objects easily on the screen, screens or tablets sensitive to touch or to special pens, and so on). Video interfaces can control tapes and disc players; speech synthesis can be used for spoken output, and (slowly) speech input capabilities are developing. Sound synthesis can be used for learning or composing music; and realtime clocks can set timers for gaming and simulations.

Handheld units already have a brief history of use apart from educational purposes. To give two examples, the US military has tested light and portable "tactical terminals" which can plug into central resources through military radio. On the civilian side, the Japanese firm Seiko has unveiled a 3½ lb. handheld computer for accounting, billing, and light word-processing chores. Handheld units are also appearing geared to specific scientific uses.

To date, a major handheld hit has been an educational product in the consumer market: Texas Instruments' popular Speak 'n' Spell, which teaches spelling and plays a word game, at low cost (under $100), and with the novelty of synthesized voice.

Two major developmental projects are targetting handheld educational units at present. Since the early seventies, the Smalltalk project at Xerox PARC[5] has aimed to produce a "Dynabook," a handheld computer with high resolution graphics, by 1984. Secondly, the Centre Mondiale pour le Developpement de la

Microinformatique, recently established in France, is working on the goal of a book-sized microcomputer with voice communications features, as part of a larger vision of worldwide use of computers as learning tools.

Software:

There are two types of software in computer learning: applications software (the actual learning content programs with which the individual interacts), and system or "facilitory" software, the operational programs for the computer that enable basic and general things to be done. Two sorts of system software are particularly important in CL.

First, *Portability software* programs can allow applications to be moved from hardware of one manufacture to another. Incompatibilities between different computers are a major problem, especially in the microcomputer marketplace, a point discussed in Chapter Six. Secondly, the need for *authoring tools* to make content creation faster and easier has absorbed an enormous amount of attention in the past, and a number of author languages and authoring systems have been developed. (See Inset A.) However, few appear satisfied with the state of the art today.

Contradictory views prevail on the subject of authoring tools and they stem at least in part from the fact that needs for authoring can vary widely. The question is: who is doing authoring and where? The elementary school teacher who wants to write lessonware needs a simple low-cost system that runs on a microcomputer, and may not want to learn to program. This individual may gratefully trade flexibility for ease of use. In contrast, in industrial training, in-house programming expertise may be available, and the value of an authoring system would lie in the extent to which it speeds up production without limiting programming options. CL could also be produced at specialized authoring centres, equipped with CL expertise and with timesaving authoring tools. Increasingly, when the scale of a project justifies it, a team approach is favoured, to combine the expertise of programmers, educational design specialists and subject matter experts.

INSET 2-A

Authoring Tools:

Content creation in CL is a lengthy process: between 200 and 300 hours of development are often required to produce one hour of an actual CL application.

Authoring tools for quicker and easier creation of CL content are of two varieties: author languages and authoring systems. An author language is a high-level language for the specific purpose of making CL content. It makes the programming required for a CL application an easier task. An authoring system is a high-level software interface which similarly speeds up production of CL content, but does so by minimizing the programming required. (For example, an author language would have a range of commands for the detailed specification of lesson components, while with an authoring system, such specifications would not be required--the system itself would supply default conditions, or prompt the author for information in small steps.) A goal of authoring systems has been to allow authors to make CL applications with little or no programming expertise.

The list of author languages includes TUTOR (for the PLATO system), the National Research Council's NATAL, which has been implemented on several computers, and PILOT, available on a number of microcomputers. Examples of authoring systems include CAN's EASSy programs and TICCIT's APT, Authoring Procedure for TICCIT. (These systems are discussed in Chapter Five.)

Authoring systems were developed from author languages, to aid in content creation--handling input of text, graphics, audio and other material. Later, authoring systems tackled lesson definition, with simple ways to specify lesson structure (e.g., the presentation of material, processing of student responses, and the use of branching sequences). Authoring systems minimize programming in several ways: through high level commands (which could be equivalent to multiple commands and considerable detail in an author language); through prompting of the author; and/or through the use of a predetermined form of instruction. TICCIT, for example, has an instructional logic built into the system. Within this framework, the author simply provides content. The Authoring Procedure for TICCIT (APT) has enabled non-programmers to produce an hour of content with 100 hours of development, half the time a programmer would otherwise require.

Some authoring systems have achieved fairly widespread use, such as the PASS system, developed by Bell and Howell. PASS uses a predefined authoring format;

prompts the author in ordinary English and will in fact cue the novice through the entire authoring process; contains automatic branching and grading; and has capabilities for colour graphics and videodisc and tape. Most importantantly, PASS runs on an Apple microcomputer, and requires no programming experience.

The limitations in current authoring systems, however, are many. Most basically, authoring systems typically develop text-based tutorials or testing sequences in prespecified patterns or "templates." Many claim that this works against variety and creativity. Author languages, while they require more programming, nonetheless offer greater flexibility. The tradeoff lies between flexibility and ease of use.

Secondly, authoring systems are weak in handling a number of colourful and useful enhancements to text-based CL. Simple methods for creating graphics are often lacking, as are convenient means to handle multimedia materials such as videodisc. The use of simulation at present is limited to authors who can program; authoring tools could help define input conditions, output states, and the causal links between them.

Thirdly, there are no authoring systems that handle knowledge-based or artificially intelligent approaches to CL, in which learning occurs as a dialogue between the student and the computer. In these systems, content and instructional strategies take the form of semantically related concepts and inference rules. Such systems require complex associative databases which are laborious to make, so that authoring tools could be particularly productive. Such tools could encourage the use of knowledge-based CL.

The question of authoring tools is a sensitive one in Canada, where for ten years the development of the NATAL author language has absorbed federal attention in CL r&d. NATAL is a language that emphasizes flexibility and completeness; but its evolution has been slow and it requires large computer resources. Its use in commercially feasible applications has yet to be proved.*

**See Chapter Five.*

Content (Computer Learning Applications)

Content is CL material itself: the actual learning applications software with which the individual interacts. Content is the substance of computer learning. To draw an analogy, "Gone with the Wind" is a classic piece of "content" that has been seen on film reels, broadcast tv (black and white, colour, primetime or late night), videocassettes and videodiscs, and it can be expected to reappear on unforeseeable new media in the future. "Hardware" is insignificant in the eyes of its audience.

The word "courseware" has been the standard industry term to refer to CL applications in the past. Now, however, a distinction has been drawn between "courseware" (entire courses of learning by computer), and smaller chunks of content, called "lessonware". Applications in the future will extend to new forms of interaction with the computer and the terminology for CL is sure to expand.

CL applications have covered countless topics and have appeared in numerous forms, and student interest and effective learning have generally resulted.[7] Its success is usually attributed to the intense interactivity of CL, which absorbs the student's attention, and to individualization, which can fit the computer's responses to the individual learner.

Nonetheless, it can be said that computer learning to date has been rudimentary: the power of the computer as a learning tool has hardly been tapped.

Outlook

Looking back, for the most part computer learning has been a kind of hobbyist activity taking place within educational institutions. Apart from a few centres of development, most CL material has been made by teachers themselves writing simple programs, particularly for microcomputers. And, while sophistication in computer learning has steadily increased, apart from lab experiments it has been constrained by the limited commercial success of CL and by the high cost of using advanced features.

These conditions are changing. The commercial environment for computer learning has become more hospitable, and the education, training and perscom markets are beginning to come of age. Most importantly, one can expect that the unique capabilities of the computer as a learning tool will be drawn upon with increasing sophistication. Artificial Intelligence will make computers smart; simulated environments will either teach or simply let the individual learn without curriculum; and most computers will talk.

Extensive r&d is still needed to empower the computer as a learning tool. Two important areas of development are the use of speech and the arrival of intelligent expert systems. (See Insets B & C.)

It is impossible to predict the forms that CL will take in the future. One can imagine handheld units, including "job aids" for consultation at work. In schools, multimedia creative learning systems may appear. A child might play and compose music by using colours and drawings on a screen.[8]

One conclusion, however, is clear: there is ongoing development in this field, and so far the use of the computer for learning has been little more than primitive. Developments in areas such as artificial intelligence are likely to transform computer learning applications. Furthermore, new types of computer learning (learning without teaching, for example) are gaining momentum in channels of development outside the CL mainstream. No planning for computer learning should rely too heavily on the frame of reference of the status quo.

Speechifying

The inability of computers to converse has been a critical communications gap. However, progress is being made in both speech synthesis, and the much more difficult speech recognition.

Current speech recognition technology has an extremely limited vocabulary, has problems adjusting to different voices, and has almost no ability to contextualize (to distinguish, for example, between "spirits" as wine and "spirits" as ghosts). Yet its advantages are so enormous that systems capable of recognizing fewer than a hundred words are now commercial products.[9]

Speech synthesis is a much easier task, and "talking chips" are being used cheaply in a number of consumer products. Expect them soon in car dashboards, microwave ovens, and toys.

The first talking consumer product was an educational one: Texas Instruments' "Speak 'n' Spell", which taught spelling and played a simple game. TI has a new talking product to teach children how to read: The "Speaking Reader", which has a phenomenal vocabulary of 200,000 words, and will retail at only $120.

The Speaking Reader uses 128 basic elements of speech (called allophones) which can be combined to form words and sentences. A child looks at a word or a picture in a special TI book, and a bar code accompanying each image has a code for the allophones needed by the voice synthesizer to speak the appropriate words. The child points a "magic wand" at the bar code, and the machine will talk.

INSET 2-C

Smart Computers

Artificial intelligence (AI) programming, like CL, involves programming that processes ideas and knowledge instead of numbers. AI programs use if-then rules (for example, the computer can be certain that if an animal has tusks, then it is not a cat). They may also use networks of facts that are linked associatively, so that the computer can tell how various pieces of information are related. (The computer can "know," for instance, that both mastodons and elephants have tusks but also be aware that mastodons are extinct.)

The AI field has been a small and close-knit community clustered within a few university centres, a breed unto its own probing the nature of intelligence and how it can be imitated within a computer.

Now, however, after years of basic research, and with advances in computer power, commercial products based on AI are appearing. Most are expert systems, computerized consultants equipped with an area of technical expertise. Mycin, a medical advisor, diagnoses certain diseases and prescribes antibiotic drugs. Dipmeter Advisor is a geology expert developed by a major oil services company, to interpret data collected from drilling sites. To create Dipmeter, researchers observed a top field engineer every day for six months, to imitate through if-then rules his special expertise, his practical knowledge and experience, and his means of problem-solving. Experts "replicated" by AI have been surprised at the extent to which their "gut feeling" conclusions can be methodically arrived at by a smart computer. An AI system will also explain how a conclusion was reached, so that human experts can assess the system's judgement. Some can improve their own knowledge-base with new information.

While there are only a handful of expert systems in use today, a flood of others are expected, beginning in specialized scientific and industrial settings, and spreading to factories and offices and (some say) to consumer markets, perhaps by the end of the decade. The limitations at present are the lengthy time needed to create the "expert" and the power of computer resources required.

Already, however, a new generation of microcomputers can use LISP (the AI programming language), and both limitations are likely to soon disappear.

By its very nature, educational computing calls for the use of knowledge-based computers, and a number of early examples of AI-based systems were produced for CL. SOPHIE (developed at Xerox PARC), is an expert in troubleshooting electronic circuits. It can interact with a student in natural language, and either SOPHIE or the student can ask questions. As the student practices with the simulated circuit, SOPHIE knows what he or she should be trying to do: if a mistake is made, some pointed questions will be asked. BUGGY is an expert in the kinds of errors ("bugs") students make in doing simple math problems. BIP models the learner's capabilities. WHY, an expert in meteorology, takes the Socratic approach to tutoring: if a student overgeneralizes about a cause of weather conditions, WHY raises a counter-example.

Such educational systems stood out in their time as ground-breaking efforts; but during that period AI was a challenge so mind-numbing that interest was confined to a rarified research environment. This context has changed: commercial AI products are about to come of age. While the first push in commercial AI may come in moneyed industries, education demands the best, and CL should be the smartest kid on the block.

The Japanese are now focussing on intelligent machines in their lengthy and costly "Fifth Generation Computer Project," which aims to create a machine that will read, write and speak several languages, learn, think and solve problems, and have the capacity to "program itself." Cornerstones of the research work ahead include: inference powers, associate memory, and powerful hardware (logic chips many times as powerful as the most advanced experimental models, and core memories with a trillion bits of information). The achievement of these aims is admittedly uncertain. Project leaders have sought international cooperation and hope to attract US expertise in AI. Yet even if projects fail to reach their targets, they will galvanize research efforts, and they may also result in some lucrative products en route, such as a "super personal computer" that is part of the research agenda.

FOOTNOTES: CHAPTER TWO

[1]The computer typically has proved to either improve learning or to show no difference when compared to the traditional classroom approach. Chambers, J., and Sprecher, J. (1980).

[2]See, for example, Ontario Teachers' Federation (1981), p. 12; Brebner, Ann, and Hallworth, H. (1981); and Goldenberg, E.P., Special Technology for Special Children (Baltimore, Md.: University Park Press, 1980).

[3]See Inset, p. 22.

[4]"Turtle geometry" creates a simple, fun and aesthetic graphics environment in which to explore geometric shapes and relationships. It is described in Chapter Five.

[5]Palo Alto Research Centre. Smalltalk is discussed in Chapter Five.

[6]See Chapter Five.

[7]See Footnote 1 above.

[8]A project at the University of Toronto allows the user to explore "paint pots" to specify musical instruments, and "timbre factories" to synthesize music by using either a keyboard or drawing on a screen.

[9]Russel Wills, Microprocessor-Based Media, International Development Research Centre, Ottawa, 1982.

CHAPTER THREE DELIVERY TECHNOLOGIES

The applications software that is the substance of computer learning can be accessed by computer hardware in several ways. One possibility is the use of self-contained or "standalone" equipment, such as a microcomputer executing a computer program stored on a diskette, or a videodisc system. Alternatively, telecommunications links of various sorts could be used to deliver content to the user's machine. Networks, "downloading", and such forms of delivering content as "teletext" and "videotex" are explained in this chapter, as are microcomputers and videodiscs. Also, delivery media (telephone lines, cable, tv signals and other media) are discussed.

Standalone, networks, and downloading

Computer hardware comprises three broad categories. First, standalone computer resources are self-contained in an individual unit. Examples include a micro-computer using software stored on a "floppy" diskette, a videodisc system, or combined microcomputer-videodisc units.

Hardware can also be linked through telecommunications to external resources. For example, a simple computer terminal has no capability of its own, and is dependent on a continuous connection to a mainframe or minicomputer. As a third possibility, hardware may have standalone power but also may be able to use telecommunication links. Microcomputers in particular offer this flexibility.

Telecommunications can be used to link hardware in many kinds of networks, but two are particularly relevant in computer learning. Local Area Networks (LAN's) are used to connect pieces of equipment within a relatively small area, i.e., a classroom, or training centre. Secondly, geographically distributed networks provide links between locations that can be hundreds or thousands of miles apart.

EXHIBIT 1

NEW TELECOMMUNICATIONS TERMS

DOWNLOADING	*software is "downloaded" when it is transmitted from a remote source and stored in local memory, typically in a microcomputer.*
VIDEOTEX	*pages of computer-based information are disseminated from a remote source in response to a user's demand. Two-way videotex connects the user to a remote computer by telephone or two-way coaxial cable.*
TELETEXT	*Teletext is one-way videotex. Pages of information are broadcast in the blanking interval of an off-air tv signal, or over a cable channel ("cabletext"). Pages selected by the user are "grabbed" by a decoder. from the continuously cycled series of frames.*
TELIDON	*Telidon is a means of transmitting text and graphics through "alphageometrics," using computer-programmed geometric instructions to create graphic displays.*
TWO-WAY CABLE	*cable has the interactive capability to both send and receive signals.*
SATELLITE	*Three forms of satellite communications are of interest currently:* • *satellite-to-cable: signals are transmitted by satellite to cable systems for local distribution;* • *satellite-plus-local area network: rooftop satellite equipment is linked to wideband networks within buildings;* • *DBS (Direct Broadcast Satellite): more powerful satellite signals are transmitted to relatively small and inexpensive satellite receiving dishes (1 metre or less).*
FIBRE OPTICS	*information is transmitted as pulses of light sent down hair-thin rods of glass. Capacity is over 1000 times that of existing coaxial cables.*
VIDEODISC	*As a high-density storage and playback medium, videodiscs are similar to phonograph records, but capable of storing video, audio and data content.* *Information is stored in tracks, each of which has an address and can be directly accessed. There are 54,000 tracks per disc, and each track can store one video frame.*

Networks offer a number of advantages over standalone units. Local resource-sharing is often cost-effective. In a multiple-user setting (such as a class) it may make sense to share computing resources through local area networking. For example, "disc-sharing" connects student microcomputers to a central disc drive, saving thousands of dollars that would be required to equip each unit with its own disc facility.[1] In addition, a two-way connection allows a central unit to collect student performance data, such as test scores.

Telecommunications can also provide access to content over a distance. Time-sharing, using telephone lines to connect to a remote central computer, was a dominant early model in the computing world, and both the PLATO computer learning system and the Minnesota Educational Computing Consortium[2] built major operations following this pattern.

However, over the years microcomputers with standalone capabilities appeared. Also, a taste for low-cost computing developed and distance telecommunications costs can now appear prohibitive. Even the well-established Minnesota system is struggling with telecommunications costs, having lost its former state subsidy for these expenses. More and more, "downloading" of remote content to local units can be expected to take the place of protracted communications links over distance.

Software is *downloaded* when it is sent through a telecommunications link and stored in local memory, typically in a microcomputer. The microcomputer then acts as a standalone unit, equipped with the downloaded program, and there is no need to retain the telecommunications link to the source. Various technologies could be used for downloading, and only one-way transmission is required. For example, a national corporation has been formed to send software through FM radio signals to owners of Apple systems across the US.[3] Telephone lines or off-air tv signals could also be used. Cable tv, because of its immense wideband capacity, is especially suited to downloading. Cable companies have downloaded video games commercially to subscribers in the US for some time. Now, NABU Manufacturing Corporation is conducting market tests in Canada to download both video games and LOGO computer learning software to subscribers' homes. Cable and other delivery media are discussed further, below.

Videotex, Teletext and Telidon

Two new terms have come into vogue in telecommunications parlance: "teletext" and "videotex." Both are ways of accessing "pages" of computer-based information displayed on a screen. Both are closely associated with "Telidon" in Canada (see Inset 3-A).

"Telidon" is a means of transmitting information using a special type of coding for graphics display that was invented in the Department of Communications' government labs in Ottawa. Though videotex and teletext are new and still almost entirely unproven in the marketplace, an incipient Telidon/videotex/teletext industry has received considerable encouragement from the federal government, which perceives a future growth area in which Canada has a technological lead. A number of Canadian manufacturers make Telidon terminals, and several firms have specialized in creating Telidon pages. The government has variously supported field trials, matched industry hardware purchases, engaged in international standards-setting, and generally attempts to promote Telidon, videotex, and teletext domestically and abroad.[4] Meanwhile, though Telidon has been linked with videotex and teletext it could be used with other delivery technologies as well. There is, for example, some initial use of Telidon with videodiscs.

Videotex and teletext could deliver "pages" for computer learning as for any application, and there have been several experiments in Canada using Telidon for education.[5] Other early work has explored the combination of Telidon with existing CL systems. Most simply, Telidon terminals have been used as machines to deliver CL. Videotex and teletext have been envisioned as mass market phenomena, and Telidon terminals are expected to be cheap. However, other links between Telidon and computer learning (such as the use of a videotex network as an online delivery means for CL, or the downloading of videotex frames for execution locally), largely remain to be explored.[6]

One problem is that a CL program is likely to be more complex than most videotex applications at this time:

> . . . a single hour of instruction can easily utilize 300 or 400 "frames" of information. Responses must be interpreted and acted upon; a single course may have the equivalent of several thousand frames of data. The pathways through these data have to be selected in terms of student responses and of the algorithms written into the course by the author.[7]

The "menu" or "tree branching" approach incorporated in videotex and teletext has been a particularly limiting structure. Also, most videotex units have not had keyboards to allow flexible student responses.

Potentially, videotex systems could provide a network for widespread distribution of CL material, along with access to reference databases. However, despite the interest of major corporations such as AT & T, the development of videotex remains highly uncertain. While videotex was first conceived as a mass-market, commercially available service, the fledgling industry has already re-strategized and is focussing instead on a market for private in-house systems within organizations.

Teletext, meanwhile, is more limited technically than videotex. The size of a teletext database is limited (200 pages using a spare line in a tv signal, 4000 pages using a full channel on a cable system). Transmission is one-way only. And, while special videotex terminals with screens and keyboards are being manufactured, teletext is oriented to tv technology, using the tv for display plus a simple keypad (without alphanumeric characters) for input. These are not hopeless limitations: the 4000 pages available on a cable channel could allow a program of substantial size, and "hybrid" systems have combined one-way teletext with a telephone connection back to the central computer. Still, these factors make teletext an unlikely medium for computer learning.

INSET 3-A

Videotex, Teletext, Telidon

"Videotex" refers broadly to two-way links from a user to a remote source of information, for information retrieval, banking and shopping, or more extensive interactions such as computer learning. Teletext is the one-way counterpart to videotex: information is sent only from the source to the receiver, embedded in a tv signal, for instance, or transmitted over a cable-tv channel. A cycle of pages continuously repeats itself, and the user's decoder "grabs" the appropriate pages out of this transmitted stream. Both teletext and videotex use a "menu" or "tree structure" to access content, whereby the user makes a series of selections that eventually lead to the right pages of information.

To take an example, using teletext about 200 pages of information can be sent in a continuous cycle embedded in a spare line in an ordinary tv signal. Imagine the teletext user in front of the home tv set. She flips on the teletext keypad (that looks much like a remote tv channel selector). A special decoder connected to the tv set then "grabs" the "Welcome to Teletext" page out of the 200 page cycle, and displays it on the tv. This page gives the user a "menu," or set of choices about what she wants to see next, such as: (#1) news and sports; (#2) entertainment; and so on. The user wants entertainment and pushes #2 on the keypad. The decoder grabs the "Entertainment" page and displays it on the screen. The user sees another set of choices: (#1) movies; (#2) theatre; and so on. She pushes #1, et cetera, proceeding through a sequence of choices until she gets the information she wants. The process is described as a "tree structure" of choices: the user makes decisions that lead to further branching points, continuing up the tree.

Videotex displays pages of information in a similar way, but through a direct telecommunications link accessing pages in the computer where the information is stored. Various new models of special videotex terminals resemble computer terminals or microcomputers, with their own video display screens, while teletext is more closely associated with television technology. Videotex terminals also have a full-alphabet keyboard capable of more sophisticated interaction with the computer than the menu method.

Telidon is a means of transmitting codes for graphics display. "Alphamosaic" systems build up a picture on a screen by filling in coordinates on a matrix.

Each page consists of a mosaic or matrix of a certain number of rows and a certain number of characters per row. Thus each position on the matrix can be specified and filled with colour to create a picture.

Telidon works more efficiently through the use of "alphageometrics", a method of generating shapes from transmitted geometric instructions. "Picture Description Indicators" provide for a set of geometric drawing primitives, such as "line" or "arc," which are sent to a microprocessor in the Telidon terminal. To draw a circle, one need only specify a starting coordinate and a radius, plus the command for "circle" which Telidon terminals understand.

Telidon graphics have been incorporated in several major standards for videotex and teletext in North America; several Telidon field tests have taken place; and several Canadian hardware manufacturers make Telidon terminals.

Thus, apart from relatively simple applications, as means to deliver pages of content videotex and teletext appear to offer little to computer learning at present, despite the keen policy interest in their development. Either government-funded r&d or a market imperative will be needed to support the technical improvements required. The downloading of entire software programs seems a more immediately promising form of delivery. This downloading could be accomplished by either videotex or teletext systems, with varying ease depending on the telecommunications medium used.

Meanwhile, other advances in videotex/teletext are converging with CL requirements. Telidon microcomputers are being developed, as are in-house local videotex systems, and both match trends in CL more than the model of a connection to a distant source of content to access pages. The use of Telidon for CL could well occur in the future in response to market needs, but (as both the Telidon and CL industries have learned) it is unlikely one can predict (or impose) the model of use.

Delivery Media

Content can be physically delivered by several technologies, most notably: telephone lines, off-air radio or tv signals, coaxial cable, satellite and fibre optics.

As a means to deliver information services, the telephone system has several strong points: virtually every home and office has a telephone that can be used for two-way communications. A major limitation, however, lies in the slow transmission rates achievable by phone.

Telephony is "narrowband"[8] communication, and its band width is small compared with "wideband" communications media such as cable or satellite. This can mean slow response time in new information services.

A full tv channel is a "wideband" medium with substantially more capacity than telephone lines. It also is a one-way medium, and no responses can be sent from the user to the central computer. A full tv channel is rarely available for information services, and such services (teletext signals, for example) have generally been "piggybacked" in a spare line (or "vertical blanking interval") of existing tv signals. The OECA has experimented with computer learning using teletext transmitted within tv signals. Radio signals can also be used to send data (for downloading, for instance), when fast transmission is not required, as in the plan to deliver Apple software in the U.S. by FM signals, noted above. With one-way signals, no charges are incurred through connection to a remote computer. Another advantage is the wide availability of signals, blanketing an area and accessible to all with a suitable receiver. Using satellite, national distribution of signals is possible.

Most tv viewers in Canada have access to extra tv channels through cable-tv. Cable service is available to two-thirds of all Canadians and to much higher percentages of the population in urban areas. Over 90% of the residents in Vancouver, for example, subscribe to cable television, and Canada is perhaps the most cabled country in the world.

Cable is a wideband medium with multichannel capacity. In a recent surge of franchising in the US,[9] new systems have been proposed that use two coaxial cables capable of offering over 100 channels. In Canada, the cable industry developed much earlier than in the US and the system capacity in place is more modest. Major cable companies are now "upgrading" to a 35-channel capacity.[10]

This capacity need not be allotted in units of tv channels. With two-way capability, some band width can be allocated for "upstream" signals from the user to the cable centres. This could be used for high-speed data transmission to accommodate computers. Thus, wideband capacity offers two advantages: fast response time, and the ability to accommodate multiple services--teletext, videotex, downloading, etc.

Most systems in Canada, however, are not two-way. Again, the US enjoys an advantage because of the late growth of cable-tv, which did not gain momentum until the success of pay-tv services. New systems being built in US cities can start out with state-of-the-art two-way capabilities. In Canada, upgrading is required. Extensive work on two-way capabilities is underway at several major Canadian cable systems.[11]

Besides its more familiar services in the residential tv market, the cable industry also wires "institutional networks," linking businesses, educational institutions, or public buildings with high-capacity two-way communications. Again, US developments are outstripping Canada and institutional networks are a part of most franchising applications currently. In Canada, some educational experiments are occurring in Vancouver to link several post-secondary institutions.

Finally, within individual buildings, computer manufacturing companies (unconnected to the cable industry) are using cable technology to install Local Area Networks in office settings, to provide instant communications links between new electronic office equipment. (An example is Xerox Corporation, with its Ethernet system.)

Thus cable is used in many forms as a wideband transmission medium. Satellite technology, meanwhile, offers powerful wideband transmission capability over distances. Cable-satellite networks, combining these technologies, are being used to distribute tv channels to cable companies across the country.

Newer and more powerful "direct broadcast satellites" will be able to send signals to small and low-priced "dishes" (the dish-shaped antennae used to receive satellite signals). Already, satellite is being used directly by businesses for voice and data transmission, using rooftop sending and receiving equipment connected to Local Area Networks within office buildings.

There are a number of other delivery media in use or on the horizon. Fibre optics transmits information as pulses of light sent down hair-thin rods of glass. Capacity is over one thousand times that of existing coaxial cable. Some initial use of fibre optics is occurring, primarily for high-traffic "trunk" lines between major cities. However, widespread use is not expected before the end of the century.

In the US, thousands of new stations could result from new rules for low-power tv stations (LPTV), that use weak transmission signals to reach audiences within a small radius. Microwave telecommunications are another means to send signals: also in the US, a delivery technology called "Multipoint Distribution System" (MDS) uses microwave to send omini-directional signals within a small radius (i.e., a few miles). MDS has been used for data transmission and for pay tv. However, these delivery systems have not been authorized in Canada.

<u>Industry Perspective and Regulation</u>

Telephony, Broadcasting and cable-tv are not only technologies, but are also industries, and despite technical capabilities, industry interest will be required for any information service to occur.

All three industries in both Canada and the US have shown some interest in new information services during the recent flurry of international promotion of videotex and teletext. This interest, however, is tempered by the uncertain profitability of such services, and computer learning has never ranked high in videotex/teletext circles as a potential money-maker.

Several provinces have "communications authorities" that broadcast radio and tv services, and these broadcasters can be expected to be involved in computer learning. Ontario's OECA has been outstanding to date.[12] However, the only significant commercial interest linking the telecommunications industries to computer learning presently in Canada is the planned downloading of LOGO over cable. NABU Manufacturing Corporation, an Ottawa-based company that makes computer-products for cable technology, has acquired partial ownership of LOGO Computer Systems Inc., and will download LOGO in pilots this year along with video games.

Yet the cable industry faces the most difficult policy situation of any of the three major industries. The CRTC (Canadian Radio-Television and Telecommunications Commission) has characterized cable as a "hybrid" industry, positioned between broadcasters and telephone carriers. Like broadcasters, it originates certain types of content (e.g., community programming), but like a carrier it redistributes services originated by others. Over the years, the cable industry has been tightly regulated in Canada, in order to "integrate" it with minimal damage to the broadcasting industry.[13] Leading Canadian cable companies channeled their energies into the de-regulated US market where they now offer a wide range of tv and information services.

Meanwhile, in Canada a lengthy debate on the role of cable has persisted. Should cable be treated as a carrier and regulated as such? If new services are offered, who should provide them? Cable operators argue that they need some control over what mix of services are offered to their subscribers. The regulatory issues are most troublesome with new information services, where the rationales of the past do not apply, and where the cable industry may be in competition with the telephone industry. At present, the CRTC has approved a period of experimentation by cable in new computer-based information services.[14]

However, the CRTC is not the sole governmental player involved in defining the role of cable. Several times in recent years the Department of Communications introduced legislation to Parliament which would have dealt with this question, and at present a "broadcasting strategy" is under development which proposes changes in the status of cable. Also, it is likely that some transfer of regulatory control over cable to the provincial level of government will occur in the next few years. This has been urged by most provinces,[15] and it is generally acknowledged that federal jurisdiction does not extend to many new cable activities.

Thus the regulatory status of cable is clouded by a number of factors: the uncertainty of the CRTC's position towards information services over cable; the indefinite state of federal legislation or other directives from the Department of Communications; and a probable shift of some responsibilities over cable to the provinces.

Microcomputers

Microcomputers are the highest profile type of hardware in computer learning at present, due to their increasing popularity in schools. This growth in schools is only part of a generally prosperous time in the microcomputer world, as "perscoms" (personal computers) are being bought and used for many purposes in large corporations, small businesses, and homes. The consumer perscom market and the education market for microcomputers are discussed in Chapter Four.

There are literally hundreds of microcomputer manufacturers, but three have dominated to date in the educational market: Apple, Tandy Radio Shack, and Commodore. All three are US manufacturers with divisions in Canada.[16] Also, "Apple-derived" systems are sold by Bell and Howell.

The microcomputers used in schools are standard models, with the exception of the Bell and Howell units, which include some protective features so that the machine will stand up better to classroom use. The "Canadian Educational Microcomputer" (CEM) proposed by the Ontario Government is unique not only because it upholds Canadian manufacture, but also because it would be a computer system designed specifically for educational use.[17]

Falling prices and technical advances are the norm of the computer world, and all aspects of microcomputer technology are evolving rapidly. For example, memory capabilities are increasing. At present, a 32k or 48k[18] memory is common student computers, while 64k is usual in home or business systems. However, systems with 256k memory are beginning to appear. Also, the power of the computer is increasing: in most current microcomputers, the Central Processing Unit processes 8 "bits" at a time, but 16-bit machines will probably predominate in a few years, and 32-bit machines are also near at hand.

In addition, computer enhancements are multiplying, such as special peripherals (for music, for example), better colour graphics, and special "chips" for speech capabilities, as discussed in Chapter Two. Microcomputers are also being combined with videodiscs.

While advances in hardware have proceeded at breakneck speed, software (including educational software) has lagged sadly behind. Chapter Six discusses problems in the microcomputer software marketplace, such as incompatibilities between different hardware systems, and copyright infringements that appear epidemic from a commercial viewpoint. Also the shortage of software reflects the early hobbyist history of microcomputers, which were bought by people who intended to do programming themselves. Only recently have a few applications identified a market and met its needs: the Visicalc business applications package, for example (made by Personal Software Inc.), has been hailed as the first microcomputer software "gold disc."

The lack of quality content is the problem most often cited by teachers using microcomputers in schools. Telecommunications solutions have been proposed, and "downloading" content to microcomputers is one option that is receiving considerable attention at present, to link microcomputers conveniently to remote sources of content.

Videodisc Systems

The use of videodiscs for education and training is at a very early stage, and no real pattern has emerged as yet.[19] In industrial settings, "multimedia" training is becoming a catchword, and a number of large organizations have embraced videodisc technology. Most major CL systems have developed video interfaces. In the educational world, experimental projects have explored the use of micromputer-controlled videodiscs for interactive learning. Eventually, the marriage of a low-cost microcomputer unit with a low-cost videodisc player may produce a medium for CL that is cheap, powerfully interactive, and capable of full-video tv.

A videodisc system consists of a videodisc player, a tv set, and the disc itself, which acts as a high-capacity storage medium for video information with two audio channels. Each side of the disc can hold 54,000 tv "frames."

A computer learning application using videodisc can mix video segments (such as narrative sequences, to add interest), video illustrations, graphic illustrations, or printed text. Each frame can be held as long as the individual wants to view it. Thus 20 minutes of videodisc in "running time" (about 35,000 frames) could equal six to twelve hours of actual computer learning time.

There are three technologies used for videodisc systems at present: the optical or laser system, and two types of "capacitance" systems--all incompatible. (See Inset 5-B .) There are also three general types of interactivity offered by videodisc systems, depending on the hardware used.

The most familiar videodisc systems are the low-cost consumer or home players being marketed for entertainment tv. A player could cost as little as $600; however, it has only a "manual level" of interactivity. The learner can use frame numbers to branch to specific segments, for instance. Secondly, there are "educational/ institutional" players which retail at higher prices ($2000 to $3000 US). These players have built-in microprocessors that can carry out a limited number of programming functions, such as simple answer analysis (based on a single piece of input), and automatic branching. Thirdly, a videodisc player can be interfaced with an external microcomputer, greatly increasing its interactive capability.

Using a microcomputer to control a videodisc player allows full-scale computer programs to be written to control the presentation of material and to store and analyze student response data. It also allows for computer-generated text overlays and graphics, for full alphanumeric input, and adaptive branching (based on the learner's cumulative performance). The cost of a microcomputer plus an industrial model of videodisc player would probably be several thousand dollars. A number of educational projects have experimented with this combination. Using a consumer player, costs would be substantially lower. The OISE is working on a very low-cost microcomputer that can control a consumer player, and projects that the cost

Types of Videodisc Systems

Three incompatible technologies are used at present in videodisc systemd, based on either optical lasers or "capacitance."

Capacitance methods read "pits" (bumps and valleys) on a disc through electrical charges, using a stylus that rides over the disc. In 1981, RCA began an aggressive promotion of its CED (Capacitance Electronics Disc) system, SelectaVision, for the home market. A second capacitance technology has been developed (by JVC, Victor Company of Japan) called the VHD (Video High Density) system. While the CED systems uses grooves on the disc to guide the stylus, the VHD system uses a tracking mechanism without grooves and thus can allow the display of still frames, and random access to individual frames (not possible with the CED technology).

The laser -based optical approaches use a highly focussed beam of light to read information from the disc, with no physical contact with the disc itself. Both still framing and random access are possible.

These two capabilities are critical for computer learning. "Still framing" means that a single frame can be viewed for as long as the individual wishes. Random access means that any point on the disc can be instantly accessed, in contrast to the familiar example of a cassette tape, where to arrive at a given point the player must move sequentially through the preceding material.

of the combined unit could be less than $1500--a price competitive with a typical microcomputer system alone.

The costs of producing content on videodisc can vary widely but will reflect both the high cost of CL plus the high price of video production. Very different types of video sequences could be used--studio vs. location, local vs. famous actors, etc. It could cost from $2500 to $25,000 to make a disc, and the best rule of thumb at present allows $1000 to $10,000 per videodisc minute.[20] (Ten minutes, however, could be several hours of instruction using stillframes.)

There are also costs to master the videodisc, i.e., to produce the master from which copies are made. This process costs from $3000 to $5000. Actual reproduction of the discs themselves is inexpensive and gets lower and lower as more copies are made.[21]

The history of the consumer videodisc industry has been brief and stormy. RCA launched its SelectaVision system aggressively but with disappointing results, and two formidable proponents of the laser approach (IBM Corporation, and the entertainment giant, MCA Inc.) dismantled a joint venture after an estimated $250M investment. Sales of videodisc players have been far outstripped by videocasette units which allow viewers to record tv programs. Videodisc technology that allows copying is beginning to appear in office products, but are not expected for many years in lower-priced players. Meanwhile, the experience with instructional "how-to" video casettes sold at the high price of $60 to $80 in the home market has not been encouraging.[22] Still a vision persists of a mass consumer market for CL on videodisc, in which so many discs are made so cheaply that upwardly-mobile advertisers might subsidize instructional material.

The market for institutional players has been more sedate. General Motors launched the use of videodisc for training in 1979 when it purchased 8000 industrial players to be used in over 6000 dealerships, to train salespeople, and mechanics, and to give presentations to customers. Ford Motors has also made a bulk-purchase of videodisc players. IBM is another prominent industry videodisc customer, using videodisc to teach customers how to operate small business computers in over 50 Learning Centres.

In education, several exemplary videodiscs have been made for high school and post secondary levels, almost all with NSF support. At the elementary level the Corporation for Public Broadcasting in the US has funded a number of discs. The only commercial available educational videodisc to date is the "Kidisc" (made by Optical Programming Associates), a disc for consumer players that teaches such activities as pig-latin and Irish jigs. However, a major project called SCHOOL-DISC (a combined effort of the ABC television network plus a national association of classroom teachers in the US) has set out to produce twenty one-hour elementary-level videodiscs for commercial sale.

In Canada, videodisc has been little used to date. The Ontario Institute for Studies in Education has a major project using videodisc for skills training (for machine lathe operators), and in Alberta there are several videodisc projects underway for training at the post-secondary level.[23] The OISE has focussed on the development of videodisc technology, and the lathe videodisc will be followed by a series of discs on diverse topics.

Conclusions

Though the age of the microcomputer is upon us, the importance of networking and telecommunications remains. There is an emphasis today upon the need for compact units with both standalone capabilities and easy communications.

This brief overview of delivery technologies has two implications for industrial policy. First, r&d and exemplary projects should give attention to new ways of delivering content, such as videodisc, new forms of downloading new media, etc. Secondly, telecommunications policy should encourage experimentation and new ventures. There is a tendency in Canada for telecommunications policy to hold back new media in order to protect existing chosen instruments of cultural policy, or (as in the case of the cable industry), to let a state of regulatory indecision prevail in a way that frustrates industry planning to no purpose.

FOOTNOTES: CHAPTER THREE

[1]This is discussed in Fisher (1982). Various systems allow from 8 to 127 units to be networked, using up to 8 disc drives, and perhaps making use of higher capacity hard disc technology. However, the freedom of students to work with whatever discs they want is limited.

[2]PLATO is described in Chapter Five and MECC is described in Appendix IV.

[3]INC Telecommunications will deliver software digitally by satellite to 220 public radio stations, who will then "piggyback" the software on their regular broadcast signal.

[4]$27.5M will be spent by government during 1981 and 1982. Previously, about $10M was spent by government, matched by some $30M in industry. The government has supported field trials, conferences, and a special program to stimulate industry by providing matching funds for the purchase of terminals.

[5]The OECA (Ontario Educational Communications Authority), in cooperation with the Department of Communications, began a Telidon and Education project in 1979. (The content was modest: teachers created small "lessons" or games with the help of OECA staff.)

[6]Brahan, J.W. and Godfrey, D. (1982).

[7]Ibid.

[8]The band width of a telephone line is approximately 3 kHz (kilo Hertz), and a kHz is 1000 units of frequency or cycles per second. A single tv channel is 6 MHZ (Mega Hertz) and a MHZ is one million cycles per second. Most cable systems have a capacity of 300 MHZ. New systems in the US are using 400 MHZ cables, and in some cases are laying more than one cable.

[9]In the U.S., cable franchises are awarded at the local level by city councils, while in Canada licenses are granted by the federal government.

[10] For example, the Vancouver system owned by Premier Communications Ltd. (itself owned by Rogers Cablesystems Inc. of Toronto), is upgrading to 24-channel capacity, with a goal of 35-channel capacity by 1985.

[11] There is a major project at Videotron Ltée, in Montreal to establish a two-way high-speed transmission network, and a number of other major systems, including Rogers Cablesystems Inc., are planning two-way experiments.

[12] The OECA has carried out its "Telidon and Education" project using both broadcast tv signals and telephone lines, and has other projects relating to CL as well. See Appendix III, describing provincial activities in CL.

[13] In particular the "importation" of US signals was restricted, as it was felt this would "fragment" the audiences of Canadian broadcasters who were carrying out a cultural mandate in providing Canadian content. Pay-tv was delayed for many years for a similar reason.

[14] At the end of 1978, the CRTC authorized a two-year period of experimentation in "non-programming" services, which was extended at the end of 1981. In 1981 it also approved a set of applications by major cable companies for such experiments. (CRTC Decision 81-919, p. 920.)

[15] Quebec has opposed federal jurisdiction over cable, communications, and culture for decades. In the prairie provinces, telephone companies are crown corporations who wish to control cable technology as one technical means among others to meet provincial telecommunications needs. Also, both B.C. and Ontario have challenged federal jurisdiction over pay-tv.

[16] Tandy Corp., based in Barrie, Ontario, is a division of Tandy of Fort Worth, Texas; Apple Canada Inc., of Toronto, is a division of Apple Computer Inc., of Cupertino, California; and Commodore Business Machines Ltd., of Toronto is a division of Commodore International Ltd. in the US.

[17] See Appendix III. The educational design would include ergonomic considerations, i.e., high-quality user interfaces, and other features.

[18]One "k" of memory equals 1024 "bytes." A "byte" equals eight "bits," and a "bit" is one digit in a binary number. It takes eight "bits" to represent a single alphanumeric character (i.e., a letter or a decimal number). "A", for example, is represented by "1000001" in binary form. All computers work with binary numbers.

[19]See D'Antoni, S. (1982) for a review of current use of educational videodiscs.

[20]Greg Kearsley (1982).

[21]For example: Sony of Canada sends a premaster to facilities in Japan at preformat costs from $2500 to $3000, plus replication costs from $20 (for 300 discs) to $35 (for 25 discs). 3M Company in London, Ontario charges similar prices and uses a US facility. Educational Research Institute of B.C. (1982), p. 44.

[22]Kalba Bowen and Associates (1981).

[23]Educational Research Institute of B.C. (1982), p. 45.

PART II

INDUSTRY

CHAPTER FOUR THREE MARKET AREAS

This chapter discusses three potential markets for computer learning: education (in schools and post-secondary institutions); training, where industry or government trains the workforce; and a "consumer market" where individuals seek learning and training on their own initiative.

There are a number of difficulties in discussing these three markets for CL. First, there is a scarcity of data about CL itself. The period of significant growth in computer learning has been brief, and few figures are available for the use of either hardware or software.

Secondly, the markets for computer learning are not well understood. Training, for example, is expected to provide the most opportunity for CL in the next few years. Yet there is little information about industry expenditures on training by traditional methods. The consumer market is the biggest question mark--the most difficult to predict, and possibly the largest in dollars over time. CL in the perscom (personal computer) market is like a newly discovered species; it is difficult to even attach a name. Furthermore this species is evolving rapidly, in an environment of consumer purchasing which is highly unpredictable. Free-form types of learning such as LOGO's turtle geometry are closer to play than to didactic teaching, and sudden fads may well occur.

At the same time, the established institutions of education and training are being affected by change. In schools, there is little sense of the eventual impacts on the education system itself that will result from the advent of powerful computer learning tools both within schools and in homes. Post-secondary institutions are straining under new demands for continuing and part-time education. Individuals are turning to the higher education system not only to enter formal programs with set curricula but for courses that interest them or that help them to develop careers. Learning as an informal process of self-development is increasing, and is breaking out of the traditional patterns for which the education system was built.

Training meanwhile has become a controversial topic. It is expected that massive training and retraining efforts will be required as computerization changes jobs and causes employment shifts. But several major reports have criticized the effectiveness of training in the past by government and industry.

Training (or retraining) is becoming a fact of working life--to use new equipment and new computer tools, to move into more opportune job areas, to keep up with new developments in specialized fields, and so on. Training outside of the workplace will become more common, as individuals seek new work skills on their own initiative or train on their own time with incentives offered by their employers.

Like education, training too is spilling out of traditional patterns--and in both cases microcomputers will be there to capture some of the overflow, offering flexibility within institutions, serving a consumer market for informal training and education, and creating new types of free-form learning as well. Computer learning will be known by many names in the future, and the boundaries of the traditional settings for learning will blur.

The three markets discussed here are broadly differentiated by the way in which CL products are acquired: whether an educational institution provides CL to students, whether industry or government supply CL to employees, or whether a consumer retail purchase takes place. The potential markets for specific types of applications are not considered. In some cases an application could pertain to all three broad markets distinguished here. Instruction on how to use microcomputer equipment, for example, is a promising applications area, and could be variously directed to educational, industrial or consumer audiences.

The Educational Market

Education has been the maternal marketplace for computer learning, providing research and development at universities, and sparse but sustaining use in schools and higher education through CL's weak early years.

Education is also an enormous marketplace. Annual spending on education represents approximately 8% of Gross National Expenditures, almost all of it supported by government. Over $28B[1] will be spent on education in Canada in 1982. Two-thirds of this money goes to elementary/secondary schools, and nearly $7B is spent on colleges and universities (Exhibit 4-1). While enrolments are expected to decline in some cases, spending at all levels is increasing steadily.

Yet today, few in the CL industry in Canada look fondly at the educational scene. Despite its attractive size and the prospect of policy influences by provincial governments that could aid Canadian suppliers, the educational market is problematic.

Microcomputers in Schools

More than one CL supplier has done some simple arithmetic about micros in schools. Exhibit 4-2 gives some sample calculations. In mid-summer 1982 there were some

EXHIBIT 4-2
VARIATIONS ON A THEME:
PREDICTED SALES OF MICROS IN SCHOOLS IN CANADA

prediction	*no. of units*	*estimated unit cost*	*total sales*
one for each classroom	*75,000*	*$2500*	*$200M*
1/10 of US market (1985)	*100,000*	*$1800*	*$180M*
1 micro for 3 students (by 1990)	*1.5M*	*$1000*	*$1.5B*
		$ 500	*$750M*
1 micro per student	*5M*	*$ 500*	*$2.5B*

EXHIBIT 4-1

EXPENDITURES ON EDUCATION IN CANADA

(ELEMENTARY/SECONDARY, COMMUNITY COLLEGES AND UNIVERSITIES)

($M)

	1979-1980	1980-1981	1981-1982	1982-1983
elementary/secondary	13,399	15,192	17,254	19,000
post secondary:				
community colleges	1,611	1,796	2,026	2,225
universities	3,948	4,360	4,827	5,319
	5,559	6,157	6,854	7,544
	$18,958	$21,349	$24,108	$26,544

Source: Statistics Canada, Catalogue No. 81-220, Advance statistics in Education 1981-1982, p. 25.

EXHIBIT 4-3

EDUCATIONAL STATISTICS (ELEMENTARY/SECONDARY AND POST-SECONDARY)

	no. of schools	enrolment	no. of micro-computers (estimate)*	ratio: students to micros	% growth in 6 mo. period	no. of colleges and universities	enrolment (full-time***)	no. of universities	enrolment: full-time	enrolment: part-time
B.C.	1890	537,000	1050	500/1	75%	19	18,160	6	31,890	15,430
Alberta	1465	451,000	1000	450/1	33%	18	18,080	5	31,500	13,630
Saskatchewan	1050	210,000	600	350/1	115%	3	2,440	3	14,740	9,040
Manitoba	825	217,400	500	450/1	na	8	3,630	7	16,590	11,860
Ontario	5020	1,882,700	5500	350/1	30%	30	81,400	21	161,800	89,800
Quebec	2840	1,189,300	250**	4700/1	na	83	133,600	7	91,700	100,700
New Brunswick	487	151,700	300	500/1	na	9	2,000	4	11,520	4,100
Nova Scotia	614	184,200	500	375/1	43%	14	3,000	10	18,570	6,280
P.E.I.	74	26,400	100***	205/1	200%	2	780	1	1,300	700
Newfoundland	661	146,000	50	3000/1	na	6	2,330	1	7,420	3,680
Total	15,027	5,017,300	9850	--	--	192	265,420	65	387,030	255,720

*March 1982. Linda Fischer and E. Brown, "Science Education and Computers in Canadian Schools," a report prepared for a Science Council Workshop (Toronto: EHL Research and Evaluation Group, March 1982).

**Interview with Tom Rich, Department of Education, July 1982

*** Ministere de l'education du Quebec, 1982.

****Part-time enrolment figures not available.

<u>Other Sources</u>: Statistics Canada Catalogue 810220, <u>Advance Statistics in Education 1981-82</u>, Tables 1, 3, 7 and 8.

10,000 microcomputers in schools in Canada, representing a hardware investment of $20M, most of it made during the last year. After years of sluggish growth, purchase figures for computers in schools are soaring. The number of units has grown at rates of 30% to 115% in a six-month period across Canada (Exhibit 4-3).

In the US, a recent survey found some CL use in over 50% of all educational institutions, compared to 15% six years ago. This increase was due mainly to microcomputers. Use of computers in 95% of public education institutions is expected within 5 years.[2] Another study predicts that sales of micros in schools (which amounted to nearly 100,000 in 1981), will grow to 250,000 by 1985, and that 1 million units will then be in place.[3]

Education is under provincial jurisdiction in Canada, and provincial governments support 66% of the costs of elementary and secondary schools.[4] However, the purchase decision to buy a microcomputer is taken at the local level, by school boards or school divisions. The microcomputers favoured to date have been mentioned earlier, made by Commodore, Radio Shack, Apple Computer, and Bell and Howell (who market an Apple unit with a few enhancements). Thus all systems bought by Canadian schools are US-made--there has been no Canadian contender as yet. In total numbers sold, Commodore machines dominate due to their popularity in Ontario. But the mix of systems varies from province to province, and in some cases (such as B.C. and Saskatchewan) Apple is preeminent.

Generally three incompatible systems are in use within each province, making the market a difficult one for a would-be software publisher and causing headaches for educational planners.

Though purchase decisions are locally made, they can nonetheless be affected by provincial policy. Later chapters discuss the procurement policy steps taken within each of the provinces, including Ontario's plan to nurture the development of a CEM (a Canadian Educational Microcomputer). All policies, however, are only facilitory: a ministry may devise means to encourage the purchase of certain systems but exerts no final control.

Thus the CL market in schools is often described as "fragmented." Three incompatible systems in use fracture the market for content suppliers. Hardware sales occur in a piecemeal fashion from a supplier's viewpoint, as one or two units are bought by individual school boards for a few thousand dollars. Meanwhile a number of provincial policies are encouraging patterns in hardware purchases that differ widely from province to province. Education mirrors some Canadian political realities: there are ten different provincial approaches, and the market is divided because of language. In Quebec alone there are over 1 million French-speaking students.

In the US, as in Canada, three incompatible systems predominate (Radio Shack, Commodore and Apple), and there too the market is one where schools make local purchase decisions. Market size, however, is vastly more attractive: over 100,000 units were sold in 1981, a figure which dwarfs Canadian sales of some 5000 units in the past year. Apple Computer Inc. alone has sold 50,000 microcomputers to schools, half of them in the last year.

Despite this market success, Apple is seeking to bolster its position in schools. New competitors are vying for a share of the growth curve in CL, including Atari Inc. There are some 250 microcomputer manufacturers today and many could be interested in the educational computing boom. Apple has offered to donate a microcomputer to each of 104,000 schools in the US, if certain tax conditions can be arranged.[5] Their reasoning runs as follows: if a school has an Apple, it will buy Apple content; it will then tend to buy more Apples that can also use the same software. Meanwhile, content suppliers will make more Apple material. The game hinges on incompatibilities between microcomputers that do not allow content to be shared.

The hardware market is clearly a highly competitive one. Most market information on CL in schools discusses hardware sales, and while bulging new software catalogues are evidence that more and more firms are supplying educational software, there is little data available on content sales. Software costs now total about $375 for the average personal computer system, compared to average hardware costs of $1600 (US),[6] and the proportion of software to hardware costs has been rising steadily as hardware costs fall and the computer world pays more attention to applications. There is a growing demand for packaged software in education as more and more teachers want to use microcomputers but don't want to write computer programs themselves. In CL, the computer is essentially a vehicle for content: the more content, the better.

Software for CL applications is the centre of the educational market and the lack of good material is deplored in both Canada and the US. Many hardware purchase decisior are swayed by the availability of good material for a specific brand of microcomputer. Pressure is being exerted upon provincial governments by teachers to organize content supply through clearinghouses, and user groups are making efforts to share content and set up libraries. The shortage of applications is a major problem.

This would seem to be a seller's market. Furthermore, Canadian content suppliers could look forward to the kind of preferential treatment that has made textbooks the only category of books in Canada where more is spent for Canadian products than for imports.[7] But content suppliers face several problems, including the tendency among teachers to copy diskettes and the incompatibilities that break up the market.[8]

Thus, from an industry viewpoint, the school market for CL in Canada is less than attractive despite the rapid growth of microcomputers. Meanwhile, the US market is in a state of feverish development as competition among hardware suppliers heats up, and content suppliers respond with new products as the number of machines increases. The ease with which hardware and content can be imported in Canada adds to the difficulties faced by a Canadian company.

post-secondary education: formal programs

There are over 250 colleges and universities in Canada, as Exhibit 4-3 shows. Each province has a ministry responsible for post-secondary education and allocates both federal and provincial money to post-secondary institutions; however the links between government and institutions are complex (as Exhibit 4-5 suggests) and post-secondary institutions operate in an independent manner.

Formal programs in post-secondary education include students pursuing university degrees, and students in colleges and institutes who take either "university transfer" or "vocational/technical" courses. The 600,000 full-time post-secondary students in Canada may seem a small group compared to the ranks of 5 million school-children. Other factors, however, add weight to the post-secondary market. First, there are hundreds of thousands of part-time students.[9] Secondly, post-secondary education is expensive: while the average expenditure per student in schools is about $3400, more than double this amount is spent for the average student in a university,[10] and sales of post-secondary textbooks total nearly three-quarters of the sums spent on elementary-secondary books (as Exhibit 4-4 shows).

EXHIBIT 4-4

CANADIAN DOMESTIC BOOK MARKET 1979 (ESTIMATES)

Total Market: Canadian Publishers + Imports

Sales

Elementary & Secondary Textbooks	*$132.3M*	*Professional & Technical Books*	*$43.1M*
Post-Secondary Textbooks	*89.2M*	*Scholarly Books*	*11.4M*
Trade Books (General Readership)	*241.9M*	*General Reference*	*96.2M*

Statistics Canada 87-601, Cultural Statistics (1979)

Post-secondary computer learning in Canada, however, has had almost no profile, and there has been little of the excitement that has marked the past years of rapid acquisition of microcomputers in schools.

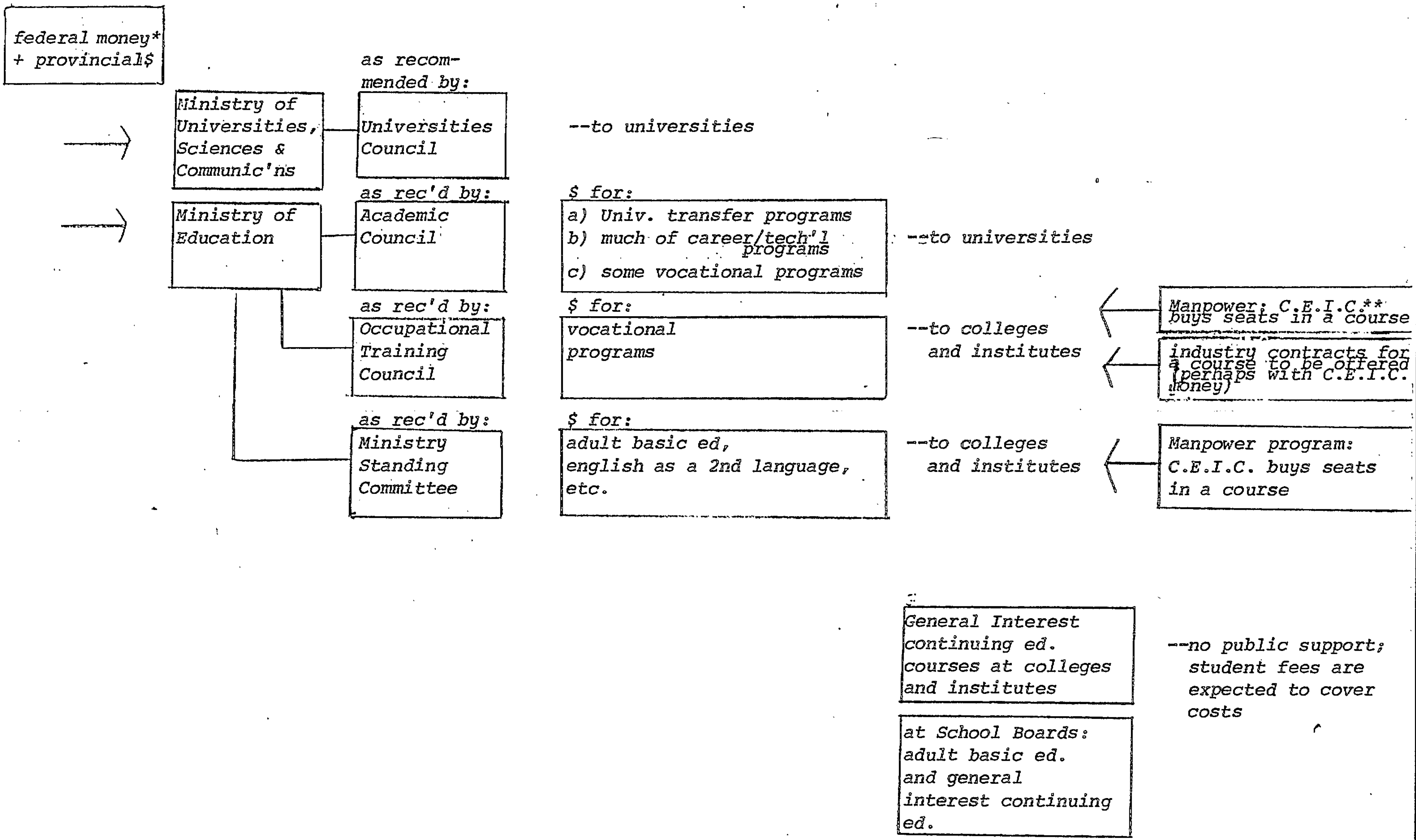
The weak use of computer learning in colleges was recently examined in Ontario, with the following conclusion: "Many colleges face a dilemma: they are very much interested in using computer assistance in the teaching process, but they need an environment that will help them start."[11] Recommendations were made for a provincial advisory committee on CL, regional resource centres, funding and coordination of courseware, and r&d in the newest technology.

A few universities and colleges stand out in the use of CL. The University of Alberta, for example, has been offering full-length courseware for some years, and a major project in Ontario developed six semester-length tutorials that have been extensively used.[12] As these two examples suggest, CL at post-secondary levels has tended to use large computers to support multiple users, who work more often with "courseware" as opposed to smaller pieces of "lessonware." This model of CL more closely resembles the use of computers in training settings than in schools. Course topics have included math, chemistry, accounting and electricity.

There is a second important aspect to computer learning in post-secondary education besides the extent of usage. It is in post-secondary institutes that the expertise that will be needed by a Canadian CL industry must be built. Students must find courses, projects and teachers to learn how to design and program CL content. Expertise in CL is in short supply and for this reason, the desultory way in which computer learning takes place in most colleges and universities is unfortunate.

EXHIBIT 4-5

POST-SECONDARY EDUCATION FUNDING: B.C. EXAMPLE



*Established Program Financing arrangements (See Appendix II)

*Canada Employment and Immigration Commission

Potentially, a college or university could both develop computer expertise and at the same time immerse the student in an environment where computer use is ubiquitous. The University of Waterloo has something of this character: its area of specialty is computer programming, and the campus is stocked with over 1000 terminals and microcomputers. Going further, a few US universities are becoming computerized showcases: Carnegie Mellon University plans to have a micro for each student, administrator, or faculty member by 1985, linked together by telecommunications networks that extend into residences and off-campus as well. At present, however, computers on campuses in Canada are seldom used by those outside the computer programming set.

trends in post-secondary education: the walls come down.

Formal programs in post-secondary education are the traditional pattern of higher education. For decades students have enrolled in degree-granting regimens of study and attended classes on campus on a full-time basis. These programs are still popular, though there is a tendency for students today to eschew general arts and sciences degrees and either turn to career programs within universities, or head for practical training at other institutions.[13] There are, however, new trends in education which are exerting pressures on the old institutions.

Part-time education has increased dramatically, especially at colleges and institutes.[14] There has also been an immense growth in "continuing education" pursued out of learner interest as a leisure activity, or as a means of self-development to acquire new work skills. In Ontario, for example, in 1979 over one-half of 200,000 part-time students at universities were taking non-credit courses. Informal education or "Continuing Ed" is now becoming a recognized form of higher education.[15]

This trend relates to Canada's increasingly educated population:

> The baby boom combined with the post-secondary "boom" of the sixties plus an immigration policy that encouraged the highly-educated to come to Canada resulted in an almost fourfold increase in degree-holders [from 1961 to 1977].[16]

This educated population has characteristic ways of spending its leisure time. It tend to watch tv less, for example, and goes more often to libraries, museums, art galleries, and so on.[17] And increasingly people are viewing informal education as a leisure pursuit.

Secondly, people are taking courses to improve their work skills. Skills requirements in many occupations are rising, and new occupations (especially involving computer skills) are coming into vogue, while opportunities are diminishing in more established areas. Changing skill requirements are causing massive training efforts on the part of government and industry. At the same time, informal training is also on the rise. People are going to classes on their own initiative to increase their job security and mobility, to adapt to a changing labour market, or to do work that is of greater interest to them.

As a result of a highly educated society and a flexible work world, people are being drawn to the educational system for individual reasons motivated by self-development or "self-actualization." Learning for self-actualization often occurs in a flexible way, without benchmarks for admission, success, or failure. It is de-institutionalized learning, pursued according to individual choice --an activity that is close to the consumer market for CL.

There are many irreplacable elements of the personal classroom setting, such as academic discourse with professors and peers, guidance and role models, and a social environment that often forms lifelong attitudes, interests and ties. In certain circumstances however, and for certain subjects, the computer may be apt. Numerous students today are choosing practical career training, which suits the use of CL more than does an affinity for a liberal arts degree. Also the growth in both part-time and continuing education indicates increasing demands for flexibility in time, place and choice of study that computer learning could potentially meet.

EXHIBIT 4-6

GOVERNMENT EXPENDITURES ON VOCATIONAL AND OCCUPATIONAL TRAINING

	1977-1978	1978-1979	1979-1980
		$.M	
Manpower Training Programs:			
federal government	618	655	690
provincial governments	167	135	226
municipal governments	-	-	-
other sources	22	14	19
subtotal	807	804	935
Other Vocational and Occupational Training:			
federal government	173	170	145
provincial governments	50	56	42
municipal governments	-	-	-
other sources	-	-	1
sub-total	223	226	188
TOTAL	1030	1030	1123

Source: Statistics Canada, Catalogue 81-208, Financial Statistics of Education, Table 25.

special forms of education

One of the main features of the computer in CL is that it is indifferent to time and place of learning. It is also an extremely patient teacher. There are several special forms of education where these abilities may recommend the computer as a learning tool.

For example, the computer has excelled in special education applications,[18] where it can be infinitely patient and allow the learner to set his or her own pace. Its potential appears high in basic skills training as well. Distance learning is another unique branch of education, where solutions to the constraints of time and place of learning have been sought for decades using succeeding waves of technology. Finally, language training is a special problem in Canada, where computers could perhaps meet educational needs. (See Inset 4A).

Training

Training is a major activity in Canada and probably costs government and industry close to $4B a year. This includes: money spent by government on manpower training programs and other training supported by government, within the public service (see Exhibit 4-6). It also includes training carried out by industry, estimated at $2B, and approximately $600M per year for training within the military.

This figure, however, includes not only expenditures for training but also salaries and wages for trainees, which vary but typically make up about 50% of total training costs. A further problem in considering the training market is that scarcely any information is available about training carried out in industry. Moreover, the information that exists is complicated by overlaps between government-supported training and training supported by industry itself.[19] Finally, it is difficult to estimate the degree to which computer-based training (CBT) could replace standard methods. It has been suggested, for example, that 5% to 50% of the millions spent on training in the military could involve computers--an estimate that allows for a wide margin of uncertainty.[20]

SPECIAL FORMS OF EDUCATION

Special education: Though the people who need special education are small in number, their education needs are enormous --the physically and mentally handicapped, the emotionally disturbed, or "problem learners" who for whatever reason fail to fit into classroom norms. The retarded, for example, need "social survival skills" such as how to handle money. The computer offers patience and individual pacing.

Basic skills: A lack of basic skills among a considerable number of working adults is a problem in both Canada and the US. 20% of the adult population in Canada does not have 9 years of school, and even those with schooling may be deficient in basic skills. A large number of adults need training in basic writing, reading, and numeric competencies, and community colleges constantly offer a set of courses for school completion and academic upgrading. Manpower programs also train in basic skills.

Language training: learning languages is a major activity in Canada. "English as a Second Language" courses abound, primarily to teach immigrants basic competency in English, and learning French is a national pre-occupation among English-speakers. French is taught in English-speaking schools across Canada. It is available, for example, in secondary schools in B.C.; yet (though it is acknowledged that the young learn languages best) little more than half of the elementary schools in the province have French classes. Within the public service, the

Distance education: teaching by correspondence began with the arrival of a cheap and reliable postal system. Various electronic technologies have followed, including radio, tv, tapes and satellite.

There have been a few outstanding examples of distance learning. In its tenth year, in 1980, the Open University in Britain registered 78,000 working adults, and 33,000 had graduated with B.A. degrees. Courses usually use printed materials with some radio, tv, and personal tutoring. The OU sells its materials world-wide and does international consulting. It has explored some new technologies (such as videotex), and has used audio-vidual systems, including microcomputers combined with videodiscs or cassettes.

In Canada, the Athabasca University is a modest equivalent: a non-campus-based university, specializing in distance learning. 350 students were enrolled in 1980.

A recent overview of distance learning in B.C. showed a mixed bag of activities. There were a handful of "distance ed" students at elementary/secondary levels; a few thousand, at three universities; and some 3500, at the B.C. Institute of Technology (almost entirely using print). The Open Learning Institute (a provincially-funded organization for distance ed) had 7500 course enrolments in 1981. "Introduction to Personal Computing," a very popular course, provides a microcomputer to each student for a modest deposit (and lets the student purchase the unit later at a reduced price). The Knowledge Network of the West (KNOW) provides an educational tv channel by satellite, available over cable-tv. Colleges and institutes provide three types of programs on KNOW: formal *phrase "gone on French leave" has been familiar for years. Some 2300 public servants were trained in French this year, while over 600 French-speakers took English courses.*

"telecourses," "teleservices" (general interest programs, with no registration), and live interactive programs where a tutor is availabl by phone.

Much greater sums are spent yearly on education than training, but marketplace conditions for training are much more attractive than in the educational world, and training is viewed as the most opportune market for computer learning today. The typical pattern for computer-based training consists of a major purchase of hardware and authoring software using systems like CAN and TICCIT,[21] followed by a substantial course development effort. While there may be uncertainty about the total potential training market, it is clear that large organizations can find computer-based training cost-effective. CBT typically reduces training time by 30%, and given that employees are paid while training, this represents a substantial cost saving.

This section describes how training is done by government and industry. However, this is only part of the training that occurs. There is also an inestimable amount of "invisible" training, as individuals take "continuing ed" training courses at post-secondary institutes on their own initiative. Training and re-training is becoming a common part of working life--to upgrade skills and keep abreast of new developments, to shift to more opportune areas, and to pursue more interesting work.

In addition, another type of informal and invisible training comprises a certain market as well: training in the use of equipment. Computer equipment provides the best example. People have to learn to use new equipment and require instruction to do so. Some manufacturers of large hardware systems are including training software packages with hardware purchases, and independent entrepreneurs are marketing software packages teaching how to program microcomputers.

Thus training, like higher education, is outgrowing models of the past and informal training is becoming more common, both within organizations and outside them as an individual pursuit.

industrial training supported by the federal government

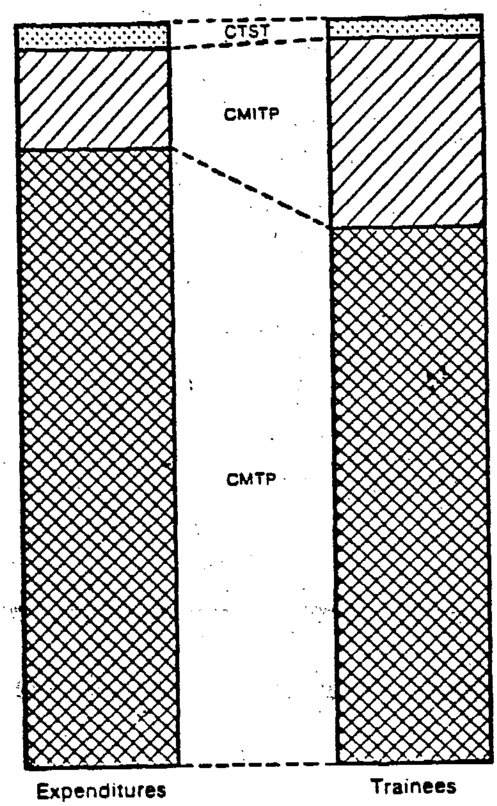
Industrial training is a complex activity to describe. It occurs on the job, within classrooms "on site" at industrial settings, or in educational institutions; and it is variously supported by industry, by the federal government, by a provincial government, or by some mixed involvement of these three parties.

EXHIBIT 4-7

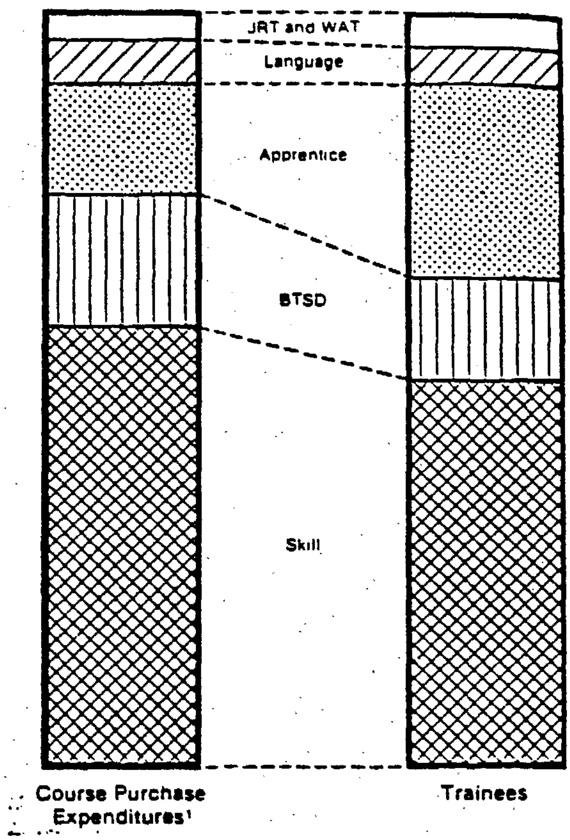
FEDERAL INDUSTRIAL TRAINING PROGRAMS

$M

TRAINING PROGRAM	1979-1980	1980-1981	1981-1982
Training through industry:			
Critical Trades Skill Training (CTST)	.9	7.5	26.7
Canada Manpower Industrial Training Program (CMITP)	101.3	106.1	111.0
Training through institutions: Canada Manpower Training Program			
seat purchase expenditures	345.9	395.0	419.9
Unemployment Insurance for trainees	137.3	157.8	166.3
other trainee allowances	84.2	103.6	105.7
TOTAL	567.4	656.4	692.1



CANADA MANPOWER TRAINING PROGRAM	1980-1981
Job Readiness and Work Adjustment Orientation	13.4
Language	41.4
Apprentice	55.5
Basic Trade Skill Development	51.5
Skill Development	204.6
TOTAL	366.4



Source: Employment and Immigration Canada (1982), Economic Council of Canada (1982)

To begin with the role of the federal government, the Canada Employment and Immigration Commission (C.E.I.C.) will spend over $1B next year on technical and vocational training. On a per capita basis, government spending on vocational training in Canada is among the highest in the world. Exhibit 4-7 shows expenditures on training programs in the past three years.

Two major programs allot money to firms to encourage training within industry (see Inset 4-B). But the bulk of C.E.I.C.'s money goes to the Canada Manpower Training Program, to "buy seats" in training classes for unemployed individuals and to provide them with financial support while training.[22]

The workings of the Manpower Training Program are a knot of federal and provincial involvement, reflecting a jurisdictional split in responsibility. All seats in training classes purchased by the federal government are bought through provincial intermediaries. This can result in some awkwardness in curriculum planning; there is no way for the federal sponsor to support a course directly.[23]

The provincial role in training differs from province to province. To take the case of B.C., the province itself supports a $4.5M Industrial Training program that gives money to employers, and also has much smaller programs for women in non-traditional trades and the training of disabled persons. The province also administers apprenticeships, monitoring the quality of training and the terms of employment.[24]

Thus the federal government has supported an enormous amount of classroom training through its Manpower Training Program but, because of a federal/provincial split in jurisdiction, it has no control over curriculum development. It would require considerable arranging, for example, for the Manpower Program to instigate the use of computers in training.

training supported by industry

There is very little information available about the extent of training that occurs within industry, and even less about the sums that are spent. The incidence of training programs in industry has been studied in recent years by the Economic Council of Canada in a project on the supply of skilled labour. While

TRAINING PROGRAMS SUPPORTED BY THE FEDERAL GOVERNMENT

The industrial training programs supported by the Canada Employment and Immigration Commission (CEIC) are of two sorts. Two programs (CMIPT and CSTP) allocate money to firms themselves to encourage industry to train, while a third (CMPT) buys places in educational institutions for unemployed individuals.

A. Training Through Industry

The Canada Manpower Industrial Training Program (CMIPT) reimburses an employer for training costs and pays a share of the trainee's wages. The employer is responsible for carrying out the training, which could be done on-the-job, in classrooms "on site", or in an institution (if the employer arranged for a course to be offered). The intent is to give seed money and encourage employers to train.

The Critical Trades Skills Training Program (CTSP) is a recent program that also works through industry, to help employers train workers in skilled trades in short supply. It reimburses employees for training and pays all or part of wages for up to two years. This program has been expanding steadily since it was established three years ago.

B. Training Through Institutions

The Canada Manpower Training Program (CMTP) is implemented through institutions: the federal government "buys seats" in classes in provincial colleges and institutes or in private training courses. Most trainees on this program are referred through Canada Employment Centres and are jobless. In addition to paying for training, the federal government either pays Unemployment Insurance Benefits or a training allowance to the trainee.

the Council's report laments the "paucity of data on training in industry," it can nonetheless draw on the results of a large survey it conducted in October 1979.[25]

This survey found that over 60% of the responding establishments had carried out some form of training in the past year. (See Exhibit 4-8.) As could be expected, large companies tended to train more. Only 20% of the programs cited used government aid.[26]

As to costs of training, "this is a subject on which virtually no information is available, at least within the public domain."[27] Only 34% of the survey respondents provided a figure for costs of training, and there were wide variations between occupations, between firms, and between methods of costing. The most expensive training was for blue collar workers, which tended to be of long duration (52 weeks or over) and tended to mix both classroom and on-the-job instruction. The average cost per trainee for product fabrication and repair was $15,700 (with variations from $1000 to $50,000 per trainee), while a four-week clerical course in the classroom cost an average of only $411.[28]

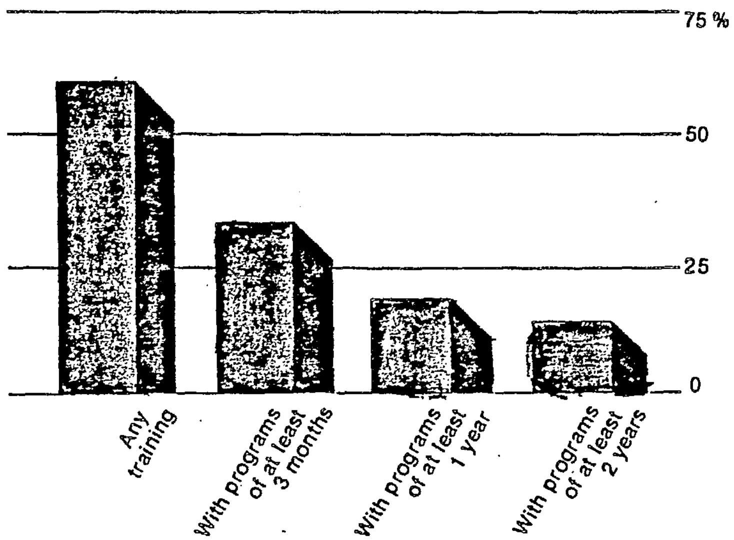
Drawing partly on this survey, and partly on estimates from C.E.I.C., it is estimated here that some $2B per year is spent by industry on training.[29] It is clear that more information is needed on the training done by industry in Canada.

This picture of training says little about the potential substitution of CL for traditional training means. CL is undoubtedly growing: a survey carried out in 1980 in the US found that computers were used for training in 21% of 113 companies contacted, compared to a figure of 10% in an earlier study in 1978.[30] Much higher figures are found among large corporations.[31] Also there are trends in training that suit the use of CBT. First, there is a worldwide trend towards more off-the-job training.[32] More and more training is done in classrooms as opposed to on-the-job, through introductory trades schools, or through classroom training for employees. Secondly, there is a trend to "generic skills training," an approach that groups together skills common to a number of occupations. For example, B.C. is replacing pre-apprenticeship programs with training modules that teach basic principles in "generic clusters," such as mechanical trades, electrical and electronics, and so on. Generic training can then be followed by specialized instruction in further classes or on-the-job.

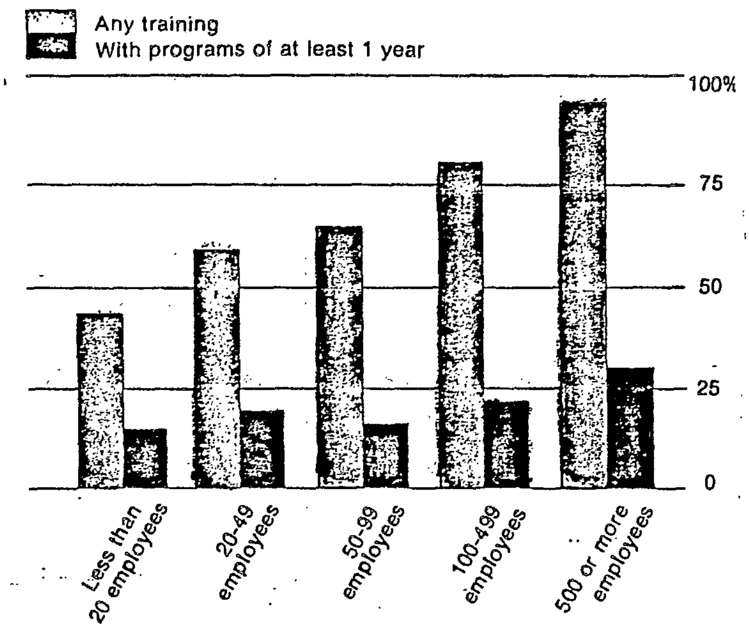
EXHIBIT 4-8

TRAINING IN INDUSTRY
Results of an Economic Council Survey (1979)

The Commitment to Training in Industry
(percentage of establishments reporting training)



The Training Effort by Size of Establishment
(percentage of establishments reporting training)



<u>Source:</u> Gordon Betcherman (1981).

Training has become a much-discussed topic recently because of an apparent failure of present methods to meet skill needs. Broad changes in the economy (including the widespread use of new technologies) are exerting new demands on the labour market, workers displaced by new technologies must be retrained, and at the same time there is a shortage of skilled manpower in many occupations. As Chapter Seven discusses, training has become a policy matter, and the government role in this market area is considerable.

advantages and examples of CBT

While the demand for training is increasing, training by traditional methods is becoming more expensive. Costs to a corporation include instructional staff and materials and wages for employees. As wages rise, so does the cost of training. At times, workers being trained must be replaced on the job, at additional expense; and if trainees travel to instructional centres in another city more expenses must be added. The main advantage of Computer-Based Training is that it typically reduces training time substantially. Accepted conventional wisdom in the industry estimates that learning time can be reduced by 30%. Also, the student/instructor ratio can be increased. Third, simulation can be used to reduce the use of expensive equipment by trainees. Further features of CBT include the delivery of training in locations outside of training centres, and the ability to give training at any time.

Thus Computer-Based Training makes "bottom line" sense. B.C. Tel, for example, is a company with large training needs, and spends $12M a year training its employees. One of its most popular courses is Digital Logic, the basic course taken by employees in dealing with computers throughout B.C. Tel operations. Over 250 students take this course at a cost to the company of $1M a year. Converting the course to computer form reduced the time needed to train from ten days to five days. Course development costs amounted to $175,000, and equipment costs for a TICCIT system that supports 20 terminals were $500,000. Thus at least $375,000 is saved per year (more if students complete courses quicker), and the system will pay for itself within three years.[33] In fact course completion is faster than expected and within two years the savings through the system may have exceeded its cost.

B.C. Tel's digital logic course is an example of "generic" training that has a market outside of the company that created it. Telephone companies worldwide use similar technology, and the B.C. Tel Education Centre has been exploring the possibility of selling both its training course and the TICCIT system itself on a domestic and an international basis.

There are numerous other examples of major uses of CBT. (See Inset 4-C.) Pilots at United Airlines train on a flight simulator (supplied by CAE Electronics Ltd. of Montreal) that is so real they sometimes emerge shaking from a simulated head-on collision. The simulator costs some $10M but is still only a fraction of the cost of a real airplane and can be operated at one-tenth the cost.[34] IBM has used computer simulation in its executive management training program for a number of years.[35] Digital Equipment Corporation distributes computer-based instructional packages to its training centres for management instruction, technical training and customer education. Holiday Inns, Inc. uses computer simulations of hotel operations to train managers in business planning and financial forecasting skills. There have been experiments with the use of computer simulations for nursing in Quebec.[36] The large Credit Agricole bank in France has used micro PLATO for self-paced training and computer based training is being used in nuclear power plants in France. There are countless examples of CBT, and the list is expanding.

The military is a special case, as in the US various military agencies have been catalyst users of CBT, stimulating the development of new technologies such as interactive videodisc. In Canada, however, while the armed forces have experimented in a small way with CBT over a number of years, this has not resulted in significant support for computer learning, and more recently, a major CBT contract for military training was awarded to a US firm.

Most CBT examples discussed here exemplify the mini-computer or mainframe computer model of training, where multiple users access central computer resources. A new trend is also beginning as microcomputers diffuse in small businesses and within large corporations. It was estimated (in 1981) that some 750,000 business persons were using microcomputers.[37] A recent survey of 160 large firms found that 50% of the companies responding were using computers to train, and that 71% of these included the use of microcomputers.[38] While the capacity of microcomputers is still limited (and simulations, for example, might exceed microcomputer capacity), an increasing use of microcomputers can be expected, and eventually packaged software products will evolve.

EXAMPLE AREAS FOR COMPUTER BASED TRAINING (CBT)

the military

*The US military has been a driving force in the use of CBT. Its training needs are enormous: $10.5B will be spent on the training of individuals in fiscal year 1982. Flight training alone accounts for nearly $1.5B, at a cost per student hour of over $330,000. Specialized skills training costs $2.3B, at an average cost per student hour of $3400.**

The U.S. military has been noted for its support of new technologies in instruction. It has in particular developed the use of simulation, and instructional videodisc. There have been transfers of technology from the military to private sector, and expertise has built up in specialized CL firms. Videodisc is now being used for basic skills training. The military has also supported research in voice technology, and Artificial Intelligence.

*The training needs of the military in Canada are much more modest but are still substantial; $600M was budgeted for 1981/1982.** The Canadian Forces trains over 12000 persons in over 120 trades per year.*

*The Canadian military has made some use of computers for training for nearly a decade. It began investigating computers as a medium of instruction in 1972. From 1975 to 1977, the CF (Canadian Forces) undertook a small CBT experiment which proved successful, but "unfortunately, no plans had been made to exploit the program's success," and it was suspended.*** In 1978 one of the CF's training schools became interested in CBT, and a test course was used that reduced the time required for classroom instruction by 30% to 60%. The study was expanded to include six more courses, and the National Research Council selected the training school as the test for its prototype NATAL system. The design and authoring of the test courses, however, have proved lengthy and little use of CBT has occurred as yet.*

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*Brian Walter (1982).

**Dept. of Supply and Services, Defence 81 (1981).

***J. Belanger (1981), p. 25.

In 1981, a flurry of interest erupted in computer circles when Canada purchased 137 F-18 fighter planes from McDonnell Douglas. 1500 hours of computer-based instruction training for these planes was required, which would have meant an infusion of $25M to $50M to a Canadian CL firm. The outcome, however, was disappointing: a division of McDonnell Douglas in the US received the training contract. Neither historically nor at present has the military in Canada played an "engine" role in CL development. The US contract, however, was conditional: if after one year, progress was not satisfactory, a new request for proposals will be issued and Canadian interest in the project is still alive.

Training in the Federal Public Service

The cost of career training activities attended by employees in the federal public service in 1980-1981 was $153.6M. This includes $70M for participants' salaries, and was a 39% increase over 1979-1980 spending. 22% more individuals underwent training in 1980-1981. Most training is provided by departments themselves, and "technical and professional" categories account for over half of all training courses.*

*In addition, the Public Service Commission spends over $29M a year in official language training.** In 1981 there were over 2300 public servants studying French for four hours a day, while 659 people were studying English.*

airlines

Airlines have been early users of CBT. Air Canada has used PLATO with new flight simulation equipment, and several US airlines have used computer-based training with varying results. British Airways, which employs over 50,000 people at 350 locations, adapted 3500 terminals to be used for a 90-hour course training staff in booking reservations. The terminals were also used for day-to-day work. The system cost approximately £30,000 less per year than traditional training methods and so paid for its development costs. (The course took

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**Treasury Board of Canada Secretariat (1982). This figure comprises the major expenditure on training. There is in addition language training and several small programs such as "educational leave."*

***Public Service Commission of Canada (1981), pp. 40, 109.*

two man-years to prepare.) The course has been marketed to a number of other airlines, including CP Air, and the purchasing airline can also acquire a complete working reservations system.

The Consumer Market

The "consumer market" for computer learning consists of learning outside of either educational institutions or organizations which train employees. The actors in this market are individuals who make choices for self-determined reasons. Computer learning in this market is associated with "perscoms"--personal computers, available for personal use. This is a retail market in which packaged CL software will be acquired.

Sales of microcomputers generally are multiplying prodigiously and show the most rapid growth in the computer industry. 865,000 units worth a total of $1.4B were sold in the US in 1981, a 70% increase over the previous year.[39] Sales of microcomputers in Canada were over $100M in 1981, and are expected to reach $250M in 1982.[40] These sales figures include equipment bought for small businesses and for home use, and these two types of purchases have been often confused. It took some time for microcomputer manufacturers to realize that the hobbyist market they first targetted was a small one, and that small businesses were buying the bulk of their systems. The proportion of microcomputers sold for "home/hobby" use is about 14%, roughly equal to those sold for education, and far smaller than the 60% figure for small businesses.[41] However, more computers may actually be available in homes: some small businesses are located in residences, and business people can take small computers home from the office. There is also a tax incentive to claim that a microcomputer is bought for business rather than personal use.

The use of CL by microcomputer owners has been scant to date, and discussion of CL in this market is speculative. At least three types of computer learning appear probable: practical instruction, both for small businesses and in the home; and in the home market, informal learning and free-form learning (conceptual learning creations that are close to play).

To consider small businesses first, the most evident immediate area for CL lies in instruction in using the microcomputer itself. Markets for practical instruction also seem likely, in general areas (such as incorporating and operating a company, for instance), and in industry-specific areas as well. Instruction could be combined with a functional application: a tax package, for example, could both provide instructions and explanations and carry out the calculations required.

In the home market, most indications are that little educational use has been made of the computers bought to date, despite the fact that manufacturers tout educational software as an uplifting aspect of their products. Apart from hobbyist programming, computers in the home are mainly used for computer games.

The advent of applications such as LOGO's "turtle graphics" may change this. The turtle's world is one of "learning without teaching" and LOGO emerged from years of serious research on how children acquire concepts. As an entertaining activity LOGO is fun but, as ATARI and Apple are careful to point out, it is also "educational." So far the way in which LOGO mixes learning and fun is unique; in time other such creations will doubtless follow.

Consumer purchase patterns for fun and entertainment are highly unpredictable. Each individual makes a purchase decision for inscrutable reasons--interest, the prestige of being among the first to buy something new, conformity to buy something because everyone else has one. Once a product takes off, these individual decisions can amount to astronomical sales figures. In an early example of a computer learning success, buyers flocked to buy handheld "Speak 'n' Spell"--a spelling game sold at $75 apiece.

The market for video games is an example of the rapid growth of a new technology. There are more than 8 million game player units in the US, and new models are now selling for some $200 with some potential to be upgraded and perform simple computer functions. Game software retails for $20 and up, and while Atari dominates there are rags-to-riches stories of companies whose sales rose to $50M within 18 months. Money spent on video games includes both the purchase of game cassettes and the mountains of quarters spent in arcades, and estimates vary from $7B to $20B. Space Invaders and Pacman alone have generated $3B in revenue.[42]

This is the volatile type of market in which educational games, "learning without teaching," or smart toys for learning will find themselves. Anything is possible.

A second aspect to the home market is more down-to-earth. Most people at various times need practical "how-to" instruction to accomplish specific tasks. The sales of "how-to" books could provide some indication of the demand for such material, but unfortunately such books are not segmented from general book sales. Instructional books have become much more visible in the past few years (books on tax tips and legal advice can now be bought in supermarkets), and publishers such as "Self Council Press" are flourishing.[43] Statistics Canada figures hint at a major jump in this market in recent years.[44] Video-cassettes of how-to material, however, have done poorly; but at $70 a cassette their cost has been high.[45] How-to material must be cheap and easy to get.

The delivery of content by telecommunications could be convenient in the home market. Also, advertisers could eventually lend a hand in the costs of "how-to" materials, subsidizing content software if it relates to their products. Eastman Kodak, for example, could sponsor a photography lesson if an inexpensive medium was available. The QUBE cable-tv system in Columbus, Ohio has explored various mixes of how-to material plus advertising, called "Infomercials." Enormous sums are spent on advertising in the consumer market, and advertising amount to 1.2% of GNP in Canada (higher in the US).

Finally, a further aspect to the consumer market relates to informal education and training. Statistics in post-secondary education discussed earlier showed a trend for individuals to take general interest types of courses as "continuing education," or to take courses on their own initiative to develop work skills.

There are millions of highly educated individuals in North America who want interesting ways to spend their leisure time. These could include how-to material to help with hobbies, and general background about history, art and travel, studying languages or studying any subject that takes one's fancy, from calligraphy to the secret life of plants.

Outside of the formal education world, what do we classify as learning? Informal learning and training will increase and new kinds of learning games and toys will appear.

The education system will find that powerful and engaging learning tools are proliferating both within its walls and outside of them. LOGO is an early example of software that is being marketed both for school use and for home computers. Meanwhile more people are coming to educational institutions not to follow set curricular programs but to choose courses as they want them, in a pattern resembling consumer purchasing. Training is also breaking out of old patterns, as people take work-oriented courses on their own. As the micro-computer begins to be used to meet new demands in education and training, often the education, training and consumer markets will merge.

FOOTNOTES: CHAPTER ~~THREE~~ 4

[1] Statistics Canada, Advance Statistics in Education 1981-1982. This figure includes expenditures on elementary/secondary schooling, community colleges and universities (Exhibit 4-1). Government supports over 92% of the costs of education in Canada.

[2] Frost and Sullivan (1982).

[3] Predictions by Creative Strategies International. Cited in Kearsley, G., and Hunter, B. (1982).

[4] In addition to provincial funds, local taxation accounts for 27% of school support; federal government for 2.6%; and fees and other sources for 4.1%. (There are a small number of federally-supported schools.) Statistics Canada, Catalogue No. 81-208, Financial Statistics of Education, 1979-1980.

[5] See Appendix IV.

[6] Financial Post, February 27, 1982.

[7] In elementary and secondary school textbooks, in 1979, Canadian publishers reported $91M net sales out of total sales (including imports) of $132M. Textbook sales are the second largest category of books in Canada, next to "trade books" or general readership books, which account for sales of $24M. Statistics Canada, Education, Science and Culture Division (private communication).

[8] Chapter Six discusses these questions further.

[9] Statistics Canada does not collect figures on part-time students at colleges and institutes so total figures are not available.

[10] The average expenditure per university student is $7500, assuming that a part-time student costs as much as a full-time student.

[11]Thorne, Stevenson and Kellogg (1981), p. 4, report to the Ministry of Colleges and Universities.

[12]At the University of Alberta, through the Educational Research Services Division, over 26,000 hours of instruction have been given yearly to some 650 students (Hunka, Steve, 1982). In Ontario, the "Individualization Project" involved the Ontario Institute for Studies in Education, which developed courseware; the Ontario Colleges of Applied Arts and Technology; the Ontario Ministry of Colleges and Universities; and the National Research Centre. A number of Toronto-area colleges, some with multiple campuses, now use this material.

[13]Statistics Canada, Advance Statistics in Education, 1980-1981.

[14]In B.C., for instance, several years ago part-time and full-time enrolment in colleges and provincial institutes was roughly equal. By 1979-1980, full-time enrolment had risen slightly (to 18,000), while the part-time figure doubled (to 30,000). (B.C. Post-Secondary Enrolment Statistics 1979-1980). In Ontario colleges, there are over 500,000 part-time registrations compared with 92,000 full-time enrolments. (Ontario Ministry of Education, "Continuing Education: The Third System," (1981).

[15]This term is used here to refer to studies and training outside of formal programs. Other terms, such as "permanent education" or "lifetime learning" are also in use. (See Ontario Ministry of Colleges and Universities, "Continuing Education: The Third System," 1981).

[16]Numbers rose from 353,000 degree holders in 1961 to 1,272,000 in 1977. P.icot, J. (1981), p. 31.

[17]Ibid., p. 58.

[18] See Footnote 2, Chapter 2, above.

[19] A further complication is that in several programs government pays a share of an employee's wages to a firm where the employee is being trained, but that this share of wages varies from program to program.

[20] Globe and Mail, October 12, 1981: "Computer-Aided Learning becomes a $5 billion Market."

[21] CAN and TICCIT are major computer learning systems described in Chapter 5.

[22] Manpower training includes the development of specific skills (mainly in clerical occupations, product fabricating, assembly and repair constructions and machinery-related trades). It also includes the classroom component of provincial apprenticeships, academic upgrading (Basic Skills Development), and several other programs (Exhibit 4-7).

[23] See Chapter 7.

[24] Support for apprenticeship is complicated: besides their on-the-job training, apprentices also take classes in institutions, and this component of training is supported by the federal Manpower Training Program. Employers could also seek provincial money for the on-the-job portion of training, through B.C.'s Industrial Training Program.

[25] Economic Council's "Human Resources Survey" sent questionnaires to 4012 firms across Canada in all industries except public administration and agriculture. There were 1354 respondents. See Betcherman (1981, 1982).

[26] Economic Council (1982), p. 84. These tended to be longer programs for blue collar workers.

[27] Betcherman (1982), p. 58.

[28] Ibid.

[29] In 1980, C.E.I.C. estimated that its share of training in industry comprised about 5% of total industry spending on training (based on a survey of training in Ontario). C.E.I.C. extrapolated from this data that training in industry in Canada cost $2B a year (including the federal contribution of nearly $100M).

The Economic Council survey, meanwhile, found that one in five training programs in industry had government support. This government support would roughly equal $100M (federal) plus $225M (provincial--see Exhibit 4-6), for a total of $335M. If this $335M supported one-fifth of the cost of training, the total figure would be some $1.7B. However, government programs pay only a share of employee wages in any training program in industry. The figure should be higher--probably at least $2B.

[30] Kearsley, et al. (1981).

[31] Ibid. 50% of responding firms (most of 160 large companies contacted) were using CBT.

[32] C.E.I.C. (July 1981), pp. 168, 172.

[33] Ron Kellison, B.C. Tel Education Centre (private communication). See also M. Westrum and R. Kellison (1980), for earlier estimates. It was expected that the TICCIT program would reduce costs per student hour from $23.68 to $13.82 once the system was operating.

[34] Globe and Mail, Dec. 8, 1982.

[35] Brown, Beth A. (Sept. 1981a). This study gives a number of US case studies, as does Kearsley, G. (1982b).

[36] National Research Council (1980).

[37] See Kearsley, et al. (1981), p. 102.

[38] Ibid.

[39] Dataquest estimates. The Financial Post, Special Report, Feb. 27, 1982, Joan Feldman, "U.S. computer markets record good growth despite recession."

[40] Evans Research Corporation. Globe and Mail, Feb. 23, 1982.

[41] Evans Research Corporation. 60% of microcomputers are bought by small businesses; 11% are used within large corporations; 14% are for "home/hobby," and 15% for education (1981). More recently, the proportion of home use computers may be increasing.

[42] Business Week, May 24, 1982.

[43] Self Council Press is a Vancouver-based firm whose sales doubled to $1.5M from 1978 to 1981. Globe and Mail, March 15, 1982.

[44] The book category that would include how-to material (Entertainment, Games, Sports, Hobbies) underwent dramatic growth from 1978 to 1979: titles increased from 117 to 799, and net sales jumped from 1.9M to 7.6M. Statistics Canada, Education, Science and Culture Division (private communication).

[45] Kalba Bowen and Associates (1981).

CHAPTER FIVE MAJOR CL SYSTEMS AND CENTRES OF ACTIVITY

Computer learning has a short history: its development began little more than 20 years ago. The early computer industry experimented with teletypewriters linked to mainframe computers to train personnel, and by 1960, IBM had made the first authoring language. By 1963, pioneer work was underway in the academic world, at Stanford University.[1]

Many early CL ventures fell by the wayside, and several large corporations (such as Time Life and General Electric) began CL projects that were soon abandoned. CL development was sustained by research efforts at a handful of universities and by public sector support. All of the major systems described in this chapter are the result of a long process of r&d that in most cases was supported by government. R&d took place in education institutions or government labs, and commercialization followed.

Each of these systems described here represents a distinctive approach to computer learning. PLATO, the earliest system, embodied the timesharing model of computing that prevailed when it began, linking geographically dispersed termlinals to a mainframe computer over telephone lines. In contrast, TICCIT (funded by the NSF at the same time as PLATO) began as a local wideband network with a small number of terminals.

NATAL is a powerful authoring language developed by the National Research Council in Ottawa as a solution to difficulties in sharing CL content. It was felt that the key to the problem would lie with an authoring language that would be widely used and implemented on a number of different machines. The lab gestation of NATAL, however, has been slow and it has yet to appear as a commercial product. CAN is another Canadian-made system, created at the Ontario Institute of Studies in Education. CAN's development has been driven by use, as the OISE supplied content and hardware for several CL projects in Ontario. Honeywell Ltd. has acquired the rights to market both NATAL and CAN.

SMALLTALK is the sole private-lab undertaking among this set of publicly-supported projects, a unique long-term research effort supported by Xerox Corporation, aimed at the production of an easy-to-use book-sized computer by

1984. Finally, LOGO proponents make up the philosophical vanguard of computer learning, expressing a new vision of the computer as a tool for conceptual learning.

SMALLTALK and LOGO are alike in that they take non-traditional approaches to learning, emphasizing fun and creativity and the use of the computer as a tool under the learner's control. PLATO, TICCIT, NATAL and CAN systems, on the other hand, are similar in that they have been developed for standard computer learning, to convey specific knowledge and skills. (Similar applications could be written in the authoring languages of each system; they would, however, be incompatible.) All four were first oriented to the educational world, but have followed a trend towards the more opportune training market. Also, all four systems have required mainframe or minicomputer resources, though in recent years some microcomputer capabilities have been added.

This chapter discusses the industrial setting for computer learning, introducing the main CL systems of the day and the major centres of CL activity where they have been developed. It also describes the growing interest of publishers in microcomputer software production. Finally, it discusses the international context for CL in terms of both competition and opportunity.

Six Major CL Systems

PLATO (Programmed Logic for Automated Teaching Operations)

PLATO is a complete computer learning system, with its own hardware and software (including the TUTOR authoring language). It is remarkable among CL systems for its bank of thousands of hours of content built up over the years, and for its network approach, by which users around the world are connected to central sources of content.

PLATO development was underway as early as 1961, and its history involves the University of Illinois, Control Data Corporation, and the National Science Foundation. In 1972, after a report on "Factors Inhibiting the Use of Computers in Education," the National Science Foundation awarded $10M to the University of Illinois for PLATO development (and $6M to TICCIT as well). Over the years, Control Data Corporation (CDC) shouldered a substantial burden in PLATO development, investing some $800M. Since 1976, CDC has marketed PLATO worldwide.

Today the University of Illinois and CDC offer independent versions of PLATO. The University offers academic content to subscribers with a research interest who tend to be involved in CL development themselves.[2] Control Data is concentrating on vocational and professionally-oriented training courses, and has over 6000 terminals in place, serving some 100,000 users. CDC has a worldwide telecommunications network with more than 20 centres in the US, Europe and other countries. A large user of PLATO could also purchase its own CDC CYBER computer (at a cost of some $2M). CDC also operates over 100 PLATO learning centres, where individuals can pay to use PLATO for training, on a course-by-course basis.

In Canada, there are PLATO systems at the University of Alberta,[3] the University of Quebec, and at Control Data Corporation in Toronto.

Despite the large number of PLATO terminals in use, PLATO has yet to turn a profit for CDC and the company expects no financial gain before 1984. The main problem has been that PLATO is expensive. Time-sharing over distances is costly, as is the special touch-sensitive plasma screen that PLATO uses. Rental of a PLATO terminal to connect with Control Data costs over $1300 a month, and even if a terminal is bought, the yearly subscription fee to the PLATO network is some $11,000. Control Data has now developed a microcomputer (MicroPLATO) and is converting online material for use through floppy discs. Yet costs are still considerable, as the PLATO microcomputer is priced at over $7000 US.

TICCIT (Time-shared Interactive Computer-Controlled Information Television)

TICCIT's history began in the late 1960's at the MITRE Corporation, (a non-profit research organization in Virginia), and in 1972 the NSF awarded $6M to stimulate TICCIT development. The goal was to create a commercially feasible system for computer-based instruction using "off-the shelf" hardware that was compatible with existing tv technology. The result was a system capable of handling up to 128 terminals attached to a central minicomputer, using modified colour tv sets as display devices. Wideband coaxial cable is used to connect the individual units to the central computer and allows instant response time. In 1976, Hazeltine Corporation acquired the commercial rights to market TICCIT systems, which are sold as "turnkey" systems including both hardware and operational software.

The cost of a TICCIT system (using 20 terminals, a Data General minicomputer, and modified Sony tv sets) is high: approximately $500,000. TICCIT has also recently developed a standalone unit using the IBM personal computer for delivery of courseware.[4]

While PLATO marketing emphasizes access to a library of content, TICCIT highlights easy authoring, with both an authoring language and an Authoring Procedure that includes a built-in course structure. The learning process has been designed for training, and is structured to feed the learner rules, explanations and tests. The learner sets his or her own pace and an Advisor makes suggestions.

TICCIT has mainly been used in US military applications and some educational settings at the college level. The Education Centre at B.C. Tel (The B.C. Telephone Company) in Vancouver has become a major user of TICCIT for industrial training. Its outlook toward TICCIT is entrepreneurial and it has plans to market its own courseware to other telephone companies, and to market TICCIT systems as well.

NATAL (National Authoring Language)

NATAL is an authoring language whose development began a decade ago, as a solution to a perceived problem. In the early seventies, a number of languages and machines were being used for CL and content sharing was impossible. NATAL's goal was a standard language which could be implemented on a variety of computers, to permit the transfer of content from one place to another. The National Research Council formed a special body, an Associate Committee on Instructional Technology (ACIT), which in 1972 issued functional specifications for a CL programming language. Ease of use, language portability, and the ability to communicate with different kinds of terminals were emphasized.

Thus NATAL was designed as a high-level language to increase a programmer's productivity and to create transportable content. Fewer lines of code are required to produce a CL application. Through NATAL the course author produces a detailed course design, and the burden of executing this design is transferred as much as possible to the computer. NATAL does not, however, offer a predetermined course structure or template at this time.

A NATAL prototype was first implemented at NRC using a DEC computer. The next phase of development began in 1979, with the award of a PILP project to Honeywell Ltd. (PILP is the "Program for Industry Laboratory Projects," a vehicle to transfer technology from government labs to industry). Honeywell was charged with a number of tasks to commercialize NATAL, including: upgrading the DEC prototype to commercial standards, implementing NATAL on IBM hardware, and implementing NATAL on the Honeywell Level 6 minicomputer.[5]

NATAL is still operating on a test basis, using Honeywell and DEC systems, and an implementation for large IBM computers is nearly completed. A general release has been predicted by the year's end.[6]

However, the Honeywell system required to use NATAL is a costly one. Hardware to support 16 to 20 users will probably cost at least $400,000, while the NATAL software would cost a further $50,000 or more. In response, two approaches are being taken. First, within the NRC, a microcomputer is being adapted to act as a standalone delivery system for NATAL. This microcomputer could draw on a library of content, online or downloaded and executed from a floppy disc.

Honeywell has also been exploring the idea of time-sharing. Two Ontario universities and some industrial clients are now using NATAL by connecting to Honeywell's computer. Also, remote "author services" are available through a national time-sharing service. Honeywell is also thinking in terms of centres which could manage the development of content by independent authors, and offer a databank of content. These ideas are reminiscent of PLATO's approach, using time-sharing and access to a pool of courseware. NATAL has an advantage in that it can use many kinds of terminals--a legacy of the early vision of NATAL as a widely-implemented system.

Honeywell Ltd. is a subsidiary of the US firm Honeywell Ltd. (U.S.), which also owns part of the European firm CII Honeywell Bull. While a Canadian hardware manufacturer might have been preferred, no Canadian firm makes the size of computer that NATAL requires. From the NRC's view, Honeywell has offered the possibility that its Canadian company could become a centre for computer learning in the large Honeywell complex, acquiring world product mandates within the Honeywell group. Honeywell also has the necessary money to sustain NATAL's growing pains and to launch major marketing campaigns--as it has done with CAN, discussed below.

At present, besides Honeywell's operations and work in the NRC lab, a number of centres across Canada are linked to the NRC computer, at the University of Victoria, for example, and the Canadian Forces Base in Trenton where several NATAL courses are being developed.

CAN (Completely Arbitrary Name)

CAN today comprises an instructional system, made up of CAN-8 software plus hardware manufactured by Honeywell Ltd.

Work on the CAN language began in 1967 at the Ontario Institute for Studies in Education, with the original aim of developing an easy-to-use authoring language. The CAN language is now used for general programming purposes, and the CAN operating system supports other software functions in addition to content authoring. The main CAN software at present includes: the CAN-8 Authoring Language; EASSy (Educator Automated Authoring Systems), a content creation facility that generates either CAN-8 programs, Telidon databases, or a program master for optical videodisc; the CANNET network processor, a communications system that links CAN-8 computers; and GAP, a Graphics Authoring System.

Because CAN has been used for actual content development projects in Ontario over the years, considerable CAN content is available. The Individualization Project, for example, produced a number of college level courses, and a project in Ontario secondary schools created CL material for over 30% of intermediate mathematics curricula. This content can now be acquired on a commercial basis from OISE. The ability to network by telecommunications between different campuses has also been emphasized.

The rights to market CAN in Canada and the US have been acquired by Honeywell Ltd., and CII Honeywell Bull will market CAN in Europe. CAN-8 and its software options are implemented on the smaller of the Honeywell Level 6 minicomputers, and a system to support 128 terminals would cost about $100,000.

Thus Honeywell (which will also market NATAL), holds the rights to the two major computer learning systems developed in Canada. Though complementary market strategies and product development may be sought, to a considerable extent Honeywell is handling two competing systems. So far, NATAL has not been a commercially available product and is being tested in Canada only, while CAN-8 has been marketed in the US and Europe with encouraging results. Eventually, the question of competition between these two systems will arise.

CAN and OISE are a major nucleus of CL activity in Canada. A significant event some years ago was the shift of CAN to the commercial marketplace. CAN-8 was developed not as the property of OISE, but of HOMECOM Learning Systems Ltd., a private company.[7] HOMECOM then built the CAN operating system for the Honeywell minicomputer. While Honeywell's contract to market CAN is with HOMECOM, it also has a contract with OISE to promote OISE courseware. Secondary interest in CAN is also springing up: a firm in Ottawa has begun to convert some CL material to CAN form, and there has been interest in implementing CAN on a Canadian-made microcomputer. HOMECOM is making CL content for a fibre optics trial in Saskatchewan. Meanwhile, OISE continues to be a major centre of CL activity, particularly moving into videodisc technology.

SMALLTALK

In 1971, a futuristic and long-term research project was begun at the Xerox Palo Alto Research Center (PARC), to produce a personal computer for the eighties. This computer was visualized as the Dynabook, a flat notebook-sized package with high-resolution graphics and a touch sensitive flat screen. Design work for the Dynabook proceeded for years as an almost legendary research effort, shrouded in mystery.

Ten years later, in 1981, the veils began to lift, and the SMALLTALK-80 programming system is being released for more general access. A leading figure has moved from Xerox PARC to Atari, Inc., and microcomputer versions of SMALLTALK are expected in the near future. Meanwhile, microprocessor technology will soon achieve the power needed for the idea of the Dynabook, and with advances in hand-held computers and flat screen technology, the Dynabook itself may soon be feasible.

SMALLTALK is the programming system designed as part of the Dynabook effort. SMALLTALK is a unique language in many ways, not least for its underlying philosophy, which emphasizes flexibility. Most computer applications today (for example, a word processing application) provide the user with an easy-to-use program, but one which is inflexible--the user must adjust to the conditions set by the application. The SMALLTALK approach is to encourage "endless possibilities and easy toolmaking" whereby the user makes his/her own computer tools. Because the burden of making these tools falls upon the user, the system needs to provide easy and casual means to generate tools and also enough pre-written tools to get the user started. Thus, for any given application the user makes a kit of tools (tools for sketching, tools for word processing, etc.), while SMALLTALK would provide an easy-to-use "kit maker."

SMALLTALK has a number of marks of style which are distinctive. For example, "icons" (tiny pictures) are often used. These icons could be used to animate math problems by making pictorial scenarios of the problem to be solved.[8] SMALLTALK has emphasized interactive graphics and animation.

More than any other system discussed so far, SMALLTALK emphasizes the active and creative role of the learner. The LOGO project takes this philosophy a step further, proposing not only that the computer should be a creative tool for the learner, but that it should be used for a new form of education entirely.

LOGO

> The first instinct of educators is to couple the new technology to their old methods of instruction. My vision is of something much grander. So I dream of using this powerful new technology not to improve the schools we have always known

> (and, to be honest, hated), but to replace them with something better. I don't believe that this something will look anything like what is now known as "Computer-Aided Instruction." I think it will be more like the growth of a new culture, a computer culture, in which the presence of computers will have been so integrated into new ways to think about ourselves and about the subject matters we learn that the nature of learning itself will be transformed.[9]

This is Seymour Papert's vision and he is the mentor in LOGO development. LOGO thinking is based on the work of the Swiss genius, psychologist Jean Piaget, who studied the ways in which children acquire concepts or "powerful ideas." Papert studied with Piaget, and then set up a lab at MIT (Massachusetts Institute of Technology) in the early 1960's. The LOGO project is also one of the few examples of computer learning to draw upon developments in Artificial Intelligence. Its most unique feature, however, is its philosophy.

In LOGO thinking, the emphasis is on learning without teaching, or "Piagetian learning." The aim is for the learner to acquire new ideas intuitively and not through formal or didactic methods. With LOGO learning, there is "no threshold and no ceiling." Papert is an iconoclast: not only does the learner control the use of the computer, he/she does so without the curriculum, grades or quizzes that characterize the formal education system. To quote:

> In many schools today, the phrase "computer-aided instruction" means making the computer teach the child. One might say the computer is being used to program the child. In my vision, the child programs the computer and, in doing so, both acquires a sense of mastery over a piece of the most modern and powerful technology and establishes an intimate contact with some of the deepest ideas from science, from mathematics and from the art of intellectual model building.[10]

It is a tenet of the LOGO approach that the computer be under the individual's control, as compliant and ordinary as a pencil:

> . . . the pencil has many uses: it is used to scribble, to doodle, to draw, to write, to work sums, or to chew on. It is used for illicit notes as well as for official assignments. I see the computer in the life of the child as equally ubiquitous and equally versatile. I also see it as equally personal. Children own pencils, they are not intimidated by them. This should be equally true of the child's personal computer.[11]

LOGO's emphasis has been on young children, as young as three and four. LOGO creates "microworlds" for children to explore and manipulate--worlds with active agents that the child directs, and with processes that the child gets to know and understand. The idea is that within such a world, for example "Mathland" where "math is spoken," one will get to know and understand math as easily as one learns French in a French-speaking country.

LOGO itself is a programming language which is sophisticated enough for adults to create elaborate software, but which uses natural language and is accessible to young children for writing programs themselves. At present, LOGO is mainly associated with the world of "turtle graphics," through which children explore geometric shapes and relations. The "turtle" is simply a small object which is moved on the screen; originally a mechanical turtle moved about on a magnetized floor space as the child directed it.

Turtle graphics are a palette of computer instructions for making geometric shapes, where the child acts as an artist learning about how shapes work. The individual uses simple programming instructions to move a "turtle" on the screen, which draws a line and thus creates shapes and patterns.[12] The child learns about geometry, about problem-solving and about programming in the LOGO language.

LOGO software is now being marketed by LOGO Computer Systems Inc., a firm based in Pointe Claire, Quebec. There is also a LOGO Learning Centre in New York, which is engaged in a Computers In Schools project, funded by the National Science Foundation, to train teachers in using LOGO. Another centre of LOGO activity is the Lamplighter School in Dallas, Texas, a model "school of the future" where 60 LOGO computers are available to 400 children from nursery school age to Grade 4. There is a LOGO project in Senegal, and one in Montreal, and a lab still exists in Massachusetts. Papert, however, and others in the LOGO group, are now in France participating in the Centre Mondiale project[13] funded by the French government to develop new approaches to the use of computers for learning.

LOGO software is available for Apple microcomputers and for Texas Instrument microcomputers, and "turtle graphics" is available for Radio Shack and Atari systems. NABU Manufacturing Corporation, of Ottawa, has developed a version of LOGO that will be offered to cable-tv subscribers this fall in pilots of new services, including video games.[14] NABU has also recently bought part of LOGO Computer Systems Inc.

The involvement of NABU underlines the point that while LOGO is being used in schools, it is equally likely to be used on home personal computers. LOGO is the first computer learning application that suits the home market so thoroughly, but a computer culture is rapidly evolving and more will doubtless follow.

There are numerous other CL systems, including CL software offered by major hardware manufacturers.[15] However, computer learning has a low profile in these companies. IBM has been a unique case, as its "Coursewriter" software was the first specialized authoring language, but Coursewriter has not evolved as might be expected. IBM has an educational system (Interactive Instructional System), but did not choose to support the long years of costly r&d without profit that have been required in major CL projects.

There has also been a certain amount of interest in CL among general suppliers of information services to homes and businesses. The Source and Compuserve, for example, are consumer-oriented computer service companies which offer a range of services that has included some attention to computer learning.[16] These companies primarily offer online services, but the Source (which is owned by Readers' Digest) now sees more opportunity in downloading educational content to personal computers.

Publishers

It takes no great leap of imagination to suppose that publishers could extend their print activities into electronic form and make software products. At the moment, however, software publishers perceive a troubled software market for microcomputers, fragmented by incompatibilities and fraught with copyright problems. Nonetheless, a few are experimenting with software, including CL applications, and also with videocassettes and discs.

A number of educational and general book publishers have begun to publish computer learning software for microcomputers. Apple has signed agreements in the US with McGraw-Hill Book Co., Addison Wesley Publishing Co. Inc., and several other publishers. Random House, Inc., is working with Radio Shack microcomputers and Scott, Foresman and Co. is working with Texas Instrument systems. Milliken Publishing Co. initially provided software for several types of hardware, but switched to work only with Apples. Choosing a system in a market with incompatible equipment is a central problem for publishers.

Houghton Mifflin Co., another publisher of educational books, has taken a unique approach and set up a subsidiary to sell its own complete CL hardware system, the Dolphin. It will then lease customers a software library based on Houghton Mifflin programs.

Many CL programs may be based on books--using characters from children's books, supplying case studies and simulations to accompany textbooks, and so on. The importance of print remains and book publishers are well suited to combine the two media.

In Canada, most publishers are US subsidiaries. McGraw-Hill Canada, for instance, has expressed an interest in CL publishing, as has its parent company in the US.

In the educational world, Canadian-authored material may be encouraged by policy; in other cases, the tendency will be to repeat US-created content acquired from parent firms.

An exception to this pattern is a small Vancouver-based publishing company, Press Porcepic, which has interest and expertise in CL. The firm will publish a book on computer learning (as it has already done for Telidon) and through a division called Softwords set up specifically for CL it will develop courseware, mainly under contract to client organizations. The company already produces software products at present (such as an Apple-Telidon interface) and its founders are active in computer learning.

Other Centres of Activity

There are relatively few centres of activity in computer learning in either Canada or the US, and most have been mentioned in the discussion of major systems above.

In addition, in Canada there are a handful of CL consultants scattered across the country, some affiliated with universities. Within universities, the Université de Québec à Montreal has a PLATO centre, as does the University of Alberta. Also at the University of Alberta, there is an Educational Research Division which has been active in CL for many years. Faculty at the University of Manitoba have developed substantial amounts of CL material, including special education applications, and the University of Victoria has a CL lab and has experimented with both NATAL and Telidon. The University of Waterloo, though it is renowned as a centre of computer programming, has not been prominent in computer learning to date.

At Concordia University in Montreal, the Quebec ministry for education has funded a major expansion of the Educational Technology Program, and a doctoral program is to be offered, with emphasis on tele-education (using microcomputers, videocassettes and other media to educate over distance), and on industrial and commercial training. Finally, the Ontario Institute for Studies in Education, mentioned earlier as the cradle of CAN development, offers post-secondary programs and is a main centre of CL activity and expertise.

In the US, several firms involved in computer learning have already been noted, including Control Data Corporation, Xerox PARC, and Honeywell Ltd.[17] A number of universities have had ongoing involvement with CL, such as the Institute for Mathematical Studies in the Social Sciences at Stanford University. The MECC (Minnesota Educational Computing Consortium) is an outstanding computer learning centre, operating a large educational network that links almost each school and college in the state to centralized computer resources. Also a number of clearinghouses have been established, such as CONDUIT and MicroSIFT. (These clearinghouses and MECC are described in Appendix IV).

The US is remarkable for a number of firms specializing in CL products and services. WICAT Systems Inc., based in Utah and New York, is a prominent example. WICAT was founded in 1980 and grew out of a research institute that had worked in educational technology for many years. WICAT particularly became involved in the early development of videodiscs (mainly through projects for the US military). WICAT now combines special hardware, special authoring software, videodisc tutoring, instructional design skills and training analysis, and offers a number of hardware and software products in addition to consulting services. The company also operates a non-profit educational institute for curriculum development and research, using a "laboratory school" with 120 elementary students.

Courseware, Inc., is another computer learning company that offers a wide range of CL products and services. Also, the Human Resources Research Organization (HumROO) in Virginia has specialized in education and training systems for many years. It too has worked with the military, including videodisc projects.

After this overview, it can be said that the CL community in Canada (and in the US as well) has been a relatively small one. Many of the main centres of activity that existed ten years ago are still prominent today. There is a small first-generation of individuals who began involvement in CL out of interest or long-term vision, coming from academic or government backgrounds rather than from the commercial world. Since the late seventies, new entrants have been drawn by the commercial opportunities that began to be visible as CL matured, and established experts have also moved into commercial roles.

The pace has quickened recently. NABU Manufacturing Corporation is one example of a new entrant, moving first to include LOGO in its pilot of new cable-tv services, and then to purchase ownership in the LOGO company itself. The hardware industry has responded to the Ontario Ministry of Education's plan to foster a Canadian Educational Microcomputer. And in answer to the Ministry's call for proposals for exemplary lessonware (which was directed to "publishers, media producers, software developers, educators and others"), over 500 submissions were sent. Meanwhile, the department of Industry, Trade and Commerce[18] is receiving an unexpected number of applications for industrial development grants in the area of computer learning.

Thus, while the CL community in the past has been small, it can be expected that in the right enviroment, with perceived opportunity, new interests will respond. The marketplace is increasingly providing commercial opportunity and policies can emphasize favourable conditions for doing business in CL.

The International Context

The international context for trade is generally considered in three categories: the industrialized countries, the Newly Industrialized Countries (or NIC's) and the Third World. In the past, patterns of trade in Canada have been wedded to the US and otherwise have tended to lie within the industrialized sphere. Increasingly, however, it is realized that trade has entered the era of the global marketplace, particularly in the case of transportable information products like computer software.

Many industrialized countries have pondered the shift toward a global marketplace and concluded that high-tech is a critical growth area, both to capture new opportunities and to avoid the balance of payment problems that will result from being a passive market for imports as high-tech accelerates. As a result, the competition in new computer-based industries is intense among industrialized nations, especially in computer hardware manufacturing. Furthermore, many such countries are adopting a protective attitude as they seek to nurture indigenous industries. While the GATT (General Agreement on Tariffs and Trade) prohibits tariff barriers, numerous non-tariff barriers are mobilized to encourage indigenous industries.

These trends have several implications. Most obviously, they make competition difficult, especially in hardware manufacturing. Trade is also becoming more complex, as a firm may have to negotiate with government, offer to set up local plants or make other conciliatory moves to sell in a particular country. Complex manipulations of multinational structures can be expected. In CL, education markets may particularly be subject to protective procurement policies. In the high-tech market, specialization, quality, and marketing become extremely important.

Meanwhile, the economies of several newly industrialized countries are flourishing, and more interest is awakening in these countries as trade partners. There too, computer industries are being developed. Some countries are making efforts in hardware manufacturing (including the replication of US microcomputers at a fraction of the US price). Several are endeavouring to develop software industries, and have devised policy strategies to support software development.[19]

The Japanese too have recognized the importance of software recently, and have established a software development centre, while software divisions within hardware manufacturing firms are also multiplying. Also, both Japan and France have taken a "Mega project" approach towards computer development with implications for CL, funding long-term r&d projects. (Japan has a massive $400M "Fifth-Generation Computer" project, and France has a much smaller project funded at about $20M yearly at the Centre Mondiale in Paris.)[20]

The Third World, meanwhile, comprise an enormous portion of the world with staggering education needs. Both France and Japan are cultivating special perspectives towards Third World use of computers.

The Third World, however, has a long history of failed high-technology projects, where foreign technocrats, perhaps in cooperation with an educated elite, sell computer equipment and other advanced technologies which remain unused, or for which no replacement parts are available. Cultural sensitivity was often lacking. In poor countries, such expensive projects were particularly inapt. Third World countries now are more likely to weigh the appropriateness of imported technology, and to resist the one-way influx of cultural goods. Co-operative projects, adapting technology and applications to a particular environment, may be sought. Canada, to date, enjoys a relatively high reputation in the Third World because it has been less associated with such projects than other countries, such as the U.S.

Third World markets for training are likely to appear first. Importing technology without training has been a particular problem in the past. Also, as industry develops, training will be needed. There may also be a demand for higher education and professional content, for which studies abroad are now required. In the longer term, general education problems, as basic as literacy, may be addressed by computer tools such as handheld special-application devices, which in a few years time may be technically powerful, cheap and compact.

In sum, the market for CL is global, and trade, particularly with new partners, should be actively encouraged. Strong international trade is particularly important in Canada with its small market and its permeability to foreign products which must be offset by exports. We especially have a history of being a passive market for US content, importing with no balancing export sales. However, as international trade occurs it must be tempered by some sensitivity in dealing with Third World markets to avoid the technocratic failures of the past and to maintain goodwill as these markets develop over time.

Above all, a good trade environment is important. Canadian firms need to operate within a favourable context of trade agreements. They also need export market support that encourages expansion into the international marketplace--financing arrangements, market intelligence, etc. Building supportive export conditions for trade should be emphasized in policy measures to advance CL.

FOOTNOTES: CHAPTER FIVE

[1]Patrick Suppes, at the Institute for Mathematical Studies in the Social Sciences (IMSSS), began using computers for drill and practice in elementary math.

[2]Yearly subscribers pay a fee of $3000 and there are 1300 terminals in colleges and universities across the US (LINK, July 1982).

[3]A $2.5M system was acquired by the University of Alberta's Instructional Systems Group in 1980. Over 30 courses have been developed and use averages about 10,000 student contact hours per month.

[4]The IBM unit could be used by a learner to access courseware stored on a floppy diskette, but could not be used for authoring. The cost of the unit is approximately $10,000--the price of the IBM plus about $3500 for the TICCIT capability.

[5]Brahan, J.W. (1980), "NATAL-74: Concept to Reality."

[6]"Natal has Emerged from the Lab," Honeywell Ltd., Toronto, Ontario: June 1982.

[7]Dr. W. Olivier, principal developer of CAN at OISE, developed CAN-8 as an independent venture.

[8]As a sample problem, two trains leave two different locations (at specified times and speeds) and are now on a collision course. A controller notices that they are on the same track. How much time is there to prevent a crash? The student guesses the answer, runs the problem, and watches an animated simulation in which trains, clocks and odometers are set in motion. (Gould, 1981.)

[9]Seymour Papert, BYTE magazine, June 1980.

[10]Seymour Papert, Mindstorms (1980), p. 5.

[11]Seymour Papert, BYTE, July 1980.

[12]As a very simple example, with four commands one can make a program that draws a flag shape (send the turtle forward, rotate it 45 degrees, send it forward a shorter distance, rotate it 45 degrees, and send it forward to complete the flag). By a command that repeats and rotates the entire flag many times, a complex snowflake-like pattern builds up on the screen.

[13]See Appendix IV.

[14]NABU will sell equipment to cable companies who in turn sell a low-priced home computer (under $1000) to subscribers. For a modest sum per month (about $8) subscribers will have access to LOGO or to video games downloaded into their computers when wanted.

[15]For example, Sperry Univac offers ASET (Author System for Education and Training; Hewlett Packard offers IDF (Instructional Dialogue Facility), and so on.

[16]Compuserve and The Source (Source Telecomputing Corporation) are computer services that offer numerous information services to customers with terminals or microcomputers across North America. Both offer a mix of business, home-oriented and computer-hobbyist services to subscribers priced at low rates, using packet-switched computer networks that can be accessed by dialling a local telephone number. Both have about 15,000 subscribers.

[17]See Botkin, J. (1980), for an overview of US projects in computer learning.

[18]Now DRIE, the Department of Regional and Industrial Expansion.

[19]Wills, Russel M., "Canadian Technological Dependence: Policy Directions from the Newly Industrialized Countries" (in preparation).

[20]See Appendix IV.

PART III

POLICY

CHAPTER SIX DEVELOPMENT ISSUES

The policy approaches taken toward computer learning have been varied, as later chapters describe. However, all tend to deal with similar questions critical to CL development. This chapter discusses:

1. the cost of content development
2. problems in microcomputer content supply
3. incompatibilities
4. r&d funding conditions
5. detrimental treatment of software as a product
6. export marketing capability
7. shortage of expertise

These issues are the central matters in CL success or failure. The first three are functional matters, problems in accomplishing CL that are encountered at once by the CL user or supplier. The high front-end costs for the development of content have always been a deterrent to computer learning. In addition, there have been a set of problems in the marketplace for content (e.g., copyright difficulties, disorganized supply channels, incompatibilities). These problems reappear repeatedly in discussions about computer learning development.

A second set of issues relate to broader industrial conditions. R&d funding has become a major instrument used by government to encourage industry to invent new products, and both short-term and long-term r&d is essential to CL. However, ultimately industry itself must take responsibility for the commercial success of a product, and here a new set of problems can arise: extra difficulty in finding financing when the product is software and not hardware, inexperience and lack of funds to enter export markets, and a shortage of available expertise in the computer learning area to supply trained staff.

It is within this context that policy initiatives concerning CL are formulated. This chapter summarizes the ways in which these factors deter the development of CL.

1. Cost of Content

Despite the falling price of computer power, costs of developing CL content remain substantial. These costs include equipment, software tools, and an extensive labour effort. It can easily take 200 hours of development to make one hour of content, and even with authoring tools, a ratio of 100:1 is considered excellent.

In training settings, almost all content must be custom made, and the price of content development has been carefully examined. In education, where microcomputers are used in schools, the situation differs. First, the labour costs of content creation have been masked by the willingness of teachers to make their own material without being paid to do so. Second, commercial software packages for microcomputers are mass-market products, manufactured in large numbers and sold at low costs.

It appears to be generally felt today that few teachers have the ability, inclination or time to create excellent materials without reimbursement. Provincial ministries of education have been faced with the fact that, unless schools simply purchase mass-produced packages created elsewhere, the costs of content development have to be contended with in some way.

Thus in both education and training, there is a search for solutions to the high costs of content development. Apart from tools to make content faster, the prime solutions at present include: (1) an emphasis on merchandising content after it has been developed through sales or licensing; (2) the use of expert production teams; and (3) the use of production centres.

Licensing and resale are magic words in CL. In education, an emphasis on merchandising is part of the more professional and commercial outlook towards content generally. MECC, for example, seeks subscriptions to its content and also markets individual software packages. In training, even though long-term savings can justify front-end costs for software development, thoughts may also turn to further gains that could be reaped through the resale of courseware. There is, however, considerable debate on the likelihood of resale of training material and some argue that firms' needs are too specialized for pre-made software to be sold. Nonetheless, in some industries the equipment used is very similar from company to company and resale potential of courseware seems high. Furthermore, there is a general trend in training to delineate sets of "generic skills." Generic training modules with wide relevance can then be used, followed by specialized instruction as needed. It is likely that if good training software is available and well-marketed, it will be bought.

Secondly, the use of specialized teams is frequently proposed as a model for CL development. Creating content draws on several kinds of expertise: instructional design, computer programming, skill in using CL technology and authoring tools, and knowledge of a given subject area. It is a rare individual who has it all.

More and more, a team approach is emphasized, through which specialists will work together to create a course.

Finally, the idea of a production centre offers several advantages. A centre could gather together a permanent core of experts, and provide a place for others to apprentice in computer learning skills. It also can assemble computer resources, such as sophisticated authoring equipment for graphics and video.

There are various models, then, for the creation of content. At one extreme there is the individual author, exemplified by the teacher authoring his or her own lessonware on a microcomputer. Next is the use of the in-house team or in-house centre, within a large organization (a corporation, a government training centre, a university, etc.). A CL user could also turn to an external production centre, on a client basis, purchasing any mix of computer resources and expertise. Finally, pre-made content could be acquired, at a fraction of the cost of customized development. The choice depends on costs, available hardware and human resources, and need for tailored or indigenous material. Increasingly, major users of CL, and also planners for CL development, are thinking as a commercial publisher might, in terms of large-scale operations making professional products with resale potential. Even when a "cottage industry" model is espoused (in which dispersed individuals make content), it is usually combined with some role for a production centre--consultation, quality management, manufacture and marketing, etc.

2. Problems in Microcomputer Content Supply

The problems experienced in content creation and content supply conditions will vary with different context for CL. In education where the use of microcomputers suits mass-produced software, the emphasis at the moment is on a number of content supply problems: poor quality, copyright troubles, and incompatibilities. In the computer-based training world, where custom-made content dominates, the major holdback to CL lies with the high costs of content creation.

The software marketplace for microcomputers is a mass market for computer content, based on high-volume production and low-price sales. A software manufacturer needs to reach numerous buyers conveniently. The user, meanwhile, who often cannot program a computer, is also anxious to have a convenient supply of good quality content. The conditions of software supply, however, have been fraught with problems. These have included poor quality, copyright infringements, disorganized supply channels, and incompatibilities.

Quality

The quality of most content for educational computing has been much-lamented, and criticism has fallen harshly upon the lessonware created by teachers themselves.

Content creation in the educational world has been largely a labour of love as teachers program their own "lessonware." There are some advantages to this method: the lessonware carries the teacher's personal stamp and is locally relevant (so that students in B.C., for example, don't find all their practice problems set in Toronto or the US). The weaknesses, however, include poor quality, a lack of evaluation, poor documentation, and a tendency to make only very simple material that doesn't tap the computer's capacity.

A trend to increased professionalization in content is expected, as is an increasing use of commercial material. Much commercially-produced material too, however, has also been criticised. "Peer review" (i.e., review by other educators), the use of expert teams, and the involvement of teachers in designing content are some of the means emphasized to improve content quality.

Copyright

The amateur software created by teachers has been "public domain" material: that is, no party expected copyright reimbursement and copies could be made with impunity. Teachers exchanged their material without expecting money to change hands. To a commercial software publisher, however, the tendency for microcomputer users to copy diskettes is a serious problem. Even with a software success story such as the Visicalc business package, in addition to actual sales thousands of pirated copies are in use that bring no revenues to the authors.

There is no clear solution in sight to copyright difficulties. A number of "technological fixes" have been considered, such as the use of "read-only" videodiscs which cannot be copied. However, videodiscs are not in common use at present. It is possible to also make floppy diskettes that do not allow copying. But microcomputer users keep back-up copies of programs as a standard practice, and teachers like to copy programs and then make their own modifications. Thus at least some copying would have to be allowed. A further limitation to technological solutions for copyright is the notorious ingenuity of computer programmers who program their way around security barriers.

Other means are used to sidestep copyright problems. Licensing arrangements (or "right to copy agreements") are made that allow all members of a given group to use and copy content freely.[1] A mixed public domain/commercial outlook towards content is also appearing. A provincial ministry, for example, could develop content that was free to any teacher in the province, but that was exported commercially.

Another approach focusses on the conditions of content supply, suggesting that if it is easy, convenient and inexpensive to get content, the motivation to copy will decrease. By this reasoning, telecommunications delivery (downloading content over cable, for instance) could offset illegal copying.

Disorganized content supply

Convenient telecommunications delivery could well be welcomed by teachers who experience frustration in acquiring content. Computer retailers give short shrift to educational software, and most material must be ordered from sources listed in educational software catalogues. The arrival of the software by mail may seem unsuited to the electronic age, and further frustration may be felt with the first use of the material, which is often disappointing. Small wonder that a teacher will pirate a copy of material that at least has been recommended by another educator. The content supply scene is a chaotic one, and virtually all provinces are exploring means to organize it, through clearinghouses and other means.

3. Incompatibilities

Incompatibility is a problem that segments the marketplace: content developed for one manufacturer's equipment cannot be used on that of another. This problem at present most affects the microcomputer market, based on mass-produced content. From the point of view of the software supplier, the market is fragmented according to hardware purchasing patterns. The school boards now buying microcomputers are unhappy because they become locked into the use of one system only: once software has been purchased for the first system they buy, they are wedded to that manufacturer if they wish to take advantage of their software investment. Provincial ministries find their planning complicated by the fact that not one but three major types of microcomputers may be in use.

Any computer has the natural ability to understand instructions in only one language, its own machine language. This native machine language differs from computers of one type to another. In addition, a computer has a set of low-level programs which make up the "operating system" that enables the computer to be used for applications programs. Compatibility problems arise when an application program is moved from a computer with one operating system to another. Often, it must be entirely re-written.

Years ago, high-level languages, such as Fortran or BASIC were intended to be machine independent. Each computer manufacturer would provide translators to transform the high-level language into the particular native language of his machine. However, "dialects" of these languages developed over time, and machine-independence never resulted

Eventually, microcomputer operating systems may become standardized. Two systems (UNIX and CP/M) are now becoming dominant. At present, however, incompatibility is a major problem and even if a program is written in the same language (such as BASIC), it can't be taken, for example, from a Pet to an Apple system. Furthermore, most established manufacturers see a distinct advantage in maintaining these incompatibilities. Apple Computer Inc., for instance, enjoys an advantage in the educational world because there is a considerable amount of content available for Apples that will not run on other microcomputers. Incompatibilities are especially a problem for microcomputer software publishers, who need a mass market in order to produce packages in large numbers that can be sold at low cost.

Even between two models of hardware from the same manufacturer, compatibility may not be possible. The Apple III was an unpopular system, in part because little software was available; it could use none of the software made for the Apple II. In response to this problem, the strategy of "upwards compatibility" has been developed: system design should ensure that, as one model is superceded by another, software can be passed on to the second system.

Standardized hardware is one approach to incompatibility, and several provinces are encouraging schools to buy a particular type of system. At the same time compatibility between different systems has been attempted in various ways. When development of the NATAL authoring language began in Ottawa years ago, a major goal was to create "a standard language . . . which can be implemented on a variety of computers."[2] NATAL, however, has just recently left the lab and requires substantial computer power, which will limit its use. The most favoured means of solving incompatibilities at the moment is the use of "portability" software for languages and machines that are widely in use.

A program is "portable" if "it can be moved from one machine to another at a cost substantially less than the cost of re-developing the program on the new machine."[3] Work on portability software is being done in Canada at both the University of Alberta and the University of Waterloo.[4]

Another technical solution to incompatibility is "emulation"; making one machine behave as if it were identical to another. In theory, with the right emulator circuit board installed, an Apple II could work as though it was a Tandy TRS-80. However, emulation is difficult. The Apple III attempted to emulate the Apple II with limited success.[5]

There are also ways to create content that facilitates its transfer from one system to another. For example, the way in which the CL program is written can minimize the programming portions that need to be modified when it is adapted for use on a new system. Also, a content supplier can pursue the strategy of producing an application for two or more systems at one time. The initial design phases of content development take up a substantial proportion of the total authoring effort. A content publisher could complete the job to this point, and then write the actual programs for two different systems, producing two versions with minimal duplication of effort. At present, software solutions (such as portability software) appear most important in meeting compatibility problems, perhaps accompanied by content creation strategies that minimize the components of a program that have to be changed.

A further level of incompatibility occurs between two different CL languages, and here the gap is virtually unbridgeable. Code written in CAN, for example, would have to be completely re-written in NATAL. If a training centre was set up in B.C. using TICCIT and a similar centre was also established in Ontario using CAN, there would be little sharing of courseware between the two--unless both centres could support both languages.

4. R&d Funding Conditions

"R&d" has been almost a banner word in recent years in policy documents, brandished as a means to achieve success in a high-tech world. It is frequently pointed out that other countries devote far greater resources to r&d than Canada.

There is no doubt that r&d is essential to CL development. Computer learning is at an early stage of evolution. As Chapter Two emphasized, its use so far has been primitive and the resources of the computer (for intelligent interaction, natural dialogue, etc.) have scarcely been touched. R&d efforts must be made, in both short-term and long-term projects: in the short-term, to meet visible market needs (such as the need for portability software); and with a long-term perspective, to support research in leading-edge areas, pursuing what are the most difficult questions of the day.

But government support of r&d is no simple panacea, and some of its limitations are discussed below.

Above all, r&d is a risky business. In a case study of three US companies, only 12% of their projects earned a decent profit. Most were stopped at early stages, but even among the commercialized projects only 40% were profitable.[6] Eventually, the project has to face the marketplace: "Most R&D projects fail because they do not sell--not because they do not work."[7] R&d costs are only a fraction of the total investment a company makes in establishing a new product. Marketing in particular may be critically important and also very costly.

In this situation, problems lie in wait when the task falls to government to pick a winner by funding r&d in industry. To name a few difficulties: decision-making is likely to be slow; it is hard to both start and stop a project; those in government are isolated from the marketplace; and it is difficult to pick the right company. There may be a tendency to reduce the risks of making a choice by giving smaller sums to more companies. Also, the federal government may have secondary agendas to spread funds across the country, which confuse the selection process. Finally, while the outcome of r&d may be technically flawless, the firm may lack the marketing strength to bring this effort to commercial success.

Industry, meanwhile, often finds that the difficulties in cultivating government grants outweigh the benefits, and many firms prefer to use tax write-offs for r&d instead. At present, r&d is allowed a 100% write-off on expenditures in the year in which expenses were incurred. An additional 50% write-off is permitted for r&d expenditures in excess of a firm's average spending on r&d in the previous three years.[8] A variety of other policies could be used to encourage industry itself to invest in short-term r&d projects (e.g., tax incentives such as accelerated write-offs, cuts in capital gains taxes, etc.).[9]

Government is also involved in r&d by supporting research in its own labs or in universities. In these settings long-term research, which government alone is likely to fund, can be carried out. Support for CL, however, has been lean.

It is an important characteristic of long-term research that, while commercial benefits may well result, they cannot be predicted:

> Who could have predicted when the double-helic structure of genes was discovered in 1953, that this would lead to the birth of the biotechnology industry a generation later? Many of the fruits of basic science are unexpected windfalls.[10]

The Japanese have incorporated this attitude in their Fifth Generation Computer Project. This is a project with ambitious goals, and it is fully acknowledged that these goals may not be reached. En route, however, "windfalls" are expected with certainty, as a result of the massive research effort that has been set in motion. The Japanese project illustrates a further point that is relevant to r&d in CL: the R&D Megaproject. The Fifth Generation Project and also the Centre Mondiale Project in France are long-term efforts that draw upon an international research community. This raises further thoughts about the role of government in r&d in Canada. Should government facilitate participation in international projects, or orchestrate larger research efforts (perhaps on a consortium basis) in Canada?

5. Detrimental Treatment of Software

Software is a flourishing business. In Canada, software sales in 1981 have been estimated at over $300M, a 30% increase over 1980, and a growth rate higher than either the computer hardware or service industries.[11] In the US, the market for software products in 1980 was $2.4B, projected to grow at an average annual rate of 28% to reach $8.4B in 1985.[12] Packaged software for microcomputers is a particular growth area.

Furthermore, software is increasing in importance in relation to hardware. In the past hardware costs generally outweighed costs for software; now, firms with large mainframe computers are spending as much on software and services as they are on hardware, and (though less is known about personal computer software), it has been estimated that the average perscom computer costs $1625 (in the US), while software expenses are $350.[13] The use of software is open-ended--for each new application more software must be generated. In the educational world perhaps more than any other, a library of content cannot be too large.

However, the nature of software has been found troublesome by those in a number of critical institutions: bankers, Revenue Canada officials, grants funding agencies, and border officials, for instance.

Software programs are pure information and so software is an intangible good. It may seem that you hold a piece of software in your hands, concealed underneath the envelope of a floppy diskette, but quite clearly the value of the diskette is what's on it.

People can conceptualize a "good" much more easily if it is something they can touch, and it has been awkward to treat information as a commodity. Consider the following inconsistencies: when software is moved by telecommunications with no tangible form, it crosses borders with no value or duty. If the software program is on cards, again no duty will be charged; but if it is on a magnetic tape, the importer will pay duty--on the tape alone. And if the software is sold at an inclusive price along with hardware, it is charged duty at the same rate as the hardware it accompanies.

Revenue Canada treats software as a taxable asset, and requires that software development costs be capitalized. But software is regarded as an intangible asset by bankers, who prefer to lend money where there is something more solid as collateral.

As a result of its awkward nature, government assistance to develop the software industry has been limited despite software's obvious importance and growth potential. Few programs have funded software firms: Industry Trade and Commerce was for years reluctant to invest in software because it did not fit the traditional framework for funding grants.[14] Tax measures to encourage software development have not been put in place. At best, government development programs have accepted software on the same basis as hardware. At worst, import duties and taxes favour foreign sources of software.[15] And nowhere has policy responded to the financing problems software firms may experience in seeking financing aid.

Several recent reports in Ontario have focussed on the need for measures to promote the software industry, and a 1981 Task Force on Microelectronics recommended that software be accorded a number of tax exemptions, tax credits, accelerated depreciation allowances and other benefits to stimulate the industry.[16] It has also been suggested that these measures may not go far enough in encouraging industry.[17] A number of newly industrialized countries have established innovative measures to nurture software production that could suggest models for Canada. Policy for software development is a new area that requires further attention, especially at the federal level where action has been lacking.

6. Export Marketing Capability

The nature of the products that Canada has exported in the past have not required extensive marketing efforts: 30% are primary commodities and raw material, and

40% are standard fabricated materials.[18] There has been little need to develop high-powered international marketing expertise, or for public sector marketing support to evolve. Also, the US market has dominated our vision, and the sense that international marketing is needed at all is relatively recent. Thus our export marketing capabilities are limited at present.

There are other constraints upon Canadian sallies into international markets. For example, there is a shortage in market intelligence available to Canadian firms. (This could include sales leads for products abroad, information on market conditions and practices, information on sales potential in foreign countries, contact lists for foreign buyers, etc.) Secondly, the small size of many firms limits their participation in large projects except in joint ventures or consortia. These firms also often lack the capital to establish an export base, and they are strained by the documentation and other complexities of international trade.

A further problem lies in poorly developed export financing instruments. Canadian banks have only recently begun to develop expertise in export financing, and private sector trading companies have played a minor role.[19]

Thus, while it is widely acknowledged that the competition in high-tech information industries takes place in an international arena, and that exports are critical to a small-market country like Canada, Canada's export market capabilities at present will be less than adequate in many cases.

7. Shortage of Expertise

Because computer learning activity has been limited in the past (both in the marketplace and in publicly-supported research settings), there are few individuals with expertise in CL.

In the educational world, there is a special problem with the lack of teacher familiarity with microcomputers. This is held to be a major factor that will restrain the use of computers in schools, and the need for teacher training has been emphasized.

More generally, high-level CL expertise is in short supply, and there are few people with skills and experience to author content, to train educators in the uses of computers for learning, to set up infrastructures such as clearinghouses and production centres, to develop new authoring tools, to work on basic research problems, and so on, in all areas critical to the advancement of CL.

The creation of expertise is an important goal in itself as part of CL development, and is a benefit that should be counted in any r&d efforts or exemplary projects that increase the pool of knowledgeable people.

3. Conclusions

The issues discussed in this chapter fall into several categories:

(a) software creation conditions (high cost of content development, shortage of expertise)
(b) market conditions (problems in content supply, incompatibilities)
(c) r&d conditions
(d) conditions of doing business (treatment of software as a product, export marketing capabilities).

Functional problems that limit CL activity itself are immediately felt and have received most attention to date. Authoring tools have been devised to try and reduce the costs of creating applications. Special software is being developed to alleviate incompatibilities, and there is an emphasis in the educational micrcomputer market upon means to organize content supply.

R&d conditions and the conditions of doing business are more general matters which may not immediately affect the ability of the user or supplier to carry out CL. Still their impact on a firm's financial success or failure may be critical. Also, from an industrial development perspective, looking to a longer-term future, r&d must promote advances in the field for future products, and marketing conditions must build stronger export capacities as well. In particular, the demands of export marketing can be difficult for a firm, and policy measures (such as tax benefits, financing aid, and provision of market intelligence) may be needed to stimulate software export. Also, the high front-end costs of creating content software underline the need for financing assistance.

FOOTNOTES: CHAPTER SIX

[1]For example, a provincial ministry of education can obtain a membership in the Minnesota Educational Computing Consortium for about $4000 plus $250 for each participating school division. MECC sends new content to the provincial contact and expects no further reimbursement regardless of use and copying.

[2]Brahan, J.W., et al., "NATAL-74: Concept to Reality" (1980).

[3]Wilkinson, Terry (1982).

[4]The Waterloo approach is to create language translators that can be easily moved or "ported" from machine to machine. Each language translator is adapted to the hardware and operating systems of different machines through a special Interface. With this translator, programs written for one machine can thus be executed unchanged on another system. The ELF system being developed at the University of Alberta's Educational Research Division is also a translator program, to translate code for a target machine.

[5]The Economist, February 20, 1982, p. 87.

[6]The Economist, June 26, 1982 ("The Pitfalls of Trying to Promote Innovation").

[7]Ibid.

[8]Tax conditions vary from province to province. Ontario, for example, allows a sales tax exemption for equipment used by manufacturers for r&d activity. Ontario, Board of Industrial Leadership and Development (Jan. 1981).

[9]Tax shelters for investors are also a possibility, though the experience with this approach in the Canadian film industry (where films may have served tax purposes but flopped as movies), lend a cautionary note.

[10]The Economist, June 26, 1982, p. 96.

[11] Evans Research Corporation, (Mississauga, Ontario).

[12] Ontario Ministry of Industry and Tourism, Microelectronics Background Papers for the Microelectronics Task Force (Ontario: October, 1981), p. 37.

[13] Financial Post, Feb. 27, 1982. It has also been estimated that buyers spend 50% more than the initial system purchase price on software over time. (Globe & Mail, Dec. 11, 1982).

[14] Computer Data, April 1981, p. 34.

[15] Import duty on computer equipment is between 10% to 15%. Added to provincial and federal sales tax, a 35% to 45% burden on equipment costs is experienced in Canada by software producers. Interdepartmental Task Force on Transborder Data Flow (1981).

[16] Ontario Task Force on Microelectronics (1981).

[17] For example, Wills, Russel M., "Softech: A Microelectronics Planning Guide for Ontario," (in preparation).

[18] Ontario, Board of Industrial Leadership and Development (Jan. 1981), ("Technology and Exports: Priorities for Ontario's Growth").

[19] Ibid.

CHAPTER SEVEN POLICY ENVIRONMENT : ACTORS AND ROLES

The policy environment for computer learning in Canada is confusingly intricate, a situation for which two main causes may be found. First, the government actions that impact CL come from two directions: an interest in industrial development on the one hand, and actual use of CL for education and training by public institutions as well.

Secondly, responsibilities for education and training in Canada are split between federal and provincial governments. Education is under provincial jurisdiction, but substantial federal involvement in manpower training exists. In addition, large sums of federal money support higher education, and several federal councils fund university research.

The development of computer learning has not been a pressing issue in the past, and as interest in it awakens it is dispersed among numerous government departments and agencies--federal and provincial, users and industrial planners. The situation is fragmented and cooperation is difficult.

A certain nucleus of interest in CL development has existed for nearly a decade, through the National Research Centre (NRC) in Ottawa. Its Associate Committee on Instructional Technology has involved most of the leading figures in CL over the years. There was also for some time an Educational Technology Branch in the federal Department of Communications, which promoted the development of CL. However, this branch was disbanded some years ago, and the NRC's committee has found little scope for action in its aim to advance CL.

Thus there are three facets to the matter of government policy for computer learning development:

- the use of CL by government institutions;
- support for CL by industrial policy; and
- the need for co-operative planning mechanisms to coordinate among the numerous government players involved.

This chapter introduces the influential government actors in education and training and in industrial development, and describes their respective roles. It also discusses the policy moves made by the provincial ministries of education dealing with the use of microcomputers in schools, which have been the main policy positions taken towards computer learning in Canada to date. Chapter Eight discusses general policy strategies and measures taken to advance CL.

In 1982, one finds that support for computer learning in Canada is weak despite CL's potential from either the educational or the industrial viewpoint. Though microcomputers are being briskly bought in schools, the educational market appears to be an environment where Canadian industry fears to tread, turning instead to training markets. In training, government has yet to become a supportive "catalyst" user of CL. The fact that research and development in CL is scarce stunts the growth of expertise; and while "high-tech" is a byword of industrial development initiatives at present, CL stands in the shadow of higher profile industries.

In general, a curious blindness prevails. On the one hand, policy-makers are struggling with the fact that training in Canada urgently needs to be remodelled, and educators are attempting to meet new demands on the educational system. In both cases new demands for computer-related skills are a major source of strain on old institutions. Yet there is no real vision of the changing needs in education and training, or the ways in which traditions are becoming recast. Nor is there a sense of the ways in which the computer as a learning tool can fit into this transition.

The Players and Their Roles

Exhibit 7-1 illustrates the main areas of government involvement in computer learning. The table is divided in two parts: interest from an educational/training perspective, and from a perspective of industrial development.

Educational and training institutions may use computers because they teach better or more cost-effectively, or because they allow unique things to be done, such as simulations. Schools may also simply want to familiarize students with the use of computers, or they may want to use the computer as an intellectual tool with which a child can build new concepts.

Ideally, from the industrial viewpoint, educational purchasing will occur in a way that fosters Canadian industry and does not only consume foreign products. The industrial goal is to share in the benefits as computers are used in education and training in Canada, and to develop CL products and services for export worldwide. Few people propose that CL hardware and software should be only Canadian; rather, Canadian products should be of international calibre so that exports balance whatever imports occur. An international outlook is also required because of the small market size of Canada.

The list of government actors is also divided into federal and provincial components. The BNA Act and Canadian history have given the provinces virtually full control over education policy, programs and institutions. At the time of confederation in 1867, however, the public responsibility in education consisted only of elementary schooling. (Higher education, to the extent it existed at all, was usually supported by religious organizations.)

Since that time education has grown more complex, and over the decades the federal government became involved in a number of ways. Continuing activity in industrial training began as early as 1910. Secondly, as post-secondary education blossomed in mid-century, it became a substantial burden to the provinces, and a federal funding program began.[1]

EXHIBIT 7-1

GOVERNMENT INTEREST IN CL (COMPUTER LEARNING)

EDUCATION & TRAINING:	FEDERAL GOVERNMENT	PROVINCIAL GOVERNMENTS
ELEMENTARY/ SECONDARY		∘ ministries of education --educational communications authorities --crown corporations dealing with computer supply ∘ CMEC (Council of Ministers of Education, Canada)
POST-SECONDARY	. [non-conditional block grants to the provinces]	. ministries dealing with post-secondary education (varies from province to province)
TRAINING	. Canada Employment and Immigration Commission --funds for training, to industry and institutions . user of training, e.g., the military . SSHRC (Social Sciences and Humanities Research Council) --social research	. ministries dealing with manpower
INDUSTRIAL INTEREST: - industry in general	. Industry, Trade and Commerce *	. ministries for industrial development
- educational technology interest	. National Research Council . Department of Communications . NSERC (National Science and Engineering Research Council)	

*now the Department of Regional and Industrial Expansion

This section deals first with the educational perspective in CL, discussing the roles of ministries and agencies who either set policy for education or who support education and training activities. Most important are:

- provincial ministries of education and the Council of Ministers of Education, Canada
- Canada Employment and Immigration Commission (skills and manpower training)
- federal departments which carry out substantial internal training (such as the military).

The industrial development interest in CL is considered subsequently.

POLICY PLAYERS IN EDUCATION AND TRAINING

i. Provincial Ministries of Education

The various provincial ministries responsible for education[2] have become the most active policy-makers in computer learning in the last few years. Faced with an influx of microcomputers in schools, and with pressure from teachers to organize a chaotic scene in hardware and software supply, the ministries have had to respond. Their actions, however, concern elementary/secondary schooling only; a virtual silence continues to reign on policy or support for CL at post-secondary levels.

Though purchase decisions for microcomputers and software are locally made within school divisions, nonetheless provincial policies to encourage certain purchases and practices can be influential. A variety of moves have been made which are discussed later in this chapter, and which are described in detail in Appendix III. Some approaches are so similar from province to province that cooperation is likely, while in other cases there is almost a polarization in underlying philosophy--for instance, whether to promote Canadian-made hardware or to simply buy US products.

In addition to the provincial ministries themselves, several provinces have educational communications agencies. Primarily such agencies have operated tv or radio broadcasting services, but activity in the area of CL is also possible. In Ontario, for instance, the OECA (Ontario Educational Communications Authority) has a wide mandate for activity in educational communications, including a role in research. Alberta has ACCESS, and in B.C. there is KNOW (the Knowledge Network of the West). Also, in a number of provinces there are crown corporations that supply provincial governments with computer products and services. Such agencies may become involved in procurement for educational computing.

While education in Canada may consist fundamentally of ten different provincial approaches, nonetheless certain issues cross over boundaries, such as satellite communications or mobility for students to move between provinces. CL is one such issue. The development of computer learning calls for planning beyond the provincial level--for courseware sharing from the educator's viewpoint, and for the aggregation of markets from an industrial viewpoint. The sole mechanism in place for coordination among provincial ministries is the Council of Ministers of Education, Canada.

ii. CMEC (Council of Ministers of Education, Canada)

The CMEC was established in 1967, "to provide a means for the fullest possible cooperation among provincial governments in areas of mutual interest and concern in education. . . ."[3]

The Council's history since that time can most optimistically be viewed as a long gestation, during which it has primarily coordinated information---presenting shared provincial views, for example, or producing guidebooks on such topics as metrification. The CMEC has lacked energy. Its decision-making process is slow, and it seems to have skirted such issues as satellite communications and computer learning, rather than embrace them. As a result, there is a sense that the CMEC is not able to deal with areas of rapid development, or act as a problem-solver in contentious areas.

These problems relate to a lack of will, and this could change. A further constraint may be a need to achieve a full consensus. The agreement of all provinces may not always occur, and partial cooperation should also be possible. If, for example, only five provinces want to establish a joint clearinghouse for CL content, the CMEC could nonetheless be useful in getting the project started.

At present, however, a major cooperative project among four provinces (on the indexing of CL material) started up informally, without the CMEC. If it had been piloted through the Council, it would have risked time delays and possible rejection as a low priority item. With some irony, now that it is underway, the project may be brought before the CMEC in later phases. The CMEC is the only formal vehicle for inter-provincial cooperation in education, and as such its weak role is unfortunate for CL.

iii. Federal Contribution to the Education System

Federal support for education occurs mainly at the post-secondary level, and Appendix II describes the federal government's role at some length. The sums involved are substantial: the federal government supports over half the costs of post-secondary education in Canada. This occurs mainly through transfers of funds to the provinces, and through a number of granting councils that support research at universities, as Exhibit 7-2 shows.

The main forms of federal support are the Established Program Financing (EPF) arrangements, which are unconditional block transfers of funds that amount to over $3B. There has been recent controversy over the lack of accountability for these funds: the sums have grown but the provinces' support for post-secondary education has not. A parliamentary task force recommended that the federal role in this area be sharpened.[4] It suggested that an annual report be made to Parliament by the Secretary of State, which would include a report on consultations with the Council of Ministers of Education, Canada on national purposes in post-secondary education. It also advised that a focal point be set up within the federal government to coordinate involvement in post-secondary education. This would include the Secretary of State (responsible for EPF transfers), plus various granting councils which support university research in universities (such as the National Research Council), and also the Employment and Immigration Commission, with its role in skilled manpower training.

iv. Canada Employment and Immigration Commission (CEIC): skilled manpower training

CEIC will spend over $1B on industrial training in Canada over the next year. Its programs work in two ways: first, the CEIC allocates money to industry itself, to encourage training to be done. Secondly, the largest program of the CEIC is the Canada Manpower Training Program (CMPT), which buys "seats" for unemployed individuals in training classes.[5]

EXHIBIT 7-2

FEDERAL EXPENDITURES AND TRANSFERS RELATED TO POST-SECONDARY EDUCATION

University education:	1979-80 (actual)	1980-81 (budgeted)
Operating grants:		
Military colleges	35.1	38.4
Other ministries: operating grants	16.3	17.8
Grants for sponsored research:		
Department of National Defense to military colleges	.7	.8
National Health and Welfare	9.2	1.3
Environment	.8	.8
Natural Sciences and Engineering Research Council	104.0	137.1
Social Sciences and Humanities Research Council	14.6	17.4
Medical Research Council	58.7	72.4
Research grants from other ministries	46.6	42.5
Capital grants	.9	1.0
Scholarship, student aid*	56.1	74.7
Cost of loans to students	47.1	63.0
Other ministerial expenditures	38.3	30.8
Total	428.9	498.0
Transfers to provinces for:		
Post-secondary education (EPF)**	2,775.5	3,074.8
Minority language programs	189.7	205.1
Total transfers	2,965.2	3,279.9

*Scholarships, bursaries, awards, student aid from many federal ministries and agencies.

**See Appendix II.

Source: Parliamentary Task Force on Federal-Provincial Fiscal Arrangements (1981).

Though the federal government supports hundreds of training courses through the CMPT, it does so through provincial intermediaries in a way that reflects the provincial jurisdiction in education. There has generally been no direct way for the federal government to fund training courses, and at times this had made curriculum planning difficult.[6]

Training has become the topic of much discussion in Canada recently.[7] Past training efforts have received sharp criticism:

> Too much of current industrial and institution training in Canada does not lead to related employment, or higher skills, or better jobs, but to continued unemployment and frustration.[8]

And at the same time, there are:

> . . . serious and chronic shortages in many highly-qualified and higher-level industrial skill occupations.[9]

Furthermore, it is expected that as computerization in the workplace changes jobs or displaces workers, an enormous amount of retraining will be required in the coming years.

Thus training has become a policy issue. Various means to stimulate training in industry have been suggested with considerable debate,[10] and the federal government has recently expanded its own role in the support of training.[11]

In 1982, a federal Training Act has been passed to establish a new Training Program in Canada.[12] One original component in this program is a Skills Growth Fund, to provide capital for training facilities for "occupations of national importance" where the development of skills is of special significance. The CEIC can now enter into an agreement with either a province or a non-profit organization, to give financial aid for training facilities--buildings and equipment, initial operating costs, and development of courses as well. This direct role in curriculum development is a change from the past.

In mid-1982, federal and provincial discussions are taking place on the interpretation of the Act. Yet the prospect of these new skills training centres has already prompted interest in the Computer Based Training industries that CEIC could support the use of CBT in a relatively direct manner if it wished.

Thus CBT could be encouraged by federal training policies in two ways: CBT could be favoured in federal programs that fund training within industry, and could also be implemented in skills training centres which use federal funds. More generally, the new Training Act acknowledges that there are serious training problems in Canada and gives the federal government a broader planning role. No matter what mix of federal and provincial agencies are used to deliver training, long-term planning for training could include the use of new technologies such as computer learning to help meet new demands.

v. Government as Trainer

The federal government also spends substantial sums yearly on its own training, within the armed forces and the public service. There is a potential for government to act as a major client for computer-based training, exploiting the computer's strong points such as simulations and reduced learning time, and giving a boost to the Canadian computer learning industry.

In the US, numerous military agencies have played a prominent role in developing computer-based technology such as interactive videodisc, and have supported basic research and advanced developmental projects. Leading expertise has been built up in a number of computer learning firms through military contracts.

In Canada the military is a much more modest institution than in the US, but nonetheless it spends some $600M a year on training. There has been some small-scale experimentation with computer-based training in the Canadian armed forces, but the sole major commercial contract to date was awarded to a US firm.[13] Neither the military, nor the much smaller training divisions in the public service, have supported computer-based training in Canada to any significant degree.

vi. Federal Government Councils

A number of government councils fund research in Canadian universities, and the Social Sciences and Humanities Research Council of Canada (SSHRC) could potentially fund research on educational topics including computer learning.[14] CL proposals, however, are typically unsuitable for SSHRC grants because they appear too technical.

INDUSTRIAL DEVELOPMENT INTEREST

This section discusses the main government parties interested in computer learning from a primarily industrial perspective. These include ministries whose mandate is industrial development, i.e., the federal department of Industry, Trade and Commerce, plus various provincial ministries. The Board of Industrial Leadership and Development (BILD), established as a Cabinet committee in Ontario, is described as the most evolved initiative among the provinces to develop the high-tech sector.

ITC and BILD are interested in high-tech development in general, and within their range of interest computer learning is simply one high-tech industry among others. Among other government players there is a specific interest in educational technology. The National Research Council has a long-standing involvement in CL and is advised by an Associate Committee on Instructional Technology, and the Department of Communications has an interest in computer/communications that has included educational projects.

i. Department of Industry, Trade and Commerce

The federal department concerned with industrial development is Industry, Trade and Commerce.[15] ITS funds a number of programs to aid high-tech industries. The primary program is EDP (Enterprise Development Program) (Exhibit 7-3), which allocates about $35M a year in computer related areas.

The Department also has a Microelectronics Support program, to establish a number of centres across Canada which can provide microelectronics-based support to local industry--undertaking custom chip design, assisting in the use of microelectronics in process control, etc.[16]

It is possible for computer learning to be funded within the parameters of existing ITC programs. The DIPP program could fund CL applications for military use and the EDP program could fund computer learning firms if their purpose in applying for the grant was "innovative" (if, for example, they developed a new technology). And the newly-established STEP program could fund CL firms in a major project with significant effects on the CL industry. Also, by analogy STEP might fund a user of CL technology as it does with CAD/CM. Even the Microelectronics

EXHIBIT 7-3

PROGRAMS TO AID COMPUTER INDUSTRIES

DEPARTMENT OF INDUSTRY, TRADE AND COMMERCE*

Electrical and Electronics Branch

D.I.P.P. Defense Industry Productivity Program

- funds firms in Canada that make products and services for aerospace and defence markets

E.D.P. Enterprise Development Program

- gives assistance to selected firms, primarily to aid manufacturing and processing sectors
- aims to foster innovation in design and development
- focuses on small and medium sized firms, in high-risk projects promising attractive rates of return
- shares up to 50% of project costs or provides insurance on a term loan

S.T.E.P. Support for Technology and Productivity

- gives support for projects with major impacts in the electronics industries
- gives support to users of applied technology (e.g., CAD/CAM--Computer-Aided Manufacturing and Computer-Aided Design)

*Now the Department of Regional Economic and Industrial Expansion

Support Program could potentially support CL--assisting a local firm to use computer-based training, for example.

There are several limitations, however, on ITC support for CL. As Chapter Six discussed, software has tended to be less fundable than hardware, even though the basic capacity for software funding does exist.. Secondly, projects to actually use CL could entail federal/provincial complications because of split responsibilities in education and training. Most fundamentally, CL has simply not been an area of high technology with any priority in the Department. Most of the funds in the program noted above are already earmarked for more favoured firms or industries. While there has been a wave of new proposals to ITC from industry to fund CL projects, CL has yet to stake out a place on the industrial strategy map.

ii. Ontario: The BILD Program

In 1980 the Ontario government established BILD (the Board of Industrial Leadership and Development) as a committee of Cabinet, centred around the Ministry of Economics and the Ministry of Industry and Trade. Six special areas of interest were set out, including technology.[17] In long-term planning for a ten-year period, it was estimated that $1.5B would be needed to reach industrial development goals. $75M was allocated over five years as initial seed money, including $430M for a technology program, to promote r&d, to nurture high-tech companies, and to expand markets.

The BILD program gives Ontario a funding and planning capability focussed on high-tech that is unique among the provinces. BILD also has scope: for example, over $200M is allocated to develop new skills and retrain workers displaced in technological change. In r&d, a new corporation will promote high-tech development and coordinate a number of research centres;[18] nurturance of high-tech firms has begun, assisted by private and federal money; and an International Corporation will market Ontario technology and expertise abroad.[19]

BILD has given considerable attention to computer learning in its first years. It has allocated $3.6M to promote both hardware production and computer learning materials, and also funded an interactive videodisc project. (These projects are described in Appendix III.)

iii. Federal Granting Councils: NRC (National Research Council) and NSERC (Natural Sciences and Engineering Research Council of Canada)

The National Research Council has been involved in CL development for nearly a decade. Of its several projects involving CL, one has stood out with a single purpose: to develop the NATAL authoring language. It is estimated that $12M has been spent on NATAL development, including some $1.5M to $2M through the Program for Industry/Laboratory Projects (PILP). The PILP program is administered by NRC to assist Canadian companies in projects that use resources within government labs. Honeywell Ltd. has worked on the NATAL language and acquired the rights to market NATAL through PILP.

Since 1969, NRC has had an Associate Committee on Instructional Technology. This committee has organized several Symposia on Instructional Technology, and produced occasional papers on such topics as the exchange of courseware. Its stated purposes are to formulate requirements for r&d in instructional technology, to promote interchange of information, to "promote and coordinate research development and applications with the aim of establishing a strong Canadian-based capability," and to encourage standardization of technology to foster the interchange of instructional material.[20] "Instructional technology" can be translated as computer learning, and the associate committee's membership has included the leading figures in CL in Canada.

Most of its activities, however, have focussed on organizing symposia and the dissemination of a small number of documents and newsletters. More forceful roles, in promoting research in CL for example, have failed to develop.

One suggestion made by the Associate Committee has been that a strategic grants program for computer learning be established by another federal granting council, NSERC (Natural Science and Engineering Research Council). NSERC strategic grants support research in Canadian universities for projects on problems "of national concern" whose "success rests on transfer to the user sector of the technology and manpower generated through the program."[21] In 1981-1982 NSERC awarded $21.7M in strategic grants.

To date, however, no such program for CL has been set up, and without a special program, CL project proposals made to NSERC encounter the mirror image of the problem noted earlier with SSHRC. CL projects are not entirely technical, but also have an educational side that makes them inappropriate for an NSERC grant.

SSHRC only funds programs with a social orientation, and finds CL proposals too technical. Without special strategic grants programs, CL will remain unsuitable for either NSERC or SSHRC funding. Joint research between the two councils has been urged, and it has also been recommended that two complementary grants programs be set up to fund CL research.

iv. The Department of Communications (DOC)

The Department of Communications has been connected with computer learning in two ways. The first concerns Telidon. DOC is closely involved in the promotion of Telidon (its own invention), and the advancement of videotex and teletext. Computer learning is one application among others that can be offered by these technologies, and some educational Telidon projects have occurred. Also, the Department is advised on Telidon development by a "Canadian Videotex Consultative Committee," which in turn has a subcommittee on Education. This subcommittee has made a number of recommendations for videotex from an educational perspective (emphasizing the need for interactive networks, for instance).

Several years ago, however, the Department had a more direct involvement in CL. DOC had an Educational Technology Branch and engaged in an extensive policy examination of the use of computers in education. In 1975, this branch published the final report of the "Federal Working Committee on Computer Communications in Education," which dealt with computer learning. This report recommended support for r&d, subsidies for national projects, a program to develop standards for technical compatibility, programs of support for CL in cooperation with provincial authorities, and funding of development projects to foster a competitive CL industry. It also proposed that a government department or agency be assigned a leading role for coordinating federal support for CL r&d--one might suspect this would be the Department itself.

Also in 1975, this Branch produced reports on videodiscs and education, and developed "ed-tech" projects in universities in several provinces. It appears that cooperation with these provinces was achieved. It also appears that lack of funds and/or federal-provincial politics intervened, as the Branch was dissolved shortly after the publication of this set of reports.

Many of the centres in r&d that exist today existed also in 1975, and one can only hypothesize how CL might have advanced with sturdy funding for r&d and developmental projects between 1975 and 1980, when commercial interest in CL picked up. These were years when CL relied on government support.

The Policies of Provincial Ministries Towards Microcomputers in Schools

Among this set of government actors whose policies affect computer learning, only the provincial ministries of education have taken definite policy steps to deal with CL development. Their actions are discussed here briefly, and described in more detail in Appendix III. Exhibit 7-4 provides a summary.

The attention of the provinces in CL is almost exclusively devoted to the elementary/secondary level. Most policy-making has been reactive, in responding to the purchase of micros by schools, while little if any attention is given to post-secondary levels.

To administrators planning for education, the sudden popularity of microcomputers in schools appeared to bring chaos. As the chairman of the Ontario Teachers' Federation put it, by mid-1979:

> . . . we were having a revolution by infiltration with no control or compatibility, no control over software, no provisions for networking, no long term capital cost planning, no long term curriculum development planning, and no long term teacher education and teacher re-education planning. It was simply helter skelter infiltration, but it was indeed a revolution. And it seemed sheer common sense to have an evolution by strategic plan, by critical path approach, rather than the anarchy of infiltration.[22]

Presented with a runaway phenomenon, the provinces have responded with varying strategies. Most have concentrated on the need for organizational mechanisms such as indexes and clearinghouses to deal with problems in content supply. Several provinces have participated in an initial project examining how CL material could be indexed, and are also exploring clearinghouse structures. A clearinghouse would catalogue the material available for different microcomputers and disseminate both information and software.

Secondly, several provinces have devised procurement policies to encourage schools to standardize one particular type of microcomputer and relieve incompatibility problems. There has also been an emphasis on teacher training. Few provinces have plans to actually develop CL material, and only Ontario is planning for CL in terms of stimulating Canadian industry.

EXHIBIT 7-4

PROVINCIAL GOVERNMENT ACTIONS TOWARDS COMPUTER LEARNING (AUGUST 1982)

PROVINCE	R&D	INDEXING, CLEARINGHOUSE, ETC.	TEACHER TRAINING	PROCUREMENT POLICIES	FINANCIAL SUPPORT
B.C.		. indexing project (several provinces participating)* . some MECC** material acquired	KNOW* (educational tv network): course on micro's for educators		. 100 Apples piloted in schools . some exemplary courseware
ALBERTA (3 year Computer Technology Project)	ACCESS (educational communications authority): considering computer-based multi-media training system -electronic communications network	. indexing project* . clearinghouse project: evaluating Math 1-12; exploring means to acquire and distribute content . ACCESS: potential clearinghouse role for post-secondary material	. Inservice project ACCESS: broadcasts aimed at educators; multimedia computer literacy workshop package	. purchase of 1000 Bell&Howell micro's to resell to schools (for standardization)	. discounts for approved and recommended content (40%, 15%) . ACCESS: some CL modules made
SASKATCHEWAN		Saskcomp (crown corporation for computers): provides a MECC membership to schools . could market the content of Saskatchewan authors	. guide to micro's	Saskcomp: stocks and sells Bell & Howell micro's	
MANITOBA	-two small pilot projects	. ministry is an institutional member of MECC . a consortium of school divisions: inservicing, content development and distribution . looking at clearinghouse idea			. Ministry of Education partly funds consortium . Also some content development
ONTARIO	. intelligent videodisc Project . educational micro. . impact of LOGO study OECA (Ontario Educational Communications Authority): Telidon & Educational project; student online database; Telidon downloading	. indexing project* . OECA: developing model of a clearinghouse (using print distribution)	OECA: "Computer Academy" tv broadcasts and correspondence course about microcomputers	. developing functional specs. for educational micro . will possibly make an approved list for CL content as is done for textbooks	- subsidized purchase of approved educational micro - exemplary c/w project $2M to develop learning material - possible crown corporation for content development

EXHIBIT 8-1 (Cont'd)

PROVINCE	*R&D*	*INDEXING, CLEARINGHOUSE, ETC.*	*TEACHER TRAINING*	*PROCUREMENT POLICIES*	*FINANCIAL SUPPORT*
QUEBEC	*doctoral program in Ed. Technology at Concordia: r&d in tele-ed., industrial training*	*. projects to catalogue and evaluate content and build a bank of "didacticiels" (i.e., CL applications)*			*- some support for content development*
MARITIME PROVINCES			*- investigating use of TVO material*		

* *B.C., Alberta, Ontario and Northwest Territories are participating in a project on the indexing and cataloguing of CL material.*

** *Minnesota Educational Computing Consortium. See Appendix III.*

Ontario leads the provinces in the level of support it is giving to CL. In some provinces activity is minimal and several sets of plans have fallen victim to higher cutbacks. Only Alberta has plans as comprehensive as those in Ontario, but Alberta has not stressed industrial development and also the projects in Ontario are further advanced. Efforts include r&d, an "exemplary lessonware" project, tv programs for teachers, and the development of a Canadian Educational Microcomputer (CEM). The BILD industrial development program has allocated $3.6M over two years to CL.

A basic decision in planning for CL is whether to "make or buy" equipment and software. Ontario has decided to try and promote Canadian capabilities in both hardware and software. Other provinces have taken the opposite approach, buying Apples and subscribing to MECC for content. The western provinces have emphasized Apple-derived systems (i.e., either Apple or Bell & Howell units), and MECC content, which is in Apple format. Thus there are two diverging paths: the "buy what is best and available" approach (with emphasis on Apple), and the "develop a Canadian product" approach.

Ontario's plan to promote a Canadian Educational Microcomputer is based on a subsidy to schools, who would receive a larger provincial grant for equipment if they purchase an approved microcomputer.[23] Several Canadian manufacturers have shown interest in meeting the specifications for an approved CEM. One company in particular was formed expressly to make such a micro: CEMCORP set out with the aim to not only become the major beneficiary of the province's granting scheme, but also to produce a worldclass product for export.[24] However, CEMCORP has had problems in its financing and its organizational structure, as it attempted to attract the money and commitment of participants who could see equal or better opportunities in proceeding with a similar CEM of their own. A further problem CEMCORP faces is the highly competitive nature of the microcomputer world, with a myriad of entrepreneurial firms and season competitors.

Ontario has also emphasized content development. A request for proposals served as a form of talent search and identified 57 would-be authors (out of 500 responses), who are now being coached in writing lessonware. There is also talk of a provincial crown corporation for content development.

Finally, Ontario employs a number of participants in CL: OECA for tv programs on computer literacy for teachers; the OISE (one of the few established centres of CL expertise) for content development; and joint planning between the Ministries of Education, the Ministry of Industry, and BILD.

And so a pattern emerges, as Ontario emphasizes hardware and software development and other provinces try to organize and train. The major ventures outside of Ontario (and one in which Ontario was an initiating force) is the indexing and cataloguing project in which several provinces are participating, which could be a forerunner to a clearinghouse.

However, the question arises: what is being organized? What content is to be indexed and used? Most content to date is generally held to be of poor quality. Secondly, without developmental projects (to support the up-front costs of content creation under weak market conditions) it is unlikely that Canadian software will be developed at this time.[25]

If Ontario is a leader in CL, will other provinces cooperate? Quebec as usual is on its own because of language--it will have little interest in sharing clearinghouses with other provinces, for example, and will have to develop its own clearinghouse and probably its own content. Also, the development of microcomputers in education has been slow in Quebec.

In English-speaking provinces, needs will tend to develop in similar ways, and there will be a tendency to support a Canadian hardware product, or use Canadian material. Other provinces would probably buy a CEM if it could compete with other micro's in price and performance, and if good content was available for it. Because different microcomputers are incompatible, content is a major influence in a purchasing choice. The decision to buy a CEM may amount to a comparison between CEM content and MECC--or upon CEM's capability to use both CEM and Apple-format material.

There are some indications of cooperation among the provinces in CL at present--for example, the indexing project that is now underway and that may lead to a clearinghouse. However, there has been no strong mechanism for cooperation and planning among the provinces. Yet, in few cases are policies being pursued as a result of ironclad, conflicting philosophies towards CL. Rather, most policies have been ad hoc, and in all likelihood there is ample ground for cooperation.

The absence of coordinative mechanisms weakens the planning base for CL development, and may weaken CL markets as incompatible systems are put into place. Also, without cooperation, some disagreeable outcomes are possible, if Ontario's development plans succeed: if Ontario's material is good, other provinces may not be able to use it because they have incompatible systems in place. Or if they do use Ontario products they will do so as a passive audience, whereas with cooperation, exchanges of material and shared authoring projects are more likely to occur.

Outcome

There are numerous points of interface between government and CL, as government acts either as educator/trainer or industrial development strategist. But these interfaces have been weak connections. Apart from planning for micro-computers in schools (where provincial ministries have been forced by circumstances to take note of CL), there is little interest in CL on the part of those who either fund projects or who could act as major users of computer learning.

There are more specific problems as well. There are cases where roles are constrained: for instance, though the federal Employment and Immigration Commission funds a great deal of training, it has had no direct role in curriculum development, and encouraging CL would have been difficult even if desired. There have also been weak roles: the Council of Ministers of Education, for example, has not been a forceful organization and the NRC's Associate Committee on Instructional Technology has failed to promote computer learning r&d. And there are also gaps. There is no granting mechanism to support CL projects at this time and CL does not fit the criteria of two main funding councils; nor does it fall within the domain of any federal department, which could either fund projects or promote CL among other policy players.

To a considerable extent these problems reflect the federal/provincial split jurisdiction in education. This is the reason, for instance, that CEIC does not directly arrange training courses though it supports their costs. This is also the reason that there is no federal funding channel for r&d or for special projects in educational technology. The Education Technology Branch that existed within one federal department was disbanded some years ago. In contrast in the US, the federal government also has no jurisdiction in education but nonetheless has had an active role and particularly has supported educational technology, including computer learning r&d.[26]

The indifference to CL also reflects a narrow understanding of major changes occurring now in education and training. Training, and the federal role in training, are in a state of flux and the systems of the past have been criticized as inadequate. How will the widely expected new demands for training be met? Neither training planners nor industrial strategists are thinking about the role that new technology could play (though technology is, in fact, a causal force that is generating new training needs). In schools, the spread of microcomputers is being treated as a peripheral interest that requires some degree of organization, while it is more likely to be a revolution that eventually will change the school system itself. Few planners seem attuned to the perscom market--either the software opportunities that lie there, or the way in which perscoms could fit trends in "continuing education" at post-secondary levels. Meanwhile, as computerization continues, post-secondary education is sleeping, neither preparing needed expertise, nor moving to use new CL technology itself.

Thus there is little sense of the role that computer learning is likely to play within a few years. It is expected that work will be computerized: there are studies of employment impacts, and programs to stimulate industry in office automation, robotics, etc. Is it not likely that learning will be computerized as well? But there is scant attention to CL in the present policy content, and the CL industry finds:

- inattention to CL by high-tech planners and by major potential government users of CL (such as the military or Employment and Immigration)
- a lack of aggregation in provincial education markets, which reflects not only the autonomy of educational institutions but also the absence of coordinating mechanisms
- a blind spot in funding for either computer learning r&d or developmental projects.

Ontario, meanwhile, stands out in some contrast to this overall pattern. Its industrial planning program has given attention to CL hardware and software industry stimulation and to advanced r&d, and planning has occurred to use procurement in schools to develop Canadian industry. While some have criticized Ontario's concentration on microcomputers in schools, nonetheless the province is remarkable for its efforts, given the larger policy environment for CL.

Ontario has combined two major perspectives: that of the user of CL for education and that of the industrial development strategist. As this chapter has shown, on a national level a number of policy players are involved from both these viewpoints. Liason and co-operation are critical. Piecemeal efforts to develop computer learning are not only inefficent; with the incompatibilities that characterize CL today, such efforts may work at cross-purposes.

Thus in the policy environment described here there are several needs in the development of CL:

(a) increased attention to computer learning among government institutions who undertake or set policies for education and training;

(b) increased attention to CL among industrial strategists in government;

(c) improved mechanisms of liason and co-operation to advance CL.

FOOTNOTES: CHAPTER SEVEN

[1]See Appendix II.

[2]See Appendix I.

[3]Council of Ministers of Education, Canada, Liaison, July 1981 (quoting from the "Agreed Memorandum" adopted by the ministers responsible for education in 1967 to establish the Council).

[4]Parliamentary Task Force on Federal Fiscal Arrangements (1981).

[5]These training programs are described in Chapter Four.

[6]If, for example, an institution wants to offer a particular course, and knows informally that the federal government is prepared to support it through seat purchases, unless the provincial training budget can first support the course it will not take place. The province funds the course initially, and when attendance begins it sends a bill to the federal government.

[7]See Canada Employment and Immigration Commission, Task Force on Labour Market Development (1981), and Parliamentary Task Force on Work Opportunities for the 80's (1981).

[8]The Honourable Lloyd Axworthy, paper presented to the federal-provincial Conference on Skills Training for the 1980's (Jan. 11, 1982), p. 30.

[9]Ibid., p. 2.

[10]The measures proposed have included: levy-grant systems, payroll-tax systems, accelerated write-offs for equipment used in training, and levies by industry associations to support training centres. Parliamentary Task Force on Work for the 80's (1981), p. 79; also C.E.I.C., Task Force on Labour Market Development in the 80's (1981), p. 169.

[11] See paper presented by the Honourable Lloyd Axworthy at the Federal-Provincial Conference on Skills Training for the 1980's (Jan. 11, 1982).

[12] Bill C-115, An Act to Establish a National Program for Occupational Training (as passed by the House of Commons, June 22, 1982).

[13] See Chapter 4 on training.

[14] The Science Council of Canada is another federal council, which examines policy issues. It has been interested in computer learning as part of a long-term scrutiny of "The Information Society," and also as part of an interest in Science and Education. It has identified problems in the development of computer learning in the past.

[15] ITC is now being re-organized to combine with certain sections of the Departments of Regional and Economic Expansion and External Affairs, and form a Department of Regional and Industrial Expansion.

[16] Five centres were originally planned, but the number was doubled to establish one centre in each province. Each will now receive $1M over 5 years.

[17] Ontario, BILD, "Building Ontario in the 1980's," (1981).

[18] The IDEA Corporation (Innovatio Development Employment and Advancement) is being established to coordinate r&d development, to promote work on new technology, to increase skilled manpower, and to facilitate use of the technology in industry. IDEA will also coordinate and fund five research centres, including a Microelectronics Development Centre in Ottawa.

[19] Ontario, BILD, "This is what was done in the first year," (1981).

[20] National Research Council (1982).

[21] NSERC (1982).

[22] ECCO, proceedings of the ECCO Working Conference, Dec. 1980 (Des Dixon, chairman of the Ontario Teachers' Federation).

[23] See Appendix III.

[24] CEMCORP is discussed further in Appendix III.

[25] Incompatibilities and copyright problems make the educational market unattractive within Canada (see Chapter Six).

[26] See Appendix IV.

CHAPTER EIGHT POLICY APPROACHES TO COMPUTER LEARNING

This chapter focusses on the strategies and policy mechanisms that can be applied in advancing CL, and also on the question of what should be targetted --particularly stressing the importance of software, which is often neglected while hardware dominates the attention of industrial strategists and other planners. In addition a number of international examples are given of approaches toward CL development.

Strategies in CL Development

There are a large number of policy moves that can be made in CL development, but they can be thought of in terms of a small set of strategies. A policy planner could variously decide to:

i) build up knowledge, cultivating a receptive environment for CL;
ii) organize content supply;
iii) organize the hardware market;
iv) act as a "catalyst user" or major client for CL;
v) fund r&d and exemplary projects;
vi) subsidize either manufacturers, authors, or users of CL;
vii) create supportive conditions of business, through tax conditions, financing assistance, export market support and trade arrangements, etc.

Exhibit 8-1 lists these seven approaches and also categorizes the main policy mechanisms that are associated with them.

The bulk of the actions taken by the provincial governments towards microcomputers in schools have served to *build up knowledge* (e.g.,teacher training), to *organize content supply*, or to *organize the hardware market*. These moves reflect the outlook of teachers, who need information, want help in getting content, and are inconvenienced by incompatibilities between microcomputers. In large part the Ministries are responding to teacher pressure. Only Ontario has combined the educator's viewpoint with industrial development, and has funded r&d, supported exemplary projects and engaged in subsidies (i.e., grants to schools).

Because local school divisions act individually, the ministries' policies are facilitory only. If, for example, standardization of microcomputers was desired to reduce incompatibilities, a ministry could devise procurement policies to encourage schools to make certain choices, and perhaps use subsidies to tip the scales. De facto standards may well emerge, either through market forces alone (--two kinds of operating systems are now becoming dominant, for instance,) or through ministerial influence. Ultimately, however, even in the school system purchase choices are ideosyncratic, based on particular needs and preferences.[1]

While provincial ministries have been most active in CL policy, there are other potential actors in computer learning development. Both C.E.I.C. (Canada Manpower and Immigration Commission) and the military could act as *"catalyst users"* for CL with stimulating effects on the CL industries, applying the features of computer-based training (simulation and reduced training time, flexibility in time and place of training, etc.), to meet their enormous training responsibilities.

Finally, government departments and agencies interested in industrial development (such as Industry, Trade and Commerce, provincial ministries of industry, and NSERC, a federal funding council), could concentrate on the latter set of strategies delineated here: *funding r&d* and *exemplary projects*, engaging in subsidies to nurture high-tech firms, and *creating favourable conditions for business*.

R&d is a virtual necessity in CL given the primitive state of hardware and software development. Long-term r&d must be supported by government, internally or in universities. Because the creation of expertise is an important goal in CL, the university setting is preferable. Meanwhile, short-term r&d is best achieved by tax measures and other incentives that encourage industry to undertake r&d itself. There are difficulties when government tries to pick winners in awarding r&d grants to industry, and furthermore r&d costs are a fraction of the costs of taking a product to commercial success. Industry is best at self-selecting its own r&d projects, and may prefer tax measures to dealing with the red tape of applying for r&d grants.

EXHIBIT 8-1

STRATEGIES IN CL DEVELOPMENT

I BUILD UP KNOWLEDGE	II ORGANIZE CONTENT SUPPLY	III ORGANIZE THE HARDWARE MARKET	IV ACT AS A CATALYST USER	V FUND R&D and EXEMPLARY PROJECTS	VI SUBSIDIZE	VII CREATE SUPPORTIVE CONDITIONS OF BUSINESS
• cultivate a receptive environment for CL: computer literacy, teacher training • establish resource centres	• exemplified by the clearinghouse: solve information problems (document and evaluate content, collect available material, index and catalogue, etc.) • establish licensing arrangements, right-to-copy agreements, etc. • acquire content and/or alleviate copyright problems through such agreements • subscribe to sources of content such as MECC • disseminate software • establish networks for distribution	• amass larger markets through bulk purchasing or procurement policies that encourage schools to buy certain machines • set standards	• purchase and use equipment • develop applications	• demonstrate "proof of concept" • set up exemplary projects • use the Request for Proposal process as a means to stimulate interest in CL	a) give money to produce hardware, software or content (through grants for r&d, exemplary projects, etc.) b) give money to user markets: • grants or special terms for those acquiring hardware, software, or content, or incurring telecommunications costs	• favourable tax conditions • financing aid • export market support • international trade agreements • beneficial treatment of software as a product • accommodating telecommunications policy

Exemplary projects are projects which set up working models that people can use, assess, and improve upon. An example is the Ontario Ministry of Education's venture in exemplary lessonware, where $2M has been allocated to create a pool of excellent material. The National Science Foundation in the US has funded a number of special projects in the past that continued their existence on a commercial or partially-funded basis (such as the CONDUIT clearinghouse for CL content). Exemplary projects have a number of strong points as a strategy in CL development. First, interest in CL can be stimulated among a wide community, by the process of requesting proposals to undertake the project. Secondly, a special project could have hardware, software and content components, thus involving different sectors of industry at the same time. Third, the project builds up expertise. And fourth, a special project is a visible undertaking that builds awareness of CL potential.

Subsidies are possible in many forms. Industrial development departments could give funds to high-tech firms who produce hardware, operational software or the applications themselves. A special program to fund CL projects would mobilize industry interest in this area. Subsidies can also be given to user markets, as the Ontario Ministry of Education has done in extending grants for the purchase of microcomputers in schools. Subsidies for the use of CL through government training programs are also possible. For example, preferential terms could be given to firms using computers to train, through the C.E.I.C. programs that fund training in industry.

The *supportive conditions of business* are perhaps the most important factor in industrial development at present. A major problem in CL industry concerns cash flow, especially when the product is a software application with high up-front development costs. Industry will respond to tax incentives, and to incentives that encourage the development of software in particular. Also, export market capability is an area of considerable weakness in Canada and given the importance of exports in a country of small market size, policy aid in this area can be extremely useful.

The policy choices towards computer learning that have been discussed here can be thought of in three broad categories:

ORGANIZE THE MARKETPLACE	GIVE FINANCIAL SUPPORT	CREATE FAVOURABLE CONDITIONS FOR CL BUSINESS
• *build up knowledge* • *organize content supply* • *organize the hardware market*	• *catalyst use of CL* • *r&d funding grants* • *exemplary projects* • *subsidies: grants to nurture high-tech firms, or support given to user markets*	• *supportive financing and tax conditions* • *encouragement for the software industry* • *encouragement of r&d supported by industry* • *encouragement of expansion into export markets*

As might perhaps be expected, the provincial ministries are concentrating their efforts on solving problems in marketplace conditions, where immediate pressures are felt. The risk that results is that the market will be organized--only to import US products. The quality of CL applications is also a concern.

In the educational environment, among provincial ministries a more forceful position is called for. Financial support should be given to content development for microcomputers and to exemplary projects at the post-secondary level. In training, catalyst users for CL (such as C.E.I.C. or the military) could advance CL in Canada enormously. Finally, industrial development policies should concentrate on creating favourable conditions for CL firms. While long-term r&d in universities must be funded, industrial policies should work not only to subsidize a few firms but rather to set a generally encouraging environment for CL. Policies should in particular provide favourable conditions for software development, and for export trade.

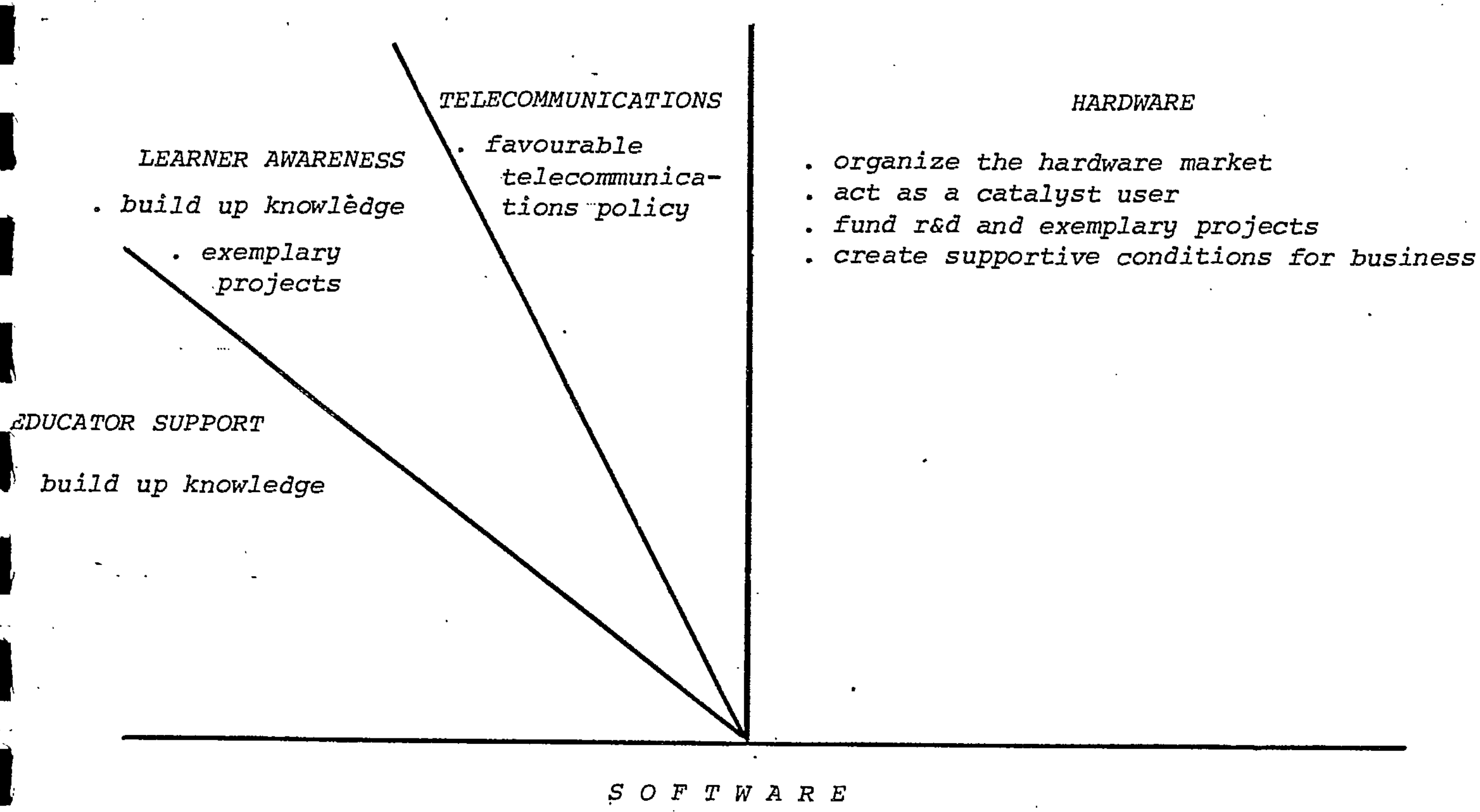
Area of Emphasis

Policy moves taken to encourage computer learning can be aimed at five target areas in CL activity: hardware; software (operational software or CL applications); teacher support; learner awareness; and telecommunications. Exhibit 8-2 lists these five elements in computer learning along with the main policy strategies associated with them. Apart from the attention given to teacher training by provincial ministries, most of the emphasis in computer learning policies falls upon either hardware or software.

EXHIBIT 8-2

AREAS OF EMPHASIS IN COMPUTER LEARNING DEVELOPMENT

and policy strategies associated with them



- APPLICATIONS SOFTWARE

- FACILITORY SOFTWARE
  - -authoring languages
  - -portability software

- organize content supply
- act as a catalyst user
- fund exemplary projects
- fund r&d
- subsidize
- create supportive conditions for business

In almost all aspects of the computer world hardware has dominated the attention of industrial strategists at the expense of software (the recent government development of Telidon being a case in point). Chapter Six discussed a tendency for software to be treated as a product that is second best to hardware, despite the flourishing growth of the software industry. Traditionally, industrial planners have felt that hardware production generated more employment than software. Once the software is written, reproduction requires little manpower, while hardware provided manufacturing sector employment. With automated manufacturing, however, this is no longer the case.

Still, software, because it is an intangible good, remains an awkward product. Though software sales are growing faster than either hardware sales or computer services, the software industry has only recently begun to receive some encouragement in industrial development policies.

Content is the missing component in CL that is most often emphasized. While the hardware market (especially for microcomputers) is highly competitive, there is a dearth of applications in all forms of CL. Furthermore, the purchase of applications is open-ended--more and more software can be bought and used. As hardware costs continue to drop and more customers buy software than write it, one foresees the day when hardware is merely a cheap vehicle for packaged software applications. Furthermore, applications will drive hardware purchases. In industrial training, hardware is acquired to deliver courses, and in schools the availability of good content will influence the choice of microcomputer bought.

Finally, software has export potential, in education, training and consumer markets. A number of applications areas seem promising for export, implemented on microcomputers or on larger computers. Most obviously there is an enormous demand for training in new computer skills: how to use microcomputers, how to use new electronic office equipment, how to write software, etc. It makes sense for this training to be computer-based. In industrial training, there are trends towards "generic" modules which suggest a resale potential for courses developed by a firm for its own training, and also suggest that a packaged software market will emerge as well as microcomputers diffuse. Also, Canada can draw on expertise to create traini[ng] applications in specific areas, such as the use of equipment in the resource industries. There are immense needs internationally, in less industrialized countries, for training in the use of new equipment,[3] and CL could serve as a learning tool.

In the school market, the incompatibilities and copyright problems that fragment software opportunity in Canada are not so crippling in the US market where hundreds of thousands of microcomputers are in place, and there too teachers complain of the lack of good software. Also in the US, the advent of a sizeable market of "perscoms" available for personal use is a near prospect, and a new and unprecedented setting for learning applications will unfold.

It is software, particularly applications software, that should be emphasized in policy to develop CL. In the educational system, the lack of good content has been decried for years. In response, the strategy taken when NATAL development began a decade ago was to develop an authoring language that would enable bountiful and easily-shared content to be made. NATAL has brought forth little content software to date; rather the development of the authoring language became an end in itself that absorbed ten years of attention. Now, the dominant response to the lack of content in schools is to merely organize content supply. Simple, direct support for content development is needed--by provincial ministries funding lessonware, through exemplary projects in post-secondary education and training, and through catalyst users for training such as C.E.I.C.

So far, only Ontario has funded a content development project. Ontario is also endeavouring to foster a Canadian manufacturing capability in hardware by giving schools grants to buy a CEM (Canadian Educational Microcomputer). Some have criticized this effort, arguing that microcomputers are cheap and plentiful and likely to become cheaper still as Japanese firms enter the market. In Taiwan, replicas of Apple computers are sold for a few hundred dollars. It seems that microcomputers are not difficult to make and that they can be manufactured for a very low price. If this is so, why not make them in Canada? The terms of Ontario's support for microcomputers in schools may not be enough for a newcomer like CEMCORP to build upon (i.e., there is no firm commitment that any one type of system will be bought), but some CEM's will probably be made. If many millions of dollars are to be spent by schools in the next few years on microcomputers, and if products that compete in price and performance can be made in Canada, it makes sense for Canadian industry to benefit in some way. The pool of Ontario-made software (or compatibility with additional software makes) may become a selling point that a Canadian product could exploit; the availability of quality software sways many purchase decisions for mircrcomputers today.

The dangers are that schools will be pressured to buy higher-priced products, either because of a "Cadillac" design or because machines simply cannot be made as cheaply in Canada. Britain, for instance, is promoting its ACORN microcomputer but the ACORN is now made in Hong Kong. One may have to re-think what kind of industrial benefits one wants and what is achievable.

Ultimately, however, the emphasis must lie on software. The software industry provides new kinds of jobs while the manufacturing sector is increasingly automated. Software is a flourishing industry with export potential, either through custom-made applications for clients or through packages. While facilitory software is needed in a few key areas (such as portability), applications software is the substance of CL.

International Examples

There are a number of examples worldwide of policy moves taken learning, and several are described in Appendix IV. While these examples are intriguing as comparisons, their relevance to Canada is limited in two ways: the policy environment differs from one country to another and also success in many cases is still unproved. Nonetheless, a few distinctive approaches to CL stand out.

France

France has a kind of monolithic educational system, controlled by the state, in which all teachers are state-employed. Thus long-term and wide-reaching planning can be done.

In pre-microcomputer days, France began an extensive program of teacher training, releasing teachers from school duties for a year to study the use of computers for education. These teachers then worked on courseware projects. Standardized hardware was used, as was a single programming language created by a French post-secondary institution. Now, with the advent of microcomputers, there is an ambitious project to place 10,000 microcomputers in schools. The trained cadre of teachers will be used to educate other teachers about computing, and all microcomputers will be made-in-France. [4]

The French project exemplifies the state-planned approach, whose advantages include the ability to settle compatibility questions by decree and to support indigenous manufacturers.

The success of the microcomputer project remains to be seen. Meanwhile, France has also adopted an international perspective toward computer learning, establishing a World Centre to develop microcomputer technology with a long-term research vision and with emphasis on the educational needs of the Third World.

Japan

Japan has a yet more ambitious long-term research initiative which relates to computer learning, though it is not specific to CL development. The "fifth-generation computer" project aims to create highly advanced artificially intelligent computer systems.[5] The goals envisioned may not be attainable within the time frame that has been set; yet through the r&d effort set in motion, it is believed certain that "windfall" commercial products will result.

Britain

Britain provides an example of what might be called middle-of-the-road state intervention in the development of CL. The government influences industrial development through procurement policies that induce the purchase of certain microcomputer systems--similar to Ontario's plan to encourage schools to buy CEM's (Canadian Educational Microcomputers).

Support is being given to two chosen microcomputer manufacturers through two related plans. First, a BBC tv series on computer literacy includes a new role for the broadcasting agency as a sales representative for the ACORN microcomputer. (The BBC receives a certain per cent of sales revenues.) Secondly, a government subsidy is available to schools who purchase either an ACORN or a second approved British-made microcomputer.

The ACORN, however, while still British, is now made in Hong Kong, where it can be assembled more cheaply. The industrial gains sought by policy have proved somewhat complex. Also, a risk associated with such procurement policies is that schools may be led to buy systems that are not their best choice.

Britain is also remarkable in the area of CL for the NDPCAL, the National Development Program in Computer-Assisted Learning, an initiative which took place during the seventies to stimulate the creation of computer learning courseware. Many of its projects are still in operation years after NDPCAL's end.

U.S.: National Science Foundation

Britain's NDPCAL project is an illustration of the use of exemplary projects, and in the U.S. as well exemplary projects in CL have had success. The NSF (National Science Foundation) has a lengthy history of support for "proof of concept" projects in CL, and provided critical funding for the PLATO, TICCIT, and LOGO systems during the early years of CL. The NSF also established several clearinghouses and educational networks, and more recently has funded interactive videodisc projects.

NSF's activities also provide an example of a federal agency playing a role in education in a country where (similar to the situation in Canada) education is not a federal responsibility. In the U.S, though no federal agency is active in any educational institution, there has nonetheless been substantial federal involvement in educational subjects. This includes the long-standing interest shown by the NSF in computers and education. In addition to funding CL projects, the NSF is particularly interested in computer literacy and in the development of the computer sciences in the educational system.

U.S.: The Military

Another major influence in the development of computer learning in the U.S. has been the military, which has acted as a major user of advanced CL technology. Various military agencies have in particular funded the development of videodisc technology, and helped to build expertise in a number of CL firms. The U.S. military has been the major catalyst user of CL to date.

Also in the U.S., 1982 saw the possibility of a massive give-away of microcomputer systems to schools by microcomputer manufacturers. Proposed changes to the tax act would make it feasible for such donations to be made, and Apple Computer Inc. (which devised the plan) has promised to donate an Apple to each of the 103,000 schools in the U.S., giving an enormous boost to computer learning and computer literacy--and hopefully establishing market dominance for itself.

A few lessons stand out in this set of international examples of initiatives in CL. Exemplary projects have shown considerable success, in the experience of both the U.K. and the U.S. The long-term perspective required for research and for developmental projects is also underlined, in the history of the projects funded by the NSF (which were supported during long years of r&d), and in the long-term projects established recently in Japan and France. The NSF's role in education in the U.S. is also of interest as an example of a federal agency's concern with a certain aspect of education that does not overstep state responsibility for education itself.

In many ways, however, each country's approach is unique to its own political and social environment and it is difficult to draw out implications for Canada. Also the success of the more recent initiatives remains to be seen.

Within Canada, the Department of Communications (DOC) has provided a certain model of industrial development in the high technology area recently, with its Telidon project. The Department "fathered" Telidon technology in its government labs, and has supported it with field trials and other mechanisms (an Industry Investment Stimulation Program, international standards-setting activities, public awareness and conferences, and so on).

The success of Telidon is still uncertain--whether it will flourish at all, or whether if it is successful, Telidon products will be made elsewhere while Canada consoles herself with parental prestige. International competitors (also supported by their respective governments) with budgets that dwarfed the DOC efforts have been one problem; the promotion of hardware at a time when no applications existed was another. Both show some of the risks of the parental approach.

The international examples discussed here have been financially supportive moves to encourage CL (through subsidies, support of teachers to train in and use CL, funding of r&d and exemplary projects, and catalyst use of CL in the case of the US military). Apart from recent initiatives in Ontario, the Canadian scene appears weak by comparison. Provinces have instigated procurement policies for schools without any elements of financial aid, teachers investigate CL on their own initiative, r&d has been weak, and so on.

Rather than only *organize the marketplace* for CL, by facilitating content supply and hardware acquisitions, a strategy of more forceful *financial support* is called for--for content development, to train teachers (through resource centres, scholarships, etc.), for exemplary projects and r&d, and through catalyst use of CL.

Beyond such moves, however, industrial policy should focus upon a third broad set of policy strategies identified here: creating *favourable conditions for CL businesses* themselves. Policy moves include financing assistance (loans under favourable terms to provide cash flow, for instance), tax incentives, and export marketing support. Finally, this chapter has also emphasized the point that software development should particularly be favoured, and no longer treated as second-best to hardware development.

FOOTNOTES: CHAPTER EIGHT

[1]The setting of standards is also criticized because it can immobilize technical development. More emphasis is placed at present on software linkages between incompatible systems.

[2]The development of videotex and teletext in general have been caught in a "chicken and egg" problem: no software applications are being written because no market of hardware is in place, and at the same time no customers want to buy hardware because there is nothing to do with it. Thus Telidon has been called "a technological solution in search of a problem."

[3]Wills, op. cit.

[4]Appendix IV has more details.

[5]See inset on artificial intelligence, Chapter 2, and also Appendix IV.

CHAPTER NINE CONCLUSIONS AND RECOMMENDATIONS*

Canada has held an advanced position in computer learning through the long years when CL existed only as a special interest among a few individuals within the academic world. Now commercially attractive CL markets are evolving in education, training and in consumer markets for informal learning as personal computers spread. Computer learning is becoming a real world phenomenom with promising potential in international markets, and it involves multiple facets of the high technology sector -- hardware manufacturing, software production, telecommunications systems plus assorted consulting services. From an industrial viewpoint, CL is ripe for attention.

CL development has been, and continues to be, closely connected to government and policy. A considerable number of government players impact CL, both from the perspective of actual use of computer learning to teach and train, and from the perspective of industrial development. The policy environment for CL is complex and includes both federal and provincial actors, whose interests are complicated by split responsibilities in education and training.

At present, despite the substantial influence of government, support for CL in Canada is weak, and higher profile industries hold the attention of planners. Also, <u>the substance of CL is software</u>, which has been a lower priority industry, overshadowed by hardware manufacturing. Furthermore, little research and development has been supported in computer learning in Canada -- despite the fact that all major CL systems of today are the fruits of years of research and development, and computer learning at present remains primitive compared to the potential of systems based on artificial intelligence.

* This chapter was co-authored by Russel M. Wills. The authors are grateful to Dr. Dorothy Phillips of the Department of Communications for the use of policy material from Wescom's national evaluation of the Telidon field trials (1983) and to Ontario's Ministry of Industry and Trade for the use of material from "Softech: A Microelectronics Guide" (1982).

Those government departments which undertake training have paid scant attention to CL -- even though pressures for improved training have become acute, and the computer offers certain advantages in many training settings. Lastly, the school market (where the use of microcomputers is rapidly increasing) is problematic, fragmented by incompatibilities and troubled by copyright problems. Teachers bemoan the lack of quality content, but still the market is unattractive to many in the CL community in Canada. Most provincial ministries of education have devised some response to CL, but the policies pursued in most cases have focused on organizing software supply (i.e. through the establishment of clearing houses) and reflect little thought for the long term implications of weak content development, or effects on Canadian industry if extensive importing occurs. In fact, diverging policies between different provinces increase incompatibility problems and make conditions more difficult for would-be Canadian software suppliers.

Finally, industrial development programs to aid CL firms can be expected to quickly bring responses from industry. Industrial development efforts, however, should concentrate on creating favourable conditions for business generally: policies should place less emphasis on awarding grants to select firms than upon establishing a generally supportive environment. The software industry in particular presents certain needs (such as difficulties encountered in seeking financing, for instance[1]), that should be addressed by supportive moves.

It is a broad conclusion of this study that more direct development and export support for CL (in addition to organizational and secondary activity such as teacher training, the indexing of existing material, and so on) is required immediately. More support for actual content creation is called for: quality content is scarce at present and could be sold domestically and exported abroad. Also, without strong content development, the likelihood of evolving into a passive market for U.S.-made material is high.

More active financial support for computer learning is also recommended in several other cases: through "catalyst use" of computer learning by government departments; through grants to universities for long term research and development; and through exemplary projects.

However, it must be noted that CL software and technology are in a relatively early stage of development, and we are only beginning to understand how CL will be used and what kind of markets will evolve. It is impossible to plan with certainty within the frame of references on the status quo. This fact particularly makes selection processes difficult, in funding research and development or exemplary projects, or in awarding grants to specific firms. However, any substantial efforts in CL at this time will build up expertise (an important secondary benefit), and lead to hardware and software improvements. While one cannot second-guess the future, support for specific projects now can mobilize CL resources, while accompanying policies emphasize favourable conditions for industry in general.

A number of specific recommendations for computer learning policy are offered below. A key recommendation presented in this report concerns a need for a co-operative mechanism. Given the number of government actors involved in CL development from the education/training and the industrial viewpoints, the risk of fragmented activity is high. Fragmentation in the case of computer learning implies both disjointed activities and technical incompatibilities which partition the markets for applications software. CL also needs a proponent in the policy environment: a party which can make its case before those departments responsible for tax policy, for instance, and liaise with the various government players whose actions impact CL.

Recommendations

1. Given the policy hiatus in computer learning between the provinces and the federal government and the lack of direct federal influence in this

area, it is recommended that a new governmental branch devoted to computer learning software and hardware be instigated to more immediately deal with the myriad of CL issues discussed in this work. Such a new branch would be most appropriately placed at the Department of Industry, Trade and Commerce or the Department of Communications, but must involve persons with trade and export expertise. If such a branch were placed at Industry, Trade and Commerce, it is important that its role not be a restricted one, limited to concerns of industrial development. Although such development should be the main focus, what is suggested here is a major effort of guardianship and promotion as has occurred with the Telidon and office automation projects. Also, the National Research Council's Associate Committee on Instructional Technology (ACIT) should be strengthened and equipped with full-time resources to become an active player in the development and promotion of computer learning and should liaise with the new government branch devoted to computer learning and training. With its technological expertise in CL, the ACIT should serve an advisory role to the new government branch. Thus, stronger ties with those concerned with industrial development than ACIT has had in the past will be necessary.

At the same time, a NRC committee focused on CL could appropriately administer a grants program for exemplary projects in computer learning and give advice on NSERC and SSHRC grants funding in CL. There is a co-ordinating role to be played as well, where those who are interested can find information relevant to the CL industries -- market information, names of Canadian firms, provincial educational policies, and so on.

2. The government should immediately instigate field trials of CL software and hardware. These trials should occur in government departments and training programs with real needs and should be directed toward the industrial development of the Canadian CL industry.

3. The government departments dealing with industrial development must give greater attention to CL. While some grants could be given to nurture high-tech firms or to support specific research and development projects in industry, emphasis should be placed on creating favourable economic conditions for CL firms generally.

Favourable financing and tax conditions should be promoted, especially for the software industry, and are subsequently detailed. Tax conditions should also promote CL research and development within industry. Federal tax policy is the responsibility of the Department of Finance; nonetheless some party with a specific interest in CL will be required to propose that favourable tax policies be set.

Providing market information is another necessary function -- e.g. studies could be funded on the domestic and international markets for CL, which are poorly understood at this time, particularly training.[2]

The development of export markets should be emphasized, and in particular the educational micro-computer of the CEM Corporation could be used as a vehicle for sales of Canadian training/educational software throughout the newly industrialized countries of the Pacific Rim (whose industries have expressed considerable interest in computer-based training) and elsewhere.

Canada is a small market and is highly permeable to imported products in CL, which must be offset by world-quality exports. A variety of mechanisms can be brought to bear to encourage expansion into export markets -- favourable trade agreements, financing aid, market intelligence, information on how to do business internationally, representatives abroad to provide information and contacts, and so on.

Export potential should also be considered in awarding funding grants to firms. Also, greater attention should be paid to markets outside of the traditional trading patterns of the past (i.e. the U.S.).

4. It is recommended that a Canada-Singapore Institute for educational technology and software by investigated as part of a CL export effort.

Singapore, one of the so-called "miracle countries" of Southeast Asia, serves as a shopping window for technology for millions of Asian people.[3]

Given Canada's excessive market dependence on the U.S. and the need to diversify Canadian exports into regions of the world such as Southeast Asia, it is recommended that the feasibility, costs and benefits of establishing a Singapore Institute for Canadian educational technology and the role it could serve in increased export diversification efforts to this part of the world be examined. Possible benefits which could accrue to Canada from such an Institute involve:

a. greater export diversification for educational/training hardware and software;

b. giving Canada an opening to a large emerging market in an area of the world where we enjoy a favourable ideological and political position; and

c. an improved understanding of CL market opportunities in Asian countries.

5. Government departments which support substantial amounts of training should use CL to deal with increasing training demands, and where CL is used should support Canadian CL industries more vigorously through procurement. In particular, Employment and Immigration, in the new roles created for it by the recent Training Act regarding training in institutions, should use computer-based training. CEIC could also encourage the use of computer-based training within firms themselves, through its programs of support for training in industry.

6. A federal program of support for exemplary projects in CL should be introduced by the new CL government branch proposed in the first recommendation. The federal government has a history of involvement in educational technology, but there is no focal point at present for this interest, nor is there any funding mechanisms to support educational technology projects including computer learning. Projects should take place with provincial co-operation; however, without a federal funding mechanism, such projects seem unlikely to occur. They are most important in the post-secondary setting where there is little activity in CL but where expertise must be built up (in instructional design, authoring, creating advanced CL software, etc.) that can be drawn upon by a growing CL industry.

7. NSERC and SSHRC (Natural Sciences and Engineering Research Council and Social Sciences and Humanities Research Council) should establish strategic grants programs to fund research on AI-based computer learning in universities, and co-operatives projects between the two councils should also be possible. The emphasis should be placed on both a number of short-term needs (in portability of software and authoring systems, for example) and longer term research in artificial intelligence-based computer learning software.

   Given the rapid and current commercial developments in artificial intelligence in the U.S., Japan and other countries, the considerable range of its present and potential industrial and business and CL applications, and the cost savings involved in substituting expert systems for human consultants, it is apparent that Canada must develop expertise in this field.

8. Provincial ministries should emphasize content development projects in both training and education, and not only organize the marketplace for CL. In addition, exemplary projects should also be funded, particularly at post-secondary levels where CL development is weak. Also, where

clearing houses are established to organize content supply, their premises could be expanded to play further roles, such as production centres, resource and information centres, centres for training and demonstrations, and so on.[2]

9. The Council of Ministers of Education Canada (CMEC) is the sole mechanism for co-operation among the provinces and has not played a strong role in the past. Most provinces share similar problems in CL, and though diverging courses are being followed, in most cases the actions taken are coping mechanisms and do not reflect fundamentally opposed positions. There may be considerable ground for co-operation. The CMEC should play a much more energetic role and provide the opportunity for co-operation and co-ordination between any of the provinces who desire it. Any co-ordination in the school market will be helpful to industry.

(We now turn to a more general microelectronics recommendations applicable not merely to CL but to a wide range of services and products in Canada.)

10. An instrument used by several countries is a more flexible taxation system than Canada's to support software and research and development in general. In some countries, e.g. Singapore, 200 percent of reinvestment of any firm's profits in research and development activities are tax-exempt, and before the manufacturing use of any new innovative process, tax exemptions are granted to prototype development and manufacture start-up phases.

It is recommended that Canadian research and development incentives involving CL software and hardware should be extended to cover engineering design and manufacture start-up costs, and firms should also be able to write off costs of training personnel in this area. The amount of exemptions should also be significantly increased, i.e. doubled, so Canadian initiations will be competitive with other nations.

11. Export diversification incentives -- in several countries a series of tax drawbacks have been implemented for firms which export high technology goods and services with a specified percentage of national content. Such a graded drawback scale should be established in Canada, giving priority to exports of CL goods and software/services. Since an intention of such diversification incentives is to enlarge the Canadian CL export market from predominantly the U.S., export incentives in the form of drawbacks and tax exemptions should be region-specific, i.e. they should be higher for Pacific Rim and South American countries.

To further encourage the formation of Canadian CL export consortia, export tax concessions should be granted when CL exports are done by Canadian controlled export consortia.

12. It is further recommended that the government instigate a program of fiscal and taxation incentives for firms which have ongoing investments in the development of CL software products, and in order tc expand domestic and export markets for Canadian producers of CL software and computers it is recommended that the government issue regulations and fiscal incentives which give preference to software services and equipment produced by the Canadian private sector, excluding those cases in which purchase within Canada is considered uneconomical.

13. Since it is in the Canadian national interest to create a CL software market not tied to specific foreign computer manufacturers, given the extent of multi-national penetration of Canadian industry, especially in the informatics areas, it is recommended that computer and software costs be more clearly defined and separated with respect to imports, and that the government adopt regulations which preclude the inclusion of software prices or services on the same import licence with hardware equipment.

14. Given the fact that the Canadian education/training system does not provide sufficient levels of software training, it is necessary to improve the efficiency of Canadian software production. It is thus

recommended that the government rapidly examine the necessary measures to ensure that Canada has sufficient personnel necessary for training in CL software production. Here it is further recommended that the government evaluate the quality of existing software training courses and assess their relationship to the job market, that existing graduate study programs in computer software be maintained and enlarged, and that special incentives be granted to multi-national subsidiaries located in Canada which will engage in sophisticated software training of Canadians. Finally, since many teachers are intimated by computer usage, it is recommended that extensive teacher training be instigated.

15. Since the Canadian software and computer sector is comprised mainly of small and medium sized firms, and these have extreme difficulty in obtaining development financing, especially of software, their capacity to obtain financing must be enhanced. Since it is also almost impossible to establish barriers to physical importation of software produced off-shore, it is recommended that the Canadian government co-operate with funding agencies to ensure that financing is provided for the development of Canadian CL software and serviceware.

This funding should encompass all phases of software manufacturing and also software marketing during its first year.

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In summary, a single agency recommended in (1) should stand out as the central player in computer learning, both to promote technological and industrial development and exports, and also to minimize fragmented activity (which can hinder industry in Canada and increase the likelihood of passive importation of foreign products).

The need is for both a central planning force and a gathering of interests. The failure of co-operative planning results not only in inefficiencies and incompatibilities, but also weakens the progress of the CL industry. It increases the chance that the old patterns of importing ready-made products will be followed as retraining and educational needs finally become urgent and are met piecemeal. Ideally, with co-operative planning, education and training needs could make use of new CL technologies, with major benefit to Canadian firms resulting from world sales.

In the early 1980's the use of computers for learning has become as obvious as their present proliferation in the workplace; the direct and audacious promotion of Canadian capabilities in this area is neither a hand-out or a bail-out, but a perspective toward the future based on common sense.

FOOTNOTES - CHAPTER NINE

1. For example, firms engaged in software development face high up-front development costs, but at the same time find that frequently bankers are uncomfortable with an intangible product. Models in solving cash-flow problems should be explored: through government loan guarantees, export support, preferable terms for loans, specialized funding agencies, etc. Tax conditions can include accelerated depreciation, reduced tax on capital gains and investment tax credits. Several newly industrialized countries provide original examples of policies to stimulate software products, including linkages between tax benefits and export performance.

2. Statistics Canada could be urged to conduct further investigations in the training area, where it has published little information for several years.

3. This country has successfully instigated a development strategy which gives predominance to knowledge-based industries such as computers, software, automatic banking and finance, and engineering/consulting services.

   This strategy is comprised of three factors: progressive industrial taxation incentives for the above types of firms, extensive export support, and manpower development to meet the demands of the new brain industries upon which Singapore is basing her future.

   As part of this latter effort, several co-operative training institutes have been recently set up in Singapore:

   - The Japan-Singapore Institute of Software Technology
   - The German-Singapore Institute of Production Technology
   - The French-Singapore Institute of Electrotechnology.

   These institutes, in addition to training Singaporeans in needed skills, serve as an integral part of trade promotion for the participating countries since if one trains people in the use of specific technical services of software, one may create a future market dependence or preference for these.

APPENDIX I

MINISTRIES RESPONSIBLE FOR EDUCATION

British Columbia	Ministry of Universities, Science and Communications Ministry of Education
Alberta	Education Alberta Advanced Education and Manpower
Saskatchewan	Department of Education Department of Continuing Education
Manitoba	Department of Education
Ontario	Ministry of Education Ministry of Colleges and Universities
Quebec	Ministry of Education
New Brunswick	Department of Education and Continuing Education
Nova Scotia	Department of Education
Prince Edward Island	Department of Education
Newfoundland	Department of Education

APPENDIX II

FEDERAL SUPPORT FOR POST-SECONDARY EDUCATION*

At the time of the BNA Act in 1867, when education was designated a provincial responsibility, post-secondary education hardly existed. By the mid-twentieth century, it had become a substantial financial burden to the provinces.

A 1937 Commission (The Royal Commission on Dominion-Provincial Relations) suggested that despite constitutional restraints, the provinces might welcome federal grants to their universities, and a 1951 Commission (The Royal Commission on National Development in the Arts, Letters and Sciences) supported the idea of federal assistance to universities, in cooperation with provincial governments. The federal government began a program of direct assistance to universities in the year 1951-1952 (amounting to 50¢ per capita in each province).

By this time, the subsidies that universities had been receiving for veteran enrolments had declined, and the grants were welcomed by the universities themselves. However, the plan was less well-received by the provinces, as a recommended intergovernmental process had not been followed. Quebec in particular opposed the grants and directed its institutions to refuse them. A federal-provincial agreement in 1959 settled the issue.

The grants increased over the years until they were replaced in 1967 by the Federal-Provincial Fiscal Arrangements Act. At that time university enrolments were expected to double in the next ten years. The federal government proposed a special arrangement of fiscal transfers to the provinces, based on "foregone tax transfers" (i.e., the government reduces its taxes by a certain amount, enabling the provinces to raise their own taxes by corresponding amounts), plus additional payments. In 1977, the Established Program Financing arrangements (EPF) came into effect. Compensation is based on population plus certain economic indicators, and is made half in cash, and half through a combination of tax transfer and further cash payments. Support varies from province to

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*See Parliamentary Task Force on Federal-Provincial Fiscal Arrangements (1981), pp. 55 ff., for a brief history of the "Evolution of Federal Support of Education in Canada."

province. In Newfoundland, for example, the federal share of funding of post-secondary education operating costs was 84%, and in B.C. it was 54%, while the average for Canada was almost 61%.* (This includes a number of direct payments to institutions and individuals in support of activities.) (See Table .)

Other forms of federal support in post-secondary education include student loan programs, and research funds for universities awarded through several granting councils, such as the National Research Council, the National Sciences and Engineering Research Council (NSERC) and the Social Sciences and Humanities Research Council (SSHRC).

Recently the EPF transfers have come under scrutiny. They are large unconditional transfers to the provinces, and neither the federal government nor Parliament receives an accounting for these transfers. Also, the transfers are made as block funds that also include support for provincial health programs, and no funds are actually earmarked for educational use. It seems that the value of the transfer for post-secondary education has grown faster than provincial support for higher education in recent years.

A 1981 Task Force (on Federal-Provincial Fiscal Arrangements) recommended that block-funding continue, but through a program that was separate from health-care support. It also proposed the establishment of a focal point for the internal coordination of federal programs related to post-secondary education (i.e., Secretary of State for EPF programs, Canada Employment and Immigration Commission for Training, plus the granting councils). A further recommendation urged greater accountability to Parliament, including an annual report which should discuss the results of federal consultations with the provincial ministers (i.e., the Council of Ministers of Education, Canada) on national purposes in education.

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*Ibid.

APPENDIX III

PROVINCIAL POLICIES TOWARDS MICROCOMPUTERS IN SCHOOLS

(AUGUST 1982)

B.C.

B.C.'s most prominent activity in computer learning has been a pilot project using Apple II microcomputers that took place in 1980.

The "Instructional Use of Microcomputers" project was a response by the Ministry of Education to requests by educators that there be some investigation of the potential use of computers in schools. About 100 machines were used, and arrangements were made to use MECC material. In addition some seed money was made available for local development of content. The project report concluded that "the single most critical issue in the use of microcomputers in the schools of B.C. was the acquisition, development and sharing of quality material relevant to the B.C. Curriculum."*

After this pilot project, however, plans within the Ministry of Education for a more extensive role in CL were curtailed by general budget cutbacks.

B.C. is also participating with several provinces in an indexing and cataloguing project for CL content. Work is being done by JEM Research (a B.C.-based firm).** The first phase of this project has been completed, producing a set of guidlines for an indexing system. National distribution is envisaged, though regional centres may later evolve, and a standard indexing format with 26 "format fields" providing information about content is recommended. Guidelines specify capabilities for various output media and keyword search methods. Phase II of the project will design the system itself and accumulate information about available content.

Finally, B.C.'s educational communications authority KNOW (The Knowledge Network of the West), has televised a course on microcomputers for teachers.

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*B.C., Ministry of Education (1981), report 03/81.

**Ontario and Alberta first supported this project. They suggested that other provinces also participate, shouldering a share of the cost. B.C., N.B., and the Northwest Territories responded.

Alberta

In June 1982, the Alberta Ministry of Education began a comprehensive 3-year "Computer Technology Program." Aims include the establishment of hardware standards, information dissemination about CL, coordination of inservicing activities, and clearinghouse functions for content. The program has four components: a clearinghouse (for Apple content only); an Education In-service Project; the creation of an education technology support group within the Ministry of Education; and a Minister's Task Force consisting of a number of "stakeholder" groups to plan where educational computing should be, in five years time.

A clearinghouse project is underway to evaluate math material. If content is highly rated, it will be treated as textbooks are--in a recommended category, 40% of costs will be subsidized; and in an "approved" category, 15% of costs will be supported. Various means to distribute content are also being explored such as sales through the School Book Branch, subscriptions, rental agreements provincial licensing agreements, and/or per pupil annual fees. Alberta was also instrumental in starting the indexing and cataloguing project being done by JEM research. Regarding teacher training, an elementary computer literacy curriculum is being piloted in 1982, and a high school curriculum will follow.

Besides these initiatives, the department of education has bought 1000 Bell and Howell microcomputers which it will resell to schools. Its motives were to advance computing, and to encourage standardization of the Apple format. Some industrial implications were considered--for example, whether a local hardware manufacturing capability could be nurtured. But the small market size in Alberta discouraged this approach.

ACCESS, Alberta's educational communications authority, has also been active in computer learning. It has broadcast a series of programs on microcomputers aimed at educators. ACCESS has also produced a print guide about microcomputers for educators, and has made multimedia Computer Literacy Workshop Packages, introducing computer awareness, illustrating classroom applications, and instructing in authoring (i.e., the use of PASS). ACCESS is also experimenting with videodisc and videotex in interactive training modules (for nursing assistants), and with some modules for teachers. ACCESS is considering a proposal to develop a Computer-Based Multimedia Training System, using advanced videodisc technology, to be used in training centres for a government department. And while the Department of Education plans to set up a clearinghouse for CL school material, ACCESS is considering a clearinghouse role for post-secondary material. Finally, ACCESS is developing an educational communications network for post-secondary institutions that will offer time-shared access to informations, and possibly downloading over telephone lines. ACCESS may also experiment with FM sidebands and satellite.

Saskatchewan

During 1981 the Ministry of Education in Saskatchewan developed plans for action in the area of microcomputer development, such as software support and pilot projects. Expenditures, however, were not approved, as CL was not perceived as a provincial priority in the current economic climate.

Saskcomp, the provincial crown corporation for the supply of computer products and services, has taken a more active role in CL, and has been selling Bell and Howell hardware and software. Bell and Howell machines now dominate in the province (making up about three-quarters of 700 systems). Furthermore, Saskcomp will provide a membership for schools in MECC (Minnesota Educational Computing Consortium, described in Chapter Five), for the acquisition of software packages. Each school division shares a cost in the membership, and Saskcomp acts as a non-profit vehicle, passing on content, making copies, and making revisions as requested by schools. (Each school division participating pays a $1000 fee, which when combined covers the $4000 MECC joining fee, plus MECC fees of $250 per institution, plus copying costs for diskettes). While it is possible that Saskcomp would also market local authors, material has not been economically viable.

Manitoba

A major action of the Manitoba Ministry of Education in CL has been its membership in MECC, absorbing the $4000 MECC joining fee, reproducing MECC content, and passing it on to school divisions (who participate in the system for a $250 fee). However, only a small proportion of the microcomputers in use in Manitoba are Apples: of 500 systems, about 50% are Pets, 30% are Radio Shack, and the remainder are Apples.

Also, the department maintains a centralized computer service for the province that serves both administrative and instructional functions on a cost-per-use basis. Through the efforts of a faculty member at the University of Manitoba who established a consortium of schools to develop CL programs, there are now over 300 programs available for the Cyber mainframe computer in use. These are being converted for Radio Shack microcomputers, and could potentially be moved to other systems also. Both the Ministry of Education and this consortium hire summer students to develop content. In addition, this computer learning consortium will provide inservicing to schools.

Finally, two modest pilot projects are being supported by the Ministry: one will evaluate the effectiveness of Apple and Pet software in a high school math setting; the second is a pilot computer awareness project at elementary-secondary levels.

Ontario

Compared to the other provinces, the Ontario government has both the most evolved and the most ambitious outlook towards CL. Ontario is the only province to have allocated substantial funds to CL development. It is also the only province to face the "make or buy" decision and choose to develop Canadian products and to work with industrial planners to this end. In particular, BILD (the Board of Industrial Leadership and Development, a cabinet committee) has given attention to CL as part of its efforts to support the high technology sector.

The Ministry of Education's educational goals in CL are linked to a philosophy that future industrial prosperity will increasingly be based on the use of computers. From this viewpoint, the long-term payoff of computer learning is a population who knows how to use computers creatively.

The most prominent efforts in computer learning in Ontario are the "Canadian Educational Microcomputer" (CEM) project, and a major content development project. Ontario was also an initiator of the indexing project in which several provinces are now participating (see note in section on "B.C." above). Its other projects include:

- an r&d project on intelligent videodisc (supported by BILD at the Ontario Institute for Studies in Education)
- research on the impacts of LOGO (supported by the Ministry of education)
- consideration of an approved list for CL content. (All textbooks for basic use in a classroom must be approved.)

The efforts in Ontario include several parties:

- The Ministries of Education and colleges and universities;
- BILD (with its perspective on development of the high-tech sector);
- The Ministry of Industry and Trade (itself a member of BILD);
- The OISE (Ontario Institute for Studies in Education), which is a major cente of CL expertise;
- The OECA (The Ontario Educational Communications Authority).

The CEM project

The Ministry of Education's first interest in CL arose from concern about the quality of learning material. It then perceived a likelihood that "offshore" hardware and content would dominate as CL developed, and talks were initiated with the Ministry of Industry and Tourism (now Industry and Trade) to consider the Canadian industrial capabilities in computer learning, and to consider also how the problem of incompatibilities could be dealt with. Subsequently, in 1981, CATA (the Canadian Advanced Technology Association) was asked to develop functional specifications for a Canadian education microcomputer--a CEM. The CEM would be singular in two respects: first, its emphasis on Canadian manufacture, and second the designing of a system specifically for educational use.

The specifications produced were a wide-ranging list of features, including:

- the use of the computer for computer literacy, as a general computer tool, for computer learning, and for communications;
- the use of a family of microcomputers, so that students could use familiar systems as they moved through the grade system, and so that compatibility of software occurs;
- support applications not only for the student-computer interface,

but for peer-group communication among students,

teacher use of the computer for record keeping, report generation, etc.;

- local networks connecting students to the teacher, remote networks where the CEM acts as a terminal connected to a larger computer, and access to videotex and teletext systems;
- a host of additional features, such as videodisc compatibility, special input devices, ability to incorporate technological enhancements, etc.

A revised set of specifications is now being developed. Meanwhile, the Ministry has indicated that a subsidy will be available to schools purchasing a computer that meets the specifications that eventually are set. This subsidy is as follows: provincial grants cover an average of 50% of the costs of the purchase of equipment. (This varies depending on local assessments--in Toronto it may be as low as 20%, and in other places as high as 90%.) However, "extraordinary expenditures" are subsidized at a higher rate, averaging 75%. Microcomputers from an approved list will be supported at the "extraordinary" level.

Several Canadian firms have indicated they would be prepared to produce appropriate CEM's. In addition, a special initiative developed in response to the Ministry's moves: CEMCORP (Canadian Educational Microprocessor Corporation).

CEMCORP hopes to not only be the major beneficiary of the Ministry's grant system, but to successfully manufacture and export a world class microcomputer tailored for educational use. Its efforts to date include cross-country travels to contact Ministries of Education in each province and to identify manufacturing and software resources across Canada. Despite these efforts, industry participation in CEMCORP remains rooted in Ontario, and while provincial ministries are "interested" no other province has stepped forward with the level of commitment to a Canadian product that Ontario has promised. Secondly CEMCORP has engaged in a major effort of research, studying ergonomics, and designing a family of systems specifically for educational use. It is expected that one-third of the development costs of the CEMCORP microcomputer will be spent on basic research. Third, CEMCORP has established a centre at a school in North York which would be its pilot school. It has plans for an "Educational Technology Centre," including a "hall of products," inservice training, demonstrations, etc.

Most of CEMCORP's energy, however, has been absorbed by efforts to organize a corporate structure (first as a limited partnership, and now as a share capital arrangement among participating companies), and to raise initial capital. There have been considerable problems. There is little firm commitment to CEMCORP among participating companies and conditions do not compel a cooperative effort. While CEMCORP could benefit from the Ontario Ministry's grant support scheme, so could any Canadian manufacturer on its own. While CEMCORP could be a favoured part, it has no assured buyers.

Thus firm commitment of participants in CEMCORP has been difficult to achieve. At time of writing, it seems the Electrohome and NABU Manufacturing Corporation (a firm oriented to cable-compatible products) will be major participants.

Educational Learning Materials Project

Using $2M allotted by BILD, the Ministry of Education has initiated a major project to develop exemplary computer learning material. A call for proposals some months ago resulted in over 500 responses. Three criteria were used in evaluation: the content should be exemplary in content, pedagogy, and the use of the computer. Fifty-seven proposals have been accepted. The first phase of development is to design the pedagogy of the applications. The Ministry will play an active role, providing guidance, consulting, etc.

One result of this initiative is that a cadre of authors has been identified. The process has already achieved a kind of talent search, in an area where expertise is scarce.

OECA

OECA pioneered in experimenting with the educational use of videotex and teletext in its Telidon and Education project, and experiments with Telidon continue, using satellite to deliver a Telidon database in one project and also experimenting with downloaded Telidon. OECA is also operating an online database of student guidance information and is developing a model for a clearinghouse of computer information for Ontario teachers that would track developments in hardware, courseware and lessonware, list people active in certain subject areas, etc. Finally, OECA has developed a "Computer Academy" to equip classroom teachers with knowledge about the use of microcomputers. The Academy consists of a series of telecasts, plus printed learning materials including questionnaires. Returned questionnaires are marked by computer. It is hoped that 10,000 teachers will register (beginning in February 1983).

Quebec

Quebec was a pioneer in the development of computer networks linking schools and post-secondary institutions to central computers for administrative purposes. It was found, however, that these administrative uses consumed computer power and that pedagogy could not also be supported.

Thus, though Quebec embraced the computer in the mainframe era, the technology was no put to educational use. Furthermore, Quebec stood firm against some early discussions about cross-Canada computer networks, for fear of loss of identity among its English-speaking counterparts. It also resisted efforts of Control Data to establish PLATO in schools and colleges.

As the microcomputer era developed, it failed to take hold in Quebec education. There are obvious problems in the availability of content, as there is very little appropriate French-language material. Even so, the use of microcomputers is remarkably low: there are only some 400 units in elementary and secondary schools.

The Ministry has undertaken several projects to catalogue and evaluate content, and to build a bank of "didacticiels" (courseware or lessonware). There are also plans to support authors in content development. There has been consideration of bulk purchasing, as has been done with computers for administrative uses. However, hardware standardization is not emphasized and instead the need for software that allows compatibility is stressed. Internal efforts are also being made to assign a more active responsibility in the area of CL.

The Maritime Provinces

The Council of Maritime Ministers of Education and the Council of Maritime

Premiers both have groups or subcommittees with an interest in educational computing. Newfoundland is an Atlantic province as opposed to a Maritime province. However, it is informally kept abreast of the Maritime deliberations on CL.

In one such group, a list of cooperative activities were recommended regarding CL, but no initiatives have yet been taken. Apart from some investigation of the use of OECA's tv broadcasts to familiarize teachers with the use of microcomputers, and an agreement in principle that bulk purchasing is desirable, there is little activity at present.

APPENDIX IV

INTERNATIONAL EXAMPLES OF PUBLIC SECTOR SUPPORT FOR COMPUTER LEARNING

US

The National Science Foundation

In the US, in a way that is similar to the provincial responsibility for education in Canada, responsibility for education rests with individual states. A few states have plunged into educational computing, such as Minnesota (discussed below). Unlike Canada, however, there is considerable federal involvement in educational subjects. Though no federal agency is active in any educational institution, the federal government funds educational technology projects, supports educational tv, examines policy issues in education, sponsors conferences, and so on.

For example, there are House Committees on Education and Labour, and on Science and Technology. The Office of Technology Assessment of the US congress has just completed an assessment of the use of computers in education. The Department of Education has funded educational tv, including popular children's programs. There have been several special commissions on Instructional Technology over the years, and the National Science Foundation has funded a substantial amount of r&d in computer learning. The NSF has a long-standing interest in computer science, and an awareness of computers as a cornerstone in industry and in the society of the future. Its approach in funding projects is to neither compete with the efforts of business and industry, nor to intrude on local responsibility for education, but instead:

> . . . to foster innovation and provide alternative systems for instructional purposes. The foundation's efforts have been aimed at "proof-of-concept" experiments, demonstrations and field tests designed to reduce the uncertainty for the commercial sector and to offer compelling educational evidence to the academic community.*

Some of the seminal projects supported by the NSF include:

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*A. Molnar (1975).

- PLATO, at the University of Illinois;
- TICCIT, at the MITRE Corporation;
- LOGO at M.I.T.; and
- the work of Dr. Patrick Suppes, at Stanford University, in the use of audio and natural language.

All these projects were begun before 1975. More recently there has been a focus on interactive videodisc projects (at the University of Nebraska-Lincoln, at WICAT, Inc., and at Utah State University, among others). Also, there has been a focus on the need for computer literacy and a project has been funded at MECC (described below) to evaluate computer literacy levels. The NSF has also considered the feasibility of a national program for computer literacy.

NSF also had an early interest in computer networks, and supported several regional computing networks. The CONDUIT clearinghouse (described below) was begun with NSF support. Another early project was Project COMPUTE to develop college-level curricula that integrated the use of computers.

MECC - Minnesota Educational Computing Consortium

The MECC is one of the outstanding organizations in computer learning, renowned for its extensive online network, and esteemed for the quality of its content. MECC software has been used in many schools across Canada (and two provinces have taken MECC memberships).

MECC was established in 1975, and its network grew to serve virtually all schools, colleges and educational agencies in the state. 96% of the 1M students in Minnesota have access to 1000 education programs. Applications are developed by MECC staff or culled from the user community (after evaluation by peers and by MECC experts.)

MECC has been based on a timesharing model, whereby terminals access a central computer by telephone lines. Gradually Apple computers have been added in schools. MECC set a standard that advocated the use of Apples, now expanded to also include Atari. Over 1000 Apple II's are in use.

MECC's annual budget was $5.6M in 1981. Special projects, such as a high school course on videodisc, received $300,000. $3.76M is spent on timeshared computing, inservice training, content development and distribution. MECC also has a large grant to develop learning packages that relate to computer literacy.

Recently, with state funding cutbacks, MECC has lost the state subsidization of telecommunication costs that it had in the past. This is likely to place greater emphasis on its supply of software for microcomputers. MECC software is generally considered superior to most commercial products and careful attention is paid to support material and documentation. "Creative Computing" magazine is now marketing MECC packages.

California State University: author stimulation project

California State University has 19 campuses (each with a distinct approach to education), 20,000 faculty members and 300,000 students. A three-year plan has been established, funded with $200,000, to stimulate content development for microcomputers. Apple microcomputers will be used both for authoring (using the PASS authoring system), and for delivery. The goal of the project is to encourage content creation in higher education, and to encourage the sharing of the material that has been made. A pilot proved successful in creating interest in CL among faculty members.

Design for computer learning material will be submitted by faculty or students and reviewed by peers from other campuses. Highly-rated designs will then be ranked by advisory committees according to the need for content in specific areas. Top-ranking designs will be programmed at a CL centre on one campus (at Fresno). The programming will occur with considerable interaction with authors. Institutional and student guides will also be prepared. The completed program and support material will be sent to all 19 campuses for evaluation. The CL programs will also be sold externally, and funds will go to support the project itself (to reimburse the funding foundation, cover programming costs, etc.), and to provide royalties to authors.

County Resource Centres for Teachers

In San Mateo county in California (in the heart of the "silicon valley"), teachers can draw on a county-level resource centre that helps them use microcomputers in schools. The centre has a hardware demonstration area, stocked with equipment lent by suppliers. A library of software allows teachers to sample content packages. Some of this content has been donated to the centre, and is "public domain," and in this case teachers can make a copy or order it by mail . There is also a collection of commercially available content, which teachers can pre-view before purchasing from commercial sources. There is a library of computer-related material as well, and finally some inservice training takes place.

This centre is the largest in California but there are several others, and the government has plans for centres to be set up in 19 regions. There are also a few such centres scattered across the rest of the US, but California appears to be leading in this idea.

CONDUIT - clearinghouse for higher education content

CONDUIT is a non-profit organization that distributes post-secondary educational software. It was originally supported by the NSF when it began in 1971. CONDUIT is now affiliated with the University of Iowa and is still partly funded by NSF.

CONDUIT distributes materials that are typically authored by faculty. Programs submitted are subjected to a selection process that includes a peer review and a technical review. CONDUIT documents the software, provides a student's guide and an instructor's guide, and distributes the package through a catalogue-order system. It publishes two catalogues: one for standard BASIC and Fortran languages and one for microcomputers (including Apple, Radio Shack TRS-80 systems, Commodore Pet, and Atari systems). All software is copyright and reproductions are prohibited. Prices are usually between $35 and $75. 148 packages are offered in numerous disciplines.

MicroSIFT

MicroSIFT is a clearinghouse designed to meet teachers' needs for knowledge and access to instructional computing software. The project began in 1980 at the Northwest Regional Education Laboratory in Portland, Oregon, under a 3-year grant from the federal National Institute for Education. At present courseware evaluations are available through a newsletter, several magazines and the online ERIC database. MicroSIFT has also developed an evaluator's guide, and an online database on Resources in Computer Education is planned for the fall. There is also a technology centre for demonstrations and training that offers workshops for educators to learn about microcomputers.

Learning Parks and Experience Centres

The Capital Children's Museum in Washington, D.C. was set up to offer interesting learning experiences to children. In its Future Centre, it provides an introduction to computers (using equipment donated in 1980 by Atari, Inc.). The Museum offers a weekend computer workshop called CompuPLAY that uses games, graphics and music in unstructured sessions with microcomputers. In its CompuTOTS course young children play educational games that convey simple programming concepts. CompuLAB lets older children explore computer applications (word processing, data analysis, etc.). There are special arrangements for CompuPARTY and CompuGAME that turn the Centre into a game arcade. Finally, teachers can spend day-long seminars at the Centre to understand the use of the computer as a learning tool.

Also in 1980, Sesame Place was established in Pennsylvania as the first in a projected series of learning parks developed by the Children's Television Workshop and Bush Entertainment Corporation. Some initial support came from the Department of Education, through the Children's Television Workshop, but Sesame Park is designed to be a self-supporting commercial venture. For an entrance fee of about $4, it offers a "total learning experience," combining physical activities, science experiments, and computer games, for ages 3-13. Over 70 computers were installed. Familiar Sesame Street characters appear throughout the park.

National Centres for Personal Computers in Education

There have also been proposals in the US for a national centre on microcomputers in education, urged in particular by Ludwig Braun (director of a laboratory for Personal Computers in Education at the State University of New York, Stonybrook). In a bill introduced some years ago by a Congressman from New York, $1M was requested to set up a centre to address the problem of lack of content. National centres would create high quality material, which in turn would encourage schools to use computers. Once the market was established, private publishers could either support or absorb the centres.*

The Technology Education Act: donating of microcomputers to schools

The Technology Education Act of 1982 (H.R. 5573) was the brainchild of Apple Computer, Inc., and was introduced to Congress by a representative from California, the "silicon state." If passed, it would accelerate the use of computers in schools enormously.

The Act would amend the Internal Revenue Code, to encourage manufacturers to donate microcomputers to elementary and secondary schools. The bill would liberalize the charitable deduction for such donations, by allowing the same tax credit that manufacturers receive in contributing scientific equipment for research at colleges and universities. It would also temporarily raise the maximum allowable charitable contribution from 10% to 30% of a corporation's taxable income--to allow Apple to proceed with a massive promised give-away that would amount to a value of between $200M and $300M.

Apple has proposed to donate a computer to each of the nation's schools--a gift of over 103,000 systems. Apple would receive a tax deduction of an estimated $27M. From the Apple point of view, the systems cost a fraction of their retail cost. The firm may be planning a move to new models and donating computers could be a way to clear stock. Most importantly, through this give-away Apple would have achieved a hold on the marketplace that could last for years. Incompatibilities between software now virtually ensure that if a school has one brand of microcomputer, and it buys software for that system, it will then stick with that manufacturer to maximize its software investment.

Other manufacturers, however, are also prepared to respond if the Act is passed. There is a tradition of donation in return for charitable contribution credit: already Commodore Business Machines has donated $15.2M of equipment to schools.

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*J. Botkin (1980).

UK

NDPCAL - author stimulation program

The NDPCAL project was a 5-year computer learning project that began in 1973 funded with £2M. NDPCAL stands for National Development Program in Computer-Assisted Learning. NDPCAL aimed to stimulate CL through development of new courseware. Different universities took on central roles for different subjects, and overall there was an emphasis on the sciences. The NDPCAL ended in December 1977, but some 60%-70% of its projects are still operating in one form or another. Also a significant number of quality CL programs developed are in use and some international exchanges may occur.

BBC Computer Literacy Project

In January 1982 the BBC began a 10-part television series to provide a beginner's guide to microcomputers. The project is part of the BBC's Continuing Education tv division, an educational broadcasting service for the adult population.

Besides the tv series itself there are several other elements in the project. A BBC book has been produced (The Computer Book) and the National Extension College offers a self-instructional course in BASIC programming. Also, viewers have access to a "referral network": over 1000 local college classes and computer clubs form a network to provide hands-on computer experience to the public. And finally a widely-publicized aspect of the project has been the BBC microcomputer.

ACORN Computers Ltd. has made a microcomputer to BBC specifications and the machines are sold through the BBC. The microcomputers cost between £300 and £400, and between February and June 1982 over 20,000 were sold. A teletext receiver is being developed and eventually the BBC could download software through its tv signals. Meanwhile, the ACORN is being made in Hong Kong where manufacturing costs are less.

The BBC project is accompanied by other efforts to promote the educational use of computers in the U.K. The Department of Industry has a "Micros in Schools" plan begun in April 1981. In secondary schools, the government will fund 50% of the purchase of either a BBC microcomputer or another British-made system (Sinclair). Computer learning projects are also occuring through the Department of Education and Science, which has a Microelectronics Education Programme, and the Scottish Microelectronics Development Programme. Britain has also launched IT82, an Information Technology year to create awareness of computers.

FRANCE: 10,000 microcomputers in schools

The French system of education is a monolithic one--all teachers are government employees, from kindergarten to university, and the same curriculum is used in all schools. Computers were introduced in schools in 1970 among 15 to 18-year olds, to be used as a learning tool with emphasis on modelling and simulation.

From 1971 to 1976 a major project in CL took place. 100 secondary school teachers were trained each year in computer sciences at university. (There were usually a thousand applicants.) During training each had to undertake a project involving the pedagogical use of the computer. Also correspondence courses in computer sciences were offered to teachers in secondary education, and some 5000 teachers participated. On return to the classroom after training the workload of these teachers was reduced three to six hours a week, to allow them to form groups and write courseware packages. Their software was evaluated, documented and distributed.

A standard hardware configuration for the use of the computer was defined, consisting of a timeshared minicomputer with 16 terminals sold for $70,000. Two companies were awarded the contract to provide this hardware. It was decided to use a single programming language and the contract to develop this language was awarded to a post-secondary institution.

The outcome of this project was a total of 58 systems installed in schools, a collection of some 500 programs (with thousands of copies of these programs in use), and a cadre of over 600 trained teachers.

Little action was taken at the outset of the microcomputer era after 1975. In 1979, a 5-year plan began to install 10,000 microcomputers in secondary schools over a number of years. The standard programming language is used to make use of existing material. The microcomputers will be compared with the timesharing model. A number of the teachers trained in the earlier project will give seminars to other teachers on the use of the computer in schools.

Centre Mondiale pour le Developpement de la Micro-informatique

In November 1981, the president of the republic of France (Francois Mitterand) announced the allocation of some $18M per year to a world centre for the development of "microinformatique." The project is a brainchild of Jean-Jacques Servan Shrieber, whose recent book Le Defi Mondial (the Global Challenge) emphasized the educational needs of the third world. Third world applicationsaare stressed in planning for the Centre, and international researchers have been sought. Most, however, have come from the US--causing some chagrin among French specialists. Especially preeminent is Dr. Seymour Papert (one of two vice-presidents), who has been joined by several colleagues in LOGO development. Thus LOGO and the philosophy of education underlying it can be expected to be influential in the Centre's research.

The activities of the Centre are threefold: The first is to develop technology, hardware and software, working with industry. A particular aim is to develop a book-sized microcomputer of powerful capacities that would be available at very low cost.

Secondly, there will be pilot projects in the third world on the use of microelectronics. Projects are already planned in Senegal, India and Saudi Arabia. Also, there will be socially-oriented experiments in France, including the use of microelectronics for the young, the elderly, etc. Plans are still in early stages.

There has been little notable activity in Japan in the area of computer learning to date. Some experimentation with the educational use of microcomputers is occurring, (Sakamoto, T., 1981), including applications for teaching English, and Tsukuba University is using microcomputer-videodisc units and has its own videodisc production centre as well.

Japan is remarkable, however, for a long-term computer r&d project which has implications for CL. The Fifth Generation Computer project is a 10-year venture backed by the Ministry of International Trade and Industry (MITI). Another research group, backed by Nippon Telegraph and Telephone, has a similar project. Some $400M has been allotted to MITI's "5G" venture.

The Fifth Generation computer project plans to build a powerful new computer equipped for a more intelligent computer era. Some of its requirements include: inference powers, associative memory, parallel processing, and vastly more powerful logic chips and core memories than are available today. The tools themselves for the project's goals in artificial intelligence will take several years to achieve.

These efforts have been noted as the first major Japanese r&d initiative which is not merely adaptive but which also breaks new ground. Even if some of the project's ambitious objectives are not attained during its timeframe, the galvanization of research efforts is expected to provide lucrative products in any case. A super personal computer, for example, is part of the research agenda.

APPENDIX V SOURCES CONSULTED

Provincial Governments (and Related Organizations)

B.C. Ministry of Education (Bill Tennant, JEM Research)
B.C. Ministry of Education--Post-Secondary Dept. (R. Ferris)
B.C. Ministry of Labour (Sara Menzel)
Education Alberta (Jim Thiessen)
ACCESS (W. Sawchuk)
Saskatchewan Dept. of Education (Bob Arco)
SASKCOMP (George Odegard)
Manitoba Ministry of Education (Duncan McCaig)
Ontario Ministry of Education (Lorne Smith, Doug Penny, Gary Bonner)
Ontario Educational Communications Authority (Peter Bowers, Maria Cioni)
Ontario Institute for Studies in Education (Bill Olivier, Bob McLean)
Ontario Ministry of Industry and Tourism (Keith Revill)
Gouvernement du Québec, Ministère de l'Education (F. Maynard, Louise Dubuc)
P.E.I. Dept. of Education (Tom Rich, Media Committee, Council of Maritime Premiers)

Council of Ministers of Education, Canada (Doug Penny)

Federal Government

Jack Brahan	National Research Council
Capt. J. Belanger	National Defence, Training Development Division
Gordon Betcheraan	Economic Council of Canada
W.E. Cowley	Industry, Trade and Commerce*, Electrical and Electronics Branch
Drew Cameron	Department of Communications
W.C. Edwards	Industry, Trade and Commerce, Electrical and Electronics Branch
Jim Feeley	Department of Communications
Arthur Cordell	Science Council of Canada
Keith Glegg	National Research Council
Dan Henslowe	Canada Employment and Immigration Commission
Pierre Lalonde	Industry, Trade and Commerce, Electrical and Electronics Branch
Dorothy Phillips	Department of Communications
Lou Reeves	Canada Employment and Immigration Commission
Lieut. Griff Richards	National Defence, Training Development Division

Other Governments and Agencies

Neil Barnes	British Broadcasting Corporation, London
Tony Bates	Institute of Educational Technology, The Open University, London
Arthur Melaud	Dept. of Education, Washington
Don Thom	Ministry of State for Science and Technology
Fred Weingarten	Office of Technology Assessment, Congress of the United States, Washington

*now the Department of Regional Industrial Expansion

Companies

Apple Computer, Cupertino Ca. (Joanne Koltnow)
B.C. Telephone Co. (Ron Kellison)
Cablesystems Engineering Ltd., a Rogers Cablesystems subsidiary, Toronto (Roger Keay)
Ceacorp, Toronto (David Fraser, Bob McLean)
Control Data Canada Ltd., Willowdale Ontario (Wendy Hunter)
Electrohome Electronics, Kitchener Ontario (Patrick Anthony)
Homecom (Bill Olivier)
Honeywell Canada, Toronto (Frank Paine)
Honeywell U.S., Los Angeles (Selwyn Brent)
Logo Computer Systems Inc., Pointe-Claire Quebec (Guy Montpetit)
McGraw Hill, Canada (Russ Guest)
Microdesign Ltd., Toronto (Robert Arn)
Nabu Manufacturing Ltd., Ottawa (Maria Cioni, John Hughes)
Softwords, a Division of Press Porcepic, Victoria (David Godfrey)

Academics

James Botkin	(International Centre for Integratilve Studies, New York)
Gary Boyd	Dept. of Communications, Concordia University, Montreal
Michel Cartier	Laboratoire de Telematique, Dept. des communications, Université du Québec à Montréal
Ernie Chang	Computer Sciences, University of Victoria
Steve Hunka	Computing Services, University of Alberta
Everett Rogers	Institute for Communication Research, Stanford University

Other

Barbara Bowen	Logo: The Computer Learning Centre, New York
Gregg Kearsley	Human Resources Research Organization, Washington

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