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ABSTRACT

Designed to provide a starting point for the teacher without computer experience, this booklet deals with both the "how" and the "when" of computers in education. Educational applications described include classroom uses with the student as a passive or an active user and programs for the handicapped; the purpose of computers in education as set forth by Seymour Papert in "Mindstorms"; administrative uses; cataloging computer courseware; in-house production of educational programs; and using the computer to retrieve information and in resource sharing. Also included are a review of ministry activities and discussions of such professional issues as health hazards of video display terminals, teaching styles, staffing, teacher training, copyright, obsolescence, budgeting, career planning, sexism, haves and have nots, and psychological barriers. A brief history of computers is followed by explanations of computer technology, computer logic, and programming languages, with samples and illustrations; a checklist for buying a microcomputer is included. Resources listed include books, periodicals, audiovisual materials, organizations, and continuing education programs. A glossary of computer terms and acronyms is also provided. (MER)

COMPUTERS DON'T BYTE

A Starting Point for Teachers Using Computers

A Resource Booklet
Published by the Professional Development Committee, O.S.S.T.F., 1981

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INTRODUCTION

Seymour Pappert, in his recent book *Mindstorms*, identifies the purpose of the computer in education when he writes:

> "It simply opens new ways for approaching thinking. The cultural assimilation of the computer presence will give rise to a computer literacy. This phrase is often taken as meaning knowing how to program, or knowing about the varied uses made of computers. But true computer literacy is not just knowing how to make use of computers and computational ideas. It is knowing when it is appropriate to do so."

This booklet deals not only with the "how" of computers in education, but also the "when" of computers. It provides a starting point for the teacher who is not familiar with computers. For those classroom teachers with computer experience, the chapters on classroom uses, resources and ministry activities may be most helpful.

> "We currently have a combination of teachers' attitudes based on lack of information which include fear (from lack of knowledge and experience), backlash (from sincere but ill-informed efforts which result in failure), frustration (from a glossy overview at a one day conference with a futuristic approach), narrowmindedness (from a hobbyist practising in the classroom) and conservatism (from concern that there is a computer bandwagon campaign)."
>
> Jim Breadner, Scarborough Board

The computer presence in our real world must be reflected in our educational system. Professional educators must come to grips with the computer and its place in the classroom. Clearly, the computer has had a significant effect on our business world, passing the $4-billion mark in annual revenue. Reduced cost of computers has made their introduction into the classroom possible.

The teaching profession is prone to the excesses which occur after a bandwagon has formed behind some new idea in education. This bandwagon will surely appear for computers (if it has not already begun) just as it formed behind "The New Mathematics" and "The Hall-Dennis Report". It should, however, be pointed out that these movements were exclusively educational in nature, whereas the computer movement is affecting all of society.

The material for this booklet was gathered and put together over the summer of 1981. Computing, by its very nature, is a rapidly changing subject; when computer ideas are placed in print, they are immediately fixed in time. Those readers interested in keeping abreast of current issues will find the chapter on resources most helpful.

EDUCATIONAL APPLICATIONS COMPUTERS IN THE CLASSROOM

CATEGORIES OF USES

I STUDENT AS A PASSIVE USER

- computer assisted instruction
- computer managed instruction
- computer assisted testing
- tutorial dialogue
- drill and practice

II STUDENT AS AN ACTIVE USER

- computer simulations and games
- computer as a display device
- computer for calculations
- word processing
- information retrieval
- computers and music

III USES FOR THE HANDICAPPED

I STUDENT AS A PASSIVE USER

COMPUTER ASSISTED INSTRUCTION (CAI)

The use of the computer to deliver instruction without constant teacher contact has many advantages in the education system.

CAI programs may be written that analyse the students' responses and then present instruction that is most appropriate for the learner's level. Instruction is only given when indicated by performance on pretests. If students are not successful on a unit of work another lesson may be presented using a different teaching method or approach. This contrasts greatly to the Programmed Learning implemented on Teaching Machines using Skinnerian principles in the past.

CAI programs, although very expensive to create due to the labour intensive programming and field testing involved, become inexpensive on a unit basis when many thousands of students use the materials. Some reports claim a cost of 19 cents per student contact hour of instruction.

In the past CAI was perceived as modelling a good teacher. As Pappert points out in *Mindstorms* we always perceive new technology in terms of the old, i.e. Automobiles were "horseless-carriages". The computer can perform functions that the teacher cannot. With the advent of microprocessors, speech synthesis, videodisk and video tape, graphic tablets and light pens, it is possible to do things on CAI that were never possible in the classroom before.

Two American Systems

Many millions of dollars of federal funding have gone into the development of two American CAI systems.

(a) PLATO: this system supported by the University of Illinois at Urbana Illinois allows many hundreds of users to develop, store and share CAI on a central Control Data computer.

(b) TICCIT (Timeshared Interactive Computer Controlled Information Television) is a system developed by the MITRE corporation at Brigham Young University to deliver CAI on small "stand alone" systems.

Local Examples of CAI

Many Ontario colleges of applied Arts and Technology use the CAN/CAI programs developed at OISE and Seneca College for remedial mathematics. Sheridan College has produced a "Micro-Math" series of CAI suitable for Secondary School applications. These programs are available and run on Commodore PET computers. Intermediate Level Mathematics available from OISE is being used in some secondary school systems throughout Ontario. There are terminals at the Lakehead, Scarborough, East York and Toronto Boards of Education. North York, the most ambitious user, has its own mini-computer which supports a terminal in each school as well as a full classroom of 20 terminals at Victoria Park Secondary School.

In the Fall of 1981 a CAI course is to be introduced at Danforth Technical School in Toronto. This unique project employs video tape and video disc technology, controlled by micro computers to present instruction on drill lathe operation. The student population will be both secondary and community college levels as George Brown College runs classes in the same building. University of Western Ontario had developed CAI materials for French language instruction implemented on micro computers.

Advantages

- students progress at their own pace as instruction is presented only when needed
- program responds in a flexible manner to students' responses
- less time is required to complete a course
- mastery of each unit may be required before moving to the next one
- statistics on ongoing student performance may be collected
- cost of instruction is generally lower.

COMPUTER MANAGED INSTRUCTION (CMI)

Computers may be used to keep track of students' progress and marks. This is particularly useful for the large amount of record keeping associated with modular units of instruction, many open plan schools in the U.S. depend on the computer for this purpose

The computer may also prescribe the next unit to be studied based on performance. The Ontario Ministry of Education is using CMI with the Lakehead Project (see Ministry section) OECA will use it in the T.V. Academy (see T.V. Academy section) Wherever the individualization of instruction is attempted the computer can be an invaluable tool

Advantages

- frees teachers from tedious record keeping
- individualized prescriptions promote efficient use of instructional time
- provides immediate feedback
- statistical feedback can be used to identify ineffective curricular units requiring improvement

COMPUTER ASSISTED TESTING (CAT)

Computers have been used for years to mark multiple choice tests. This not only frees the teacher from a repetitive, time consuming task but may also provide statistical information on validity and reliability not available readily through hand marking. Questions may be checked for validity by comparing the results of the upper, middle, and lower third of the class on each question

Computers may also print out a random selection of questions from a stored set. If these questions use numerical parameters their values may be chosen randomly within predefined limits.

e.g. Calculate the force required to accelerate a mass of 8 newtons by 15 meters / second²

The numbers '8' and '15' could change from test to test so no two students get the identical test An answer sheet is printed for each test

The Ontario Instrument Assessment Pool (OIAP) is a collection of questions prepared by the Ministry of Education to test skills prescribed in the Ministry Guidelines. These questions are classified according to identifiable skills. Many subjects have been completed to date including Mathematics, Geography, History and French. The feasibility of "computerizing" these tests is being studied and will in all probability be available in the near future.

Advantages

- frees teachers for 'teaching'
- statistical analysis of tests is possible
- 'review' sheets of test questions are easily generated
- ensures uniformity within a discipline

TUTORIAL DIALOGUE

Many classroom teachers have written this type of program to be used in their classes.

Usually some instruction is presented on one topic using textual as well as graphical display. The computer then tests the student. If certain points are misunderstood the computer may repeat the lesson in a new form. This would consist of a lesson on one topic. Excellent examples in the Geography area have been done by Jo Ann Wilton, Computer Consultant for the Peel Board of Education.

Advantages

- students may 'catch-up' on missed work
- motivation is increased
- students may find this approach easier to understand
- students may be less inhibited when 'communicating' with the computer

DRILL AND PRACTICE

A classroom teacher who has learned how to program usually designs this type of product as a first project. The student is asked a question, and told whether he is correct or not, until a final score is given or the student ends the process. Drill and practice may incorporate some humourous or competitive elements. Many students are motivated to practice skills and reinforce learning through this game playing activity.

Advantages

- easy to produce
- student is given immediate feedback
- no penalty or embarrassment for being wrong
- more time is spent on the drill
- skills are practiced

II Student as an Active User

SIMULATIONS AND GAMES

In Bloom's Taxonomy of Educational Objectives the three highest levels are often difficult to realize in the traditional classroom.

Bloom's Taxonomy:

Major Categories in the Cognitive Domain

- knowledge
- comprehension
- application
- analysis
- synthesis
- evaluation

Through the use of computer simulations the student is put into control of a process for which there is a specific goal or objective. A recent simulation written for micro computers involves the controlling of the Three Mile Island nuclear generating station. The objective of course, is to avoid blowing us up. The convenience of computer simulations is that if we do 'blow up' we can start once again.

The student is actively involved in new thinking processes when running simulations. In a simple game such as *Hammurabi*, the learner, as King, must balance certain variables. His natural resource is grain. He may plant it, store some for food, or buy land with it. The object is to increase the stores of grain without starving the subjects. For many pupils this is the first time they have been confronted with the idea of 'trade-offs' in managing a finite resource.

In *Lemonade Stand* distributed by Apple Computer Company* two students in competition must make decisions related to the business of running a lemonade stand. They must decide how much to spend on advertising, how much to charge, and how much lemonade to make. Their profits depend on a proper balance of their choices. They must also take into account the weather (which changes) and how much free sugar their mothers give them.

Simulations allow the students to build a mental model of the process, they hypothesize, test the hypothesis and test it again. It creates a flexible, creative way of thinking. The analysis of the process, synthesis of a strategy and evaluation of the outcome is a very real exercise when using simulations.

Creative Computing Magazine often publishes simulation games suitable for classroom use. Others, (like *Three Mile Island*) may be purchased from software suppliers. These products for the most part are produced in the United States and therefore have an American cultural bias.

DISPLAY DEVICE

The computer's ability to organize raw data and present the information in the form of graphs, charts and histograms has many applications. Where the learner is required to discover relationships or compare various conditions the visual presentation of an idea can be very powerful. Jo Ann Wilton's Population Pyramid program which runs on the PET* is an excellent example. In this program the student enters the populations and birth and death rates by age groups, for a given country. The computer then calculates and displays a population pyramid for the country. Commercial programs such as VISIGRAM* which runs on the APPLE* computer might be a valuable tool in areas of geographic demography.

Some computers can employ colour instead of 'black and white', others have high resolution graphics, but all computers can be used to do graphs or charts in some manner. Most micro computers can be connected to large TV monitors for full class demonstrations. At Thornlea S.S. in York County, physics students were required to graph their experimental data for the purpose of discovering scientific relationships. Many hours of work, which detracted from the learning experience, were eliminated by using a micro computer to prepare these graphs.

Advantages

- students use computer's power to investigate relationships
- removes tedious calculations required in producing charts
- eliminates tedious drawing of charts
- data may be reorganized easily to produce other graphs

CALCULATIONS

The drudgery of repetitive calculations may preclude the teaching of certain topics or may mask the more important conceptual objectives of the activity. Certain areas have been eliminated from our traditional curriculum due to requirements for complicated or advanced mathematics. When computers are programmed to perform these tasks the student may concentrate on the underlying purpose of the exercise. Learning activities which were, in the past, denied to our students may now be made available. In many cases the greatest areas of application could be for the general level student who may lack the more sophisticated mathematical skills or the patience to carry through laborious calculations. Where the results of the calculations are more important than the process itself the computer is an invaluable aid. For Family Studies we can use an "Amortization Table" program to show students the real cost of borrowing or calculate diet requirements for weight loss

Advantages

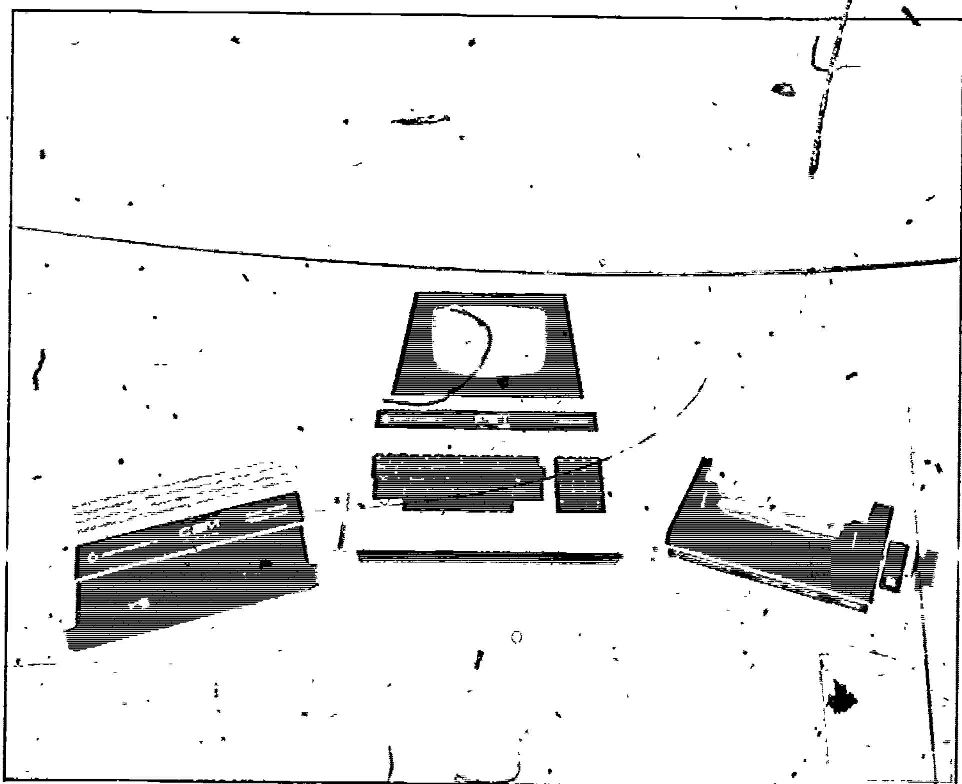
- students actively use the computer power
- students cut through the drudgery to the underlying ideas
- students learn how to apply computer power across the curriculum

WORD AND TEXTUAL PROCESSING

In addition to the training of secretarial skills, word processors can be used in many areas that require the use of writing skills.

Students do not have the patience, skills or desire to create many drafts of written material. In many cases an essay is written once, then handed in.

A typical word processing configuration: Disc drive, computer and printer.



An important writing skill is the reworking of initial ideas into a finished product. Through the use of word processors the retyping is done by the computer allowing the student to concentrate on the writing skills and not the mechanical drudgery.

Another use of the computer is to evaluate the reading level of written text. The student types in a sample of his written work and the computer analyzes and gives him the level of his product. This can also be used by the teacher to test materials to ensure their suitability to the students.

Advantages

- eliminates the drudgery of writing and rewriting
- allows students to concentrate on the creative aspects of writing
- students learn the technical skills of word processing
- products need not be deemed "right" or "wrong" but may be "fixable" or "non-fixable"

INFORMATION RETRIEVAL AND STORAGE -

Large information systems exist and are being used by business and industry. To develop the skills required to deal with this information explosion we must expose our students to experiences which require the searching and retrieval of information.

Systems which exist and may be used in a library setting include PRECIS, UTLAS, INFOGLOBE, ORBIT or DIALOGUE. Systems employed in a Guidance setting include SGIS; this Ontario based student guidance information system is used to aid students in obtaining job descriptions and personal and educational requirements of careers. CHOICES, is a system developed and used by Manpower and schools in provinces other than Ontario. It allows the user to carry on a "conversation" with the computer narrowing his choice of employment by specifying education, salary requirements and geographic area. The computer then supplies a list of careers which fit the user's requirements.

Advantages

- opens vast amounts of information to student
- teaches important skills not otherwise possible
- provides current information

COMPUTERS AND MUSIC

Many microcomputers being produced today such as ATARI, TRS-80 and Commodore's new VIC give the user music-making ability. Programs are available, or can be written for the PET or APPLE to provide the same feature.

Some of the computers allow multiple 'voices', meaning more than one note can be played simultaneously allowing the user to build up to four part harmony, or more.

Writing music on a microcomputer is much the same as producing text on a word processor. Once written it can be reworked and changed.

Programs have been developed which can test or drill a student's "ear" for music. Many activities such as;

(a) hear a note and state its pitch, e.g. "B flat"

(b) hear a phrase and repeat it by typing it in

(c) hear two notes, state whether the second was higher, lower, or the same as the first.

can easily be produced to aid students.

The computer may also display the notes on a scale as they are played. This allows a second form of communication for those who may not "hear" differences in notes or phrases. This technique can be used by the classroom teacher as an alternative to the piano for demonstrations. Sterling Beckwith, of York University, headed a project funded by the Ministry of Education, investigating the use of LOGO as a language to manipulate music and hence develop students' thinking abilities about and through the use of music. The music capability of the microcomputer cannot only be used in developing music skills, but can be used by programmers to provide another level of output communication in their programs.

Advantages

- students can practice music composition even if they lack skills on an instrument
- drill and practice for ear training is available
- music theory may be displayed in another form

III Computers and the Handicapped

Computer technology has enabled people with speaking, writing or visual handicaps to communicate at a level that would have been considered miraculous only a few years ago.

The Kurzwiel reading machine is an invaluable aid to the visually handicapped. This machine, about the size of a medium photocopier, uses laser and computer technology to "read" type-written material. It scans each line of print and then translates each letter into an English phonetic sound These sounds are then "spoken" by a voice synthesizer.

Few individuals can afford the $35,000 cost of the machine, but many institutions such as the CNIB and York University have purchased them for their visually handicapped students. New developments also include computer terminals which "speak" each letter as it is typed so that blind programmers can become more productive. This is much more efficient than terminals which type Braille symbols only. The Canadian Wheat Board hopes to purchase 25 such machines for its blind programmers.

Another recent innovation is the use of a microcomputer and speech synthesizers with a Bliss symbol board. Bliss symbols are a collection of characters each standing for a word or simple idea. People with communication handicaps can express ideas by pointing to, or otherwise displaying, a combination of the symbols.

With a keyboard composed of Bliss symbols connected to a microcomputer and speech synthesizer, ideas can be recorded in the computer's memory and 'verbalized' on command. At the Ontario Crippled Children's Centre, Brian Wilson is working with APPLE computers and the Bliss symbols. A similar project at the University of Manitoba uses TRS-80 microcomputers and speech synthesizer for the teaching of math and language skills to physically and mentally handicapped children.

Many schools in Ontario have developed their own materials for use with trainable retarded children. The computer is an excellent medium to present instruction. It is infinitely patient, it can provide simple repetitive drill without a loss of interest. Bob Drake of the Brant County School Board has used simple arithmetic drill programs written for the PET microcomputer with these handicapped students.

Carlton University and the National Research Council are investigating the use of computers to aid in the training of retarded children at the Rideau Mental Health Unit in Smiths Falls.

At Langstaff Secondary School in York County, Barb Kirkegaard has conducted a project funded by the Summer Canada 1981 Student Employment Project. She employed six people—two University psychology students, two high school computer science students and two cerebral palsy handicapped students—for the purpose of investigating and developing programs for the use of the handicapped in Secondary School. The products developed included mathematics activities which aid in the understanding of graphical concepts, text editing to aid the physically handicapped in keeping notes (the modern three-ring binder), and speech training to aid in the developing of syntax and sentence structure for adolescents who never were able to practice these skills before.

For people handicapped in a physical sense the computer is a tool which can "free their trapped intelligence". If schools are to teach the handicapped and provide them with opportunities equal to the non-handicapped the computer will become an invaluable aid in the process.

THE FORWARD LOOK: SEYMOUR PAPPERT'S 'MINDSTORMS'

> **"For me, the phrase 'comput[illegible]ncil' evokes the kind of uses I imagine children of the fut[illegible]f computers. Pencils are used for scribbling as well as wri[illegible]ing as well as drawing, for illicit notes as well as for official assignments."**
>
> S. Pappert. *Mindstorms* . . . p. 210

Pappert views the computer as a concrete learning tool which enables young students to build powerful ideas Like Piaget, Pappert believes that children are the builders of their own intellectual structures. However, he differs from Piaget by claiming that the use of appropriate learning materials and learning models is more important in intellectual development than the complexity of the idea itself. Computers provide excellent concrete learning models capable of sparking the learning process in new ways.

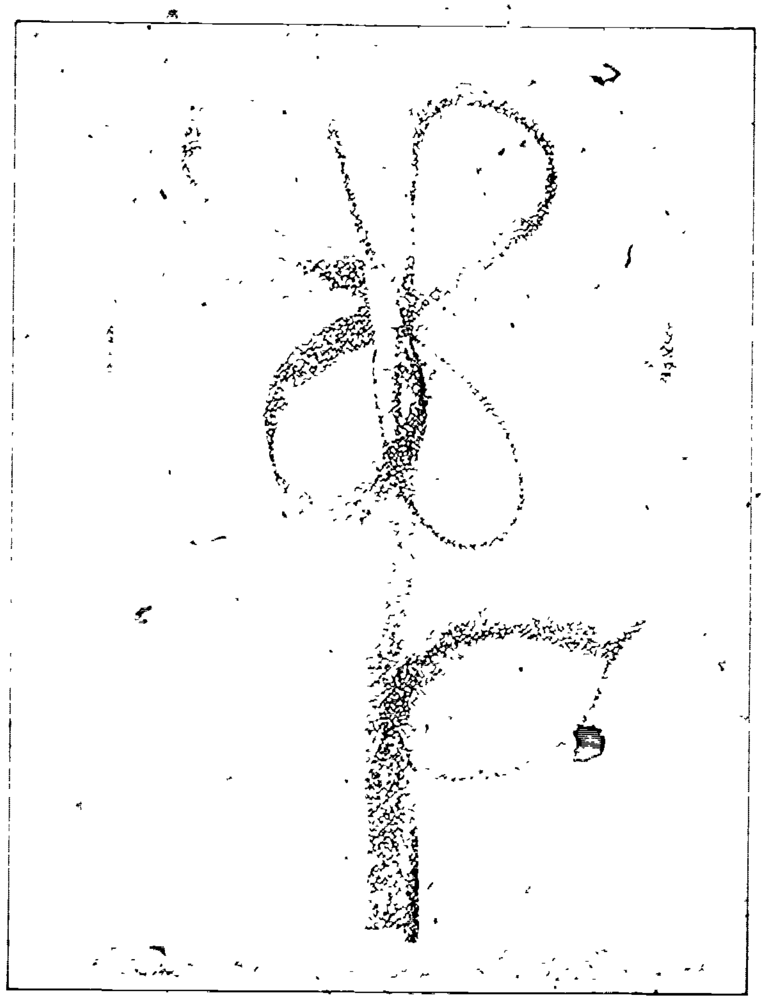
Pappert's development of 'Turtle' geometry in the LOGO project at the Massachusetts Institute of Technology seems to prove his hypothesis that children can conceptualize at a higher level with the aid of computers. A turtle is a round robot equipped with wheels, a light, bells, and a pencil. It is controlled by a computer and can be programmed to move any distance in any direction. LOGO, a simple language developed specifically for young children, is used to program geometric patterns on the floor. In this process, the children are building an intellectual structure for the concept of mathematical variables. It is a demanding process

- They **create their own task** or problem which they consider significant, determine their own approach to the solution, and then use a simple programming language called LOGO to solve it. The process of learning rather than the answer becomes the dominant activity in this kind of computer education
- **Step-by-step planning** and hierarchical organization are essential processes.
- **Solutions** are judged as neither 'right' nor 'wrong' but as 'fixable' or not 'fixable'
- **Fixing or 'debugging'** the program becomes a crucial skill transferable to almost any problem area
- This kind of computer education also requires **communication skills** students must give clear instructions in their programs and learn to comprehend the computer diagnostics.

The following example of how a young child built a garden in gradual stages from quarter circles, illustrates the process Pappert hopes to achieve at many educational levels.

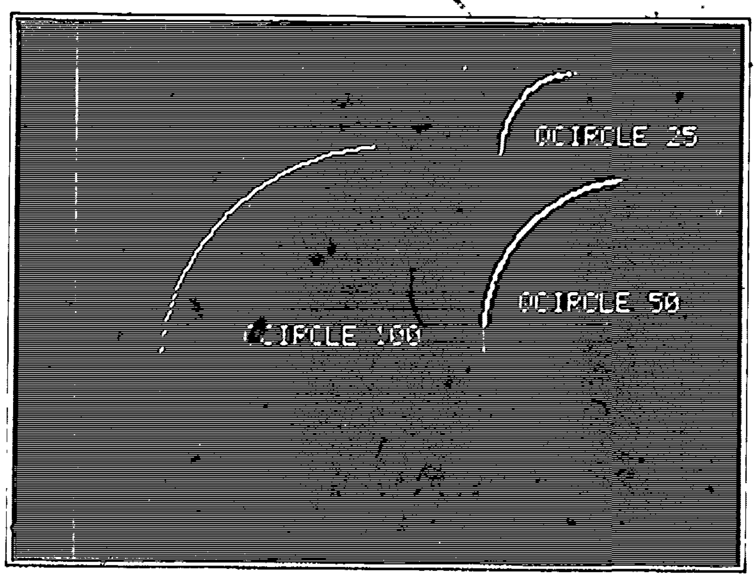
A PLAN

—Let's make the computer draw a flower like this



FIND RESOURCES

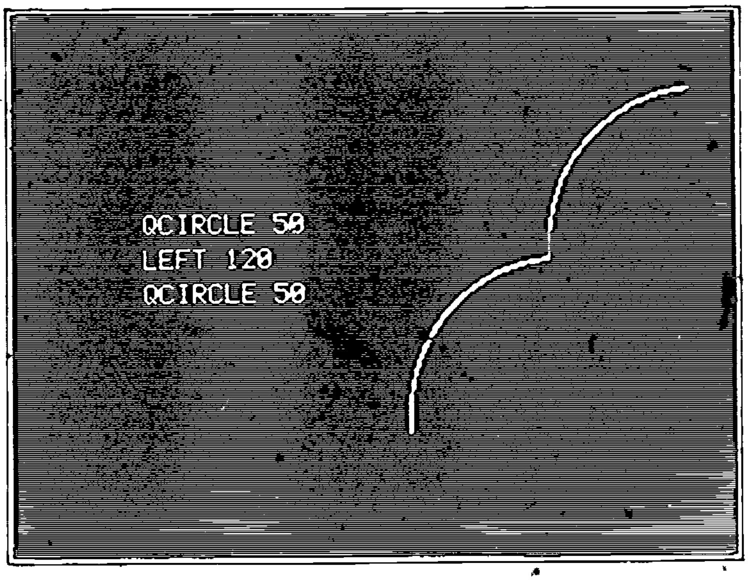
—Do you have any programs we could use?
—Yes, there's that quarter circle thing I made last week
—Show me



—It draws quarter circles starting wherever the turtle is
—It needs an input to tell it how big

FIX THE BUG

—We have to turn the Turtle between QCIRCLES
—Try 120°
—OK, that worked for triangles
—And let's hide the Turtle by typing HIDETURTLE

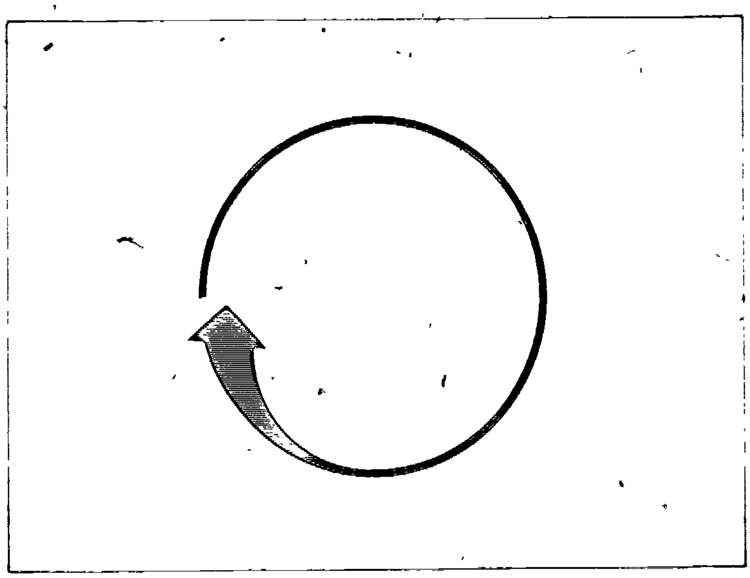


IT'S A BIRD!

—What's going on?
—Try a right turn

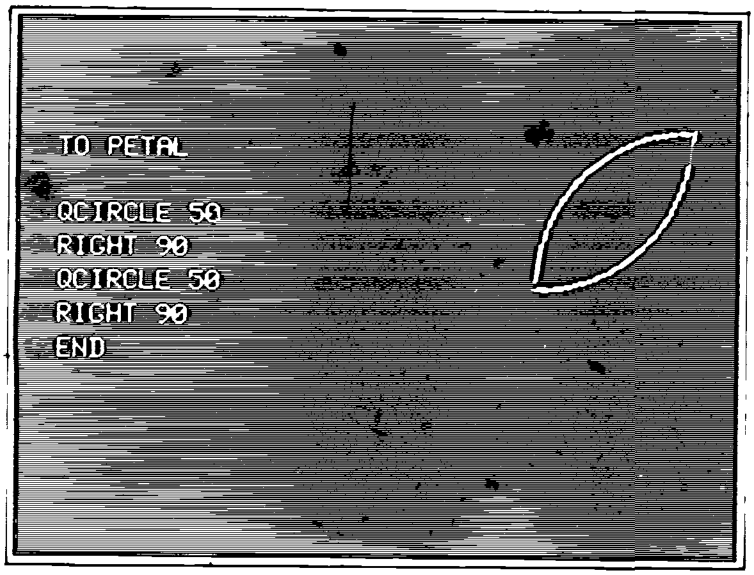
MATH TO THE RESCUE

—Do you know about the Total Turtle Trip Theorem? You think about the Turtle going all around the petal and add up all the turns 360°

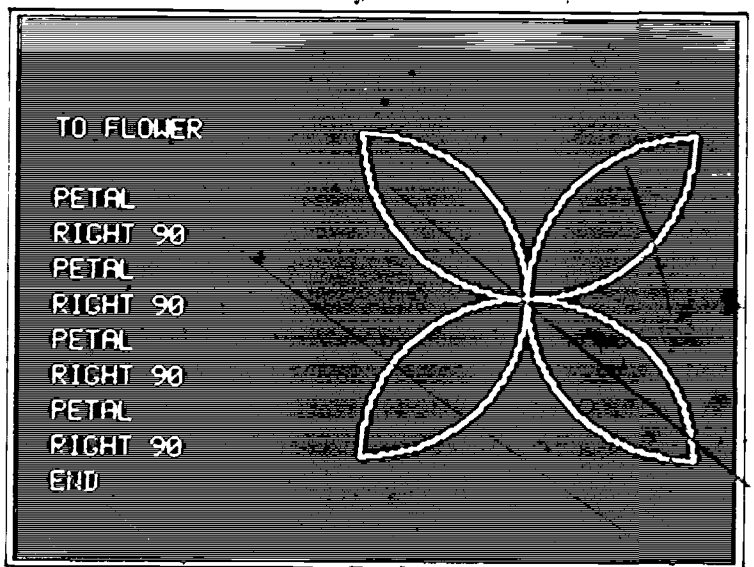


—All around is 360
—Each QCIRCLE turns it 90 That makes 180 for two QCIRCLES
—360 altogether Take away 180 for the QCIRCLES That leaves 180 for the pointy parts 90 each
—So we should do RIGHT 90 at each point
—Let's try

A WORKING PROCEDURE



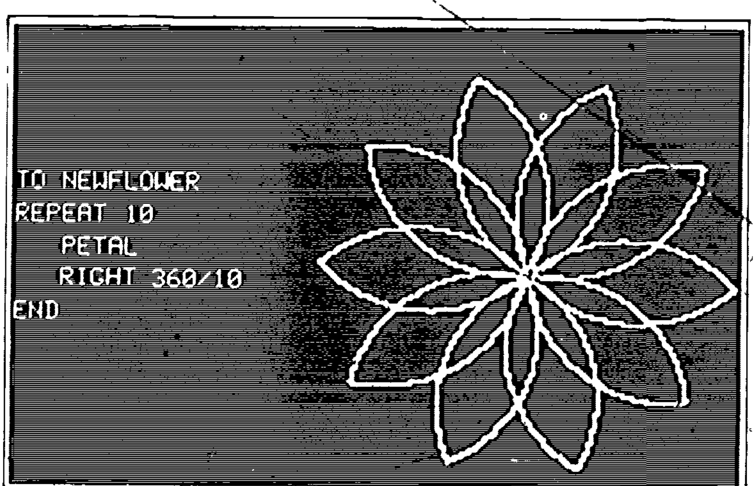
—Four make a flower



—That's more like a propeller
—So try ten

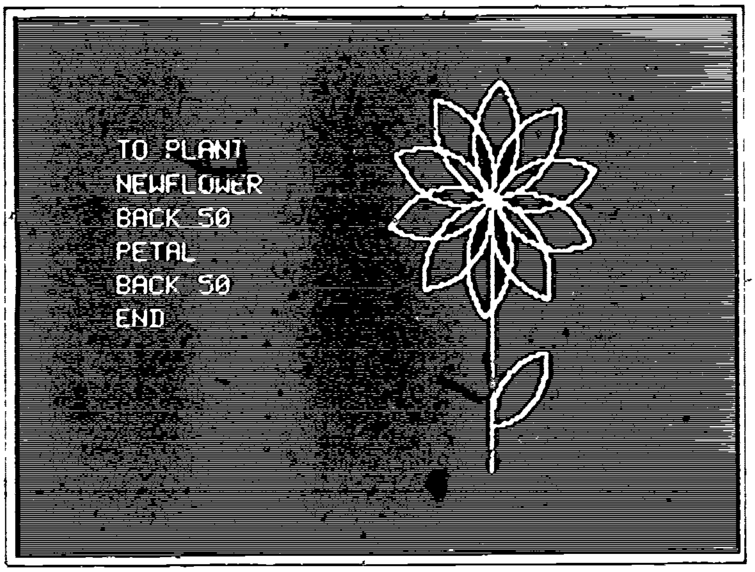
A BUILDING BLOCK

—Typing all that ten times hurts my fingers
—We can use REPEAT



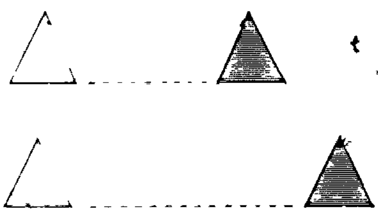
—There it is!
—But it's too big
—All we have to do is change the 50 in PETAL Make it 25
—If we let PETAL have an input we can make big or small flowers
—That's easy Just do TO PETAL SIZE QCIRCLE SIZE and so on
—But I bet we'd get bugs if we try that Let's try plain 25 first
—Then we can make a superprocedure to draw a plant

BUILDING UP



ENDS BECOME MEANS

—I have a great procedure for putting several together It's called SLIDE
You just go PLANT SLIDE PLANT SLIDE PLANT SLIDE



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TO SLIDE DISTANCE
PEN UP
RIGHT 90
FORWARD DISTANCE
LEFT 90
PEN DOWN          END
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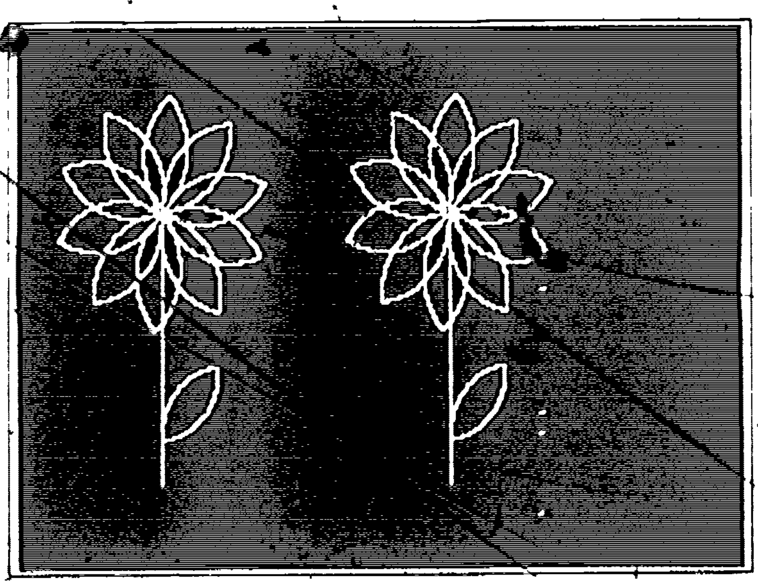
TRYING THE NEW TOOL



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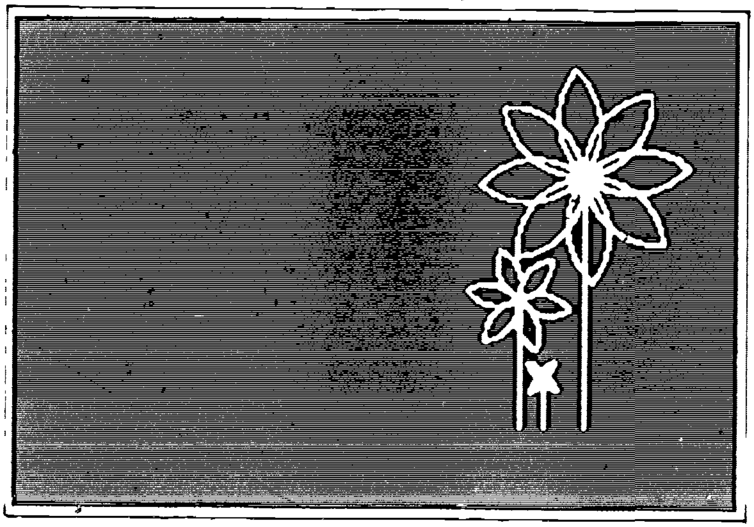
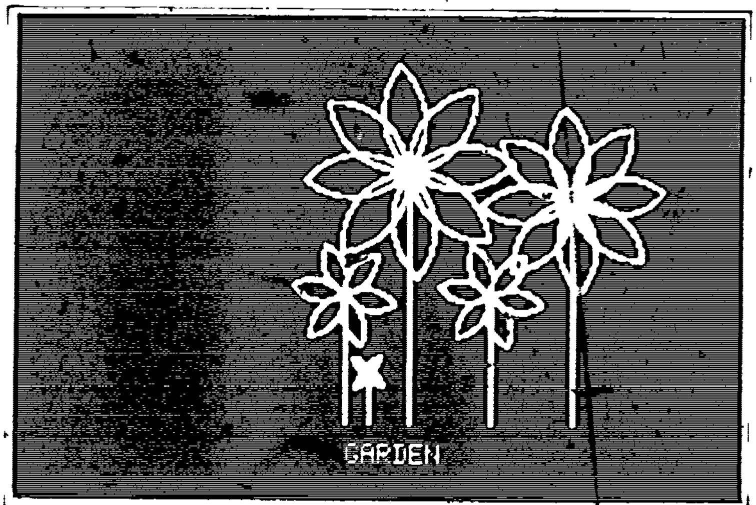
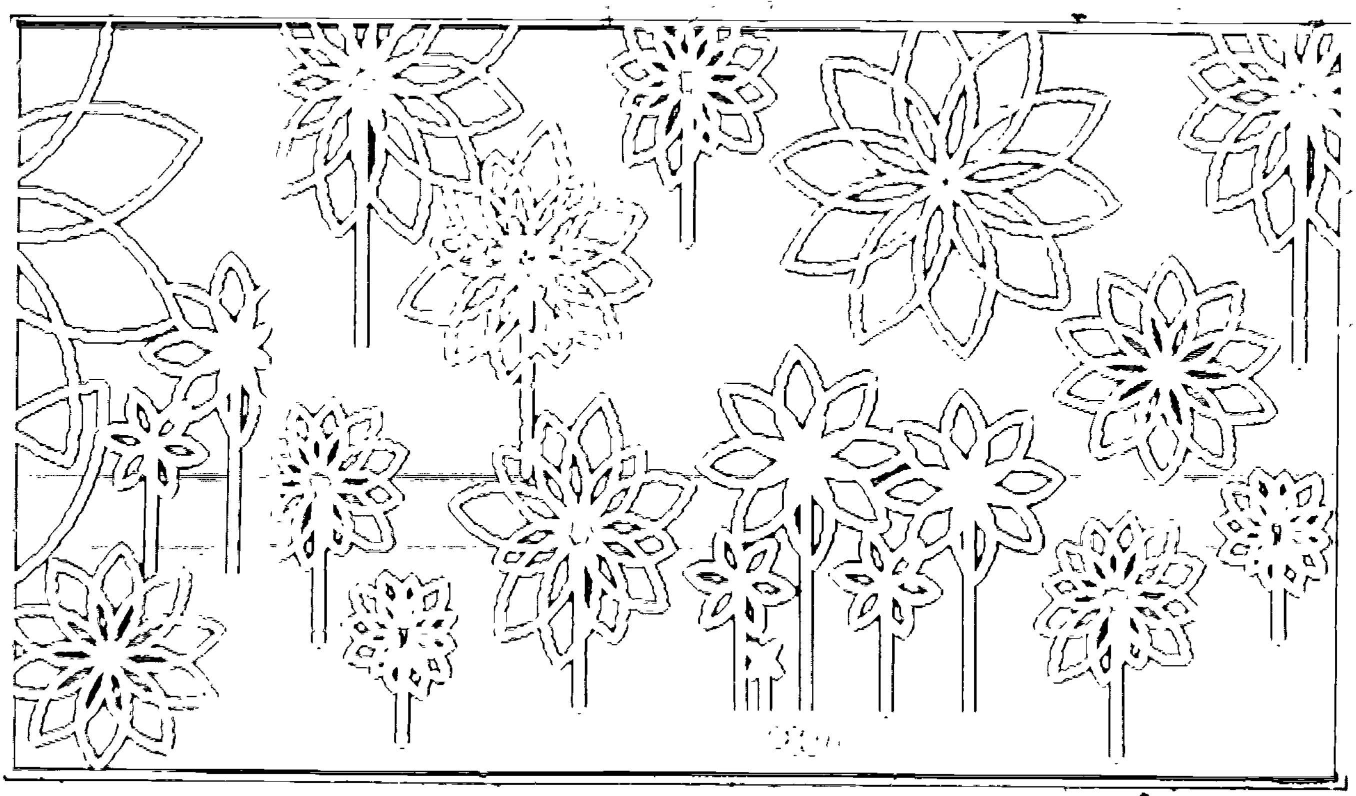




—[illegible]
[illegible]
—Maybe



The intellectual gains made with the use of the computer will amount to "mindstorms" in Pappert's view. However such mindstorms will only develop when we overcome the anachronistic thinking so often associated with new technology. The history of the typewriter provides an excellent example of this tendency. Primitive mechanical typewriters were slower than the user's ability to type. The keyboards were therefore arranged in an order which slowed down the typists and prevented jamming. The QWERTY keyboard is now anachronistic.

Modern typewriters are capable of speeds far beyond manual capacity, yet the same keyboard arrangement continues to slow us down. Evidence of this QWERTY phenomenon may be found in many of our classrooms. For instance, mathematics texts and curriculum are often designed to avoid realistic problems which necessitate difficult calculations. The old simple pencil and paper tasks may now be replaced by more realistic and complex problems. The computer should not just be used to do what we are already doing a little faster or a little better; it should be used to provide new intellectual experiences.

ADMINISTRATIVE APPLICATIONS OF MICROCOMPUTERS

TIMETABLING — Microcomputers may be used to determine class sizes and conflicts as the master timetable is built However, a larger computer would be necessary to timetable any but the smallest schools Micros may be used to change individual timetables throughout the year

ATTENDANCE — Micros can be used to keep up-to-date and accurate attendance records

LIBRARY — Micro computer programs are being developed for circulation, overdues and inventory Ron Crawford of Hamilton and Liz Bream of North York are currently experimenting with programs

GUIDANCE

- SGIS — Student Guidance Information System is an Ontario service It lists the educational and skill requirements for careers which the student has already chosen Although this system currently uses punched cards, it is possible to make it interactive For other uses of computers in Guidance, one should refer to the article "Guidance And The Computer", by Colin Leitch, Head of Guidance, Stratford Northwestern, in the March/April 1981 issue of the *School Guidance Worker.*
- Choices — Choices is a federal program funded by Manpower and Immigration It is a more open-ended program than SGIS The student selects a wide variety of desired career determinants such as education, skills, salary level and geographic location The program interacts with the student in a conversational mode gradually narrowing down his choices to a specific job A much wider spectrum of considerations are therefore presented to the student

STUDENT RECORDS — Student records can be easily entered and addressed on a micro.

BUDGET PLANNING — Programs such as Visicalc are useful tools for analyzing percentage budget changes by department This can be a useful planning and negotiating tool.

IN-SCHOOL-PRODUCTION OF EDUCATIONAL PROGRAMS

Many schools, as they acquire micro-computers, will develop a resource of computer programmers—including computer science and data processing teachers, interested students, and 'turned-on' teachers These people can be an excellent source of computer learning activities

The writing of a good computer program that can be used in the classroom is not a trivial task. For teachers without a computer programming background many hours must be spent in learning a new skill. Even experienced programmers have to learn how to translate their teaching strategies into a program suitable for students to use.

The designing, writing and testing of the program usually involves a time span of weeks or months before a truly valuable product is developed. Even though the commitment of time and effort is high there are many reasons to produce your own materials.

THE WHEEL SYNDROME

Having teachers produce their own classroom programs is often compared to "reinventing-the-wheel" since the product may already exist elsewhere. But there are advantages to this reinvention—certainly our modern cars run better on radials than they would on Roman chariot wheels. Similarly the products produced by an interested and enthusiastic teacher may be better than the one in existence.

CREATIVE PROCESS

Invention is a creative process, one that should be part of our educational environment. It can maintain teachers' enthusiasm and spark students' imaginations. Students are more interested in producing material that will be used than in working on programming exercises

THE SEARCH

If a teacher has a product in mind, even though it does exist, there is no guarantee that (a) he can find it, (b) it really does what he wants, (c) that it runs on his computer, or (d) that it runs at all The time taken in the search and adapting of another program may be better spent in the production of a new one.

THE USER POPULATION

A product developed by the classroom teacher will relate directly to teaching objectives, course content and the level of the students' reading and language skills. Too many programs developed in one class cannot be used in another because of seemingly small differences, which however, can cause frustrating experiences for the pupil.

MODIFICATION

As curriculum or course content changes, a teacher may want to be able to modify the existing program. When the program is written by someone else and poorly documented it is often very difficult, if not impossible, to change. Therefore 'self-written' programs probably have a longer useful life.

COMMITMENT

When the program is produced in the school, there is a feeling of ownership and commitment by the staff to get it running and to use it in the course. When the same product is purchased or obtained elsewhere there is not the same desire to implement it. If it needs slight modifications the program just may not be used.

PROFESSIONAL DEVELOPMENT AND ATTITUDES TO NEW TECHNOLOGY

Teachers must feel comfortable and be knowledgeable in this new computer environment in order to serve our students well. The best way to learn that the computer is a tool which can enhance the learning environment is to learn that it really is not difficult to program. The fear of the unknown is much more powerful than reality.

EDUCATION OBJECTIVES

When students write programs for classroom use they not only learn and apply programming techniques but develop interpersonal and organizational skills as well. They are forced to communicate with the teacher who requests the program. They must be able to understand the teacher's requirements and must communicate the program's limits and utility to the teacher.

SELF ESTEEM

When a student's (or teacher's) programs are found to be useful, the person's self image is certainly enhanced. There is a great feeling of pride in knowing other people are enjoying and learning from the material one has produced It makes the many hours of effort worthwhile.

SHARING

There seems to be a reluctance on the part of educators to distribute their work freely. It is a strange phenomenon because the writer still has the original product for his use, yet there seems to be very little real sharing of programs among teachers. However, if you have some products to give, you will probably get some in return.

Guide to Writing Your Programs

PLAN

There are three things to do before writing the computer program to be used in the classroom: plan, plan and plan. Be sure the program is well-thought out before touching the computer.

COMMUNICATE

When developing a program for another teacher be sure to communicate with that person while the program is being written. Too often, after hours have been spent in programming, the user says, "that's not exactly what I had in mind" or "Gee—that's great, but could you also . . ."

INTERFACE

The video screen of the micro-computer can be compared to the blackboard in a classroom. It is important to consider what the student will be looking at as he interacts with your program.

- Be sure to 'clear the screen' as a new communication is started
- In a 'dialogue' use different print for computer's responses, i.e. Upper case for student, lower case for computer.
- Double space and leave blank lines to make printed text easier to read.
- If it is available, use a short sound or musical note to signal that a line has been printed, or to indicate a student response
- Use proper punctuation Don't forget that period at the end of the sentence

LEARNER CONTROL

Let the student be actively involved in the learning experience Choices arouse interest and there will be more commitment to follow the material There are many ways in which this can be done

- When presenting textual instructions or a lesson, many programs clear the screen after a few seconds. Let the student erase the screen Usually a command such as "PRESS SPACE BAR TO CONTINUE" works well. This can be accomplished in BASIC with . . .

```
2900 PRINT "PRESS SPACE BAR TO CONTINUE."
3000 GET A$ . IF A$ <> "     " THEN 3000
```

- The users should be asked if they want instructions Let them omit it if they wish
- Provide a "menu" to allow a student to choose his learning activity e g

```
Would you like to
(A) .  see the instructions
(B) .. start the lesson
(C) .  take a test
(D) .. stop
Press A,B,C or D
```

- Let the user choose how many questions are presented in drill and practice or allow the process to end by typing the word "STOP".

ERROR TRAPS

If students working on a computer program are new to the experience, they may make mistakes, type incorrectly or press the wrong key. The program should be designed to do something sensible even when the user does not

- Numeric input
  If the computer requests a number such as
  HOW MANY QUESTIONS (1-10)?
  and the user types the word 'FIVE' instead of the numeral '5' an error message appears and the user will be totally confused To prevent the occurence of this situation the programmer may accept the input as a string variable and then convert it to a number
  e.g.

```
100 INPUT "HOW MANY QUESTIONS (1-10)". N$
110 N = VAL (N$)
120 IF N < 1 OR N > 10 THEN 100
```

- "RETURN" on a blank line
  If the user presses the RETURN key before typing a response to a request for input the computer will terminate the program At this point the user may type the word "CONT" (for continue) and the execution will resume

```
e.g. HOW MANY CM IN ONE METRE? — (student presses return key
                                         by mistake)
     BREAK       — (program stops)
     READY       —
     CONT        — (student types command)
     ? 100       — (input is requested again)
     CORRECT     — (computer responds)
     HOW MANY METRES IN ONE KILOMETRE? — (Program
                                          continues)
```

- **Inappropriate response**
  The program should check that the input is valid and reasonable for the question. If we allow the student to choose the level of difficulty of a problem we want a number within a certain range.

```
e.g. 200 INPUT "HOW HARD (1-5)";L
     210 IF L>=1 AND L<=6 THEN 240
     220 PRINT "ANSWER 1 TO 5"
     230 GO TO 200
```

  We should not accept the value if it is outside this range. In this example the question would be asked again, until the response is appropriate.

FLEXIBILITY

Teachers generally will not use a computer program if it does not reflect their ideas. Although the program may be modified or changed by the user, two conditions must exist: the user has some programming skills, the program is well organized with sufficient imbedded comments which explain the use of its variables and logic. Unfortunately neither condition often exists. ~~When the~~ program is designed, allowance can be made ~~for specifying~~ the values of parameters at the outset. For example, in a simulation of the political process the percentage of seats held by each party could be requested from the user instead of being set down by the programmer.

```
e g  HOW MANY PARTIES DO YOU WANT? 4
     NAME THEM PLEASE
     ? CONSERVATIVE
     ? LIBERAL
     ? NDP
     ? OTHER
     WHAT ARE THEIR STRENGTHS (IN PERCENTS)
     ? 41
     ? 30
     ? 28
     ? 1
```

This allows the teacher to keep the simulation relevant as the real conditions change.

TESTING

After the program has been written it must be thoroughly tested by the programmer and by the students for which it is aimed.

There are two thrusts to the testing.

- To be sure the program works, and to eliminate errors in the computer program
- To be sure the students can understand and follow the instructions

There is nothing more frustrating for a teacher who, willing to try something new, is given a program to use that does not work properly

CATALOGUING COMPUTER COURSEWARE

As schools collect and produce educational programs, cataloguing will be an important step in the sharing and distribution of materials. Teachers must be able to access the information and quickly decide what is useful for their students and capable of running on their equipment.

The following form may be used as a model for such cataloguing.

COURSEWARE CATALOGUE

Program Title: ______________________________

Subject Matter: ______________________________

Grade Level: ______________________________

Type of Activity:

Tutorial ☐ Drill & Practice ☐

Game ☐ Simulation ☐

Test ☐ Tool ☐

Language: ______________________________

Computer: ______________________________

Model: ______________________________

Memory Required: ______________________________

Peripherals Required:

Disc ☐

Colour Monitor ☐

Audio ☐

Other ______________________________

____

Copywritten:

Yes ☐ No ☐

Comments: ______________________________

____

____

____

THE INFORMATION EXPLOSION

The quantity of available information has transformed our society and altered the role of traditional education within it. Knowledge is becoming the key strategic resource, for business and industry as well as education. Teachers will be challenged to analyse both the types of materials they use in the classroom and their teaching strategies.

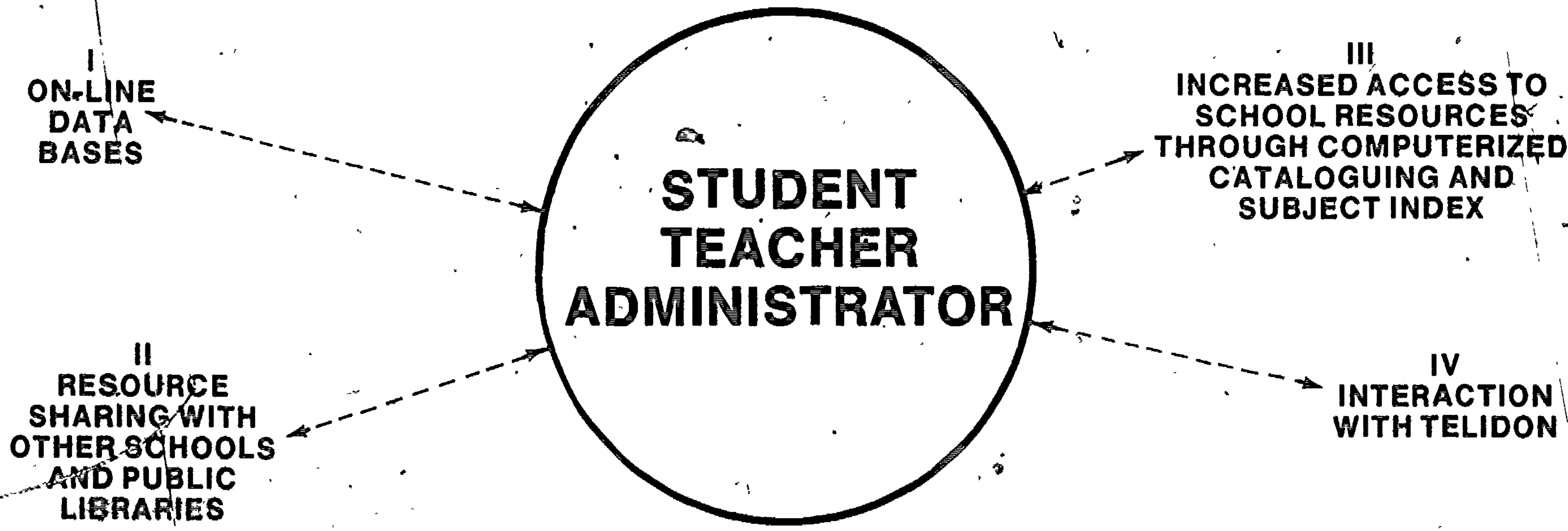
There are five key characteristics of the information explosion which affect learning.

- The **quantity of material** has grown by leaps and bounds. Prior to 1500, Europe was producing books at the rate of 1,000 titles per year. By 1960, 1,000 books were produced in 7½ months. And recently, the output of books on a world scale has approached the prodigious figure of 1,000 titles per day.
- The **speed of transmission** of information has fundamentally altered the whole decision-making process in key political, economic and social institutions. Where would the multi-national corporations be without the telephone or telex? What news would we be receiving without the satellite?
- New, **diverse forms** of information appeal to wider and wider audiences. Paper copy may be primarily replaced by electronic copy in video display terminals or microfiche. Videodiscs and computer software can create new learning environments. Computer literacy along with print and media literacy is becoming a key life skill.
- **Access** to information has been simplified and rationalized to cater to all individuals rather than remaining the exclusive preserve of "information scientists". Cataloguing and indexing systems have had to be reformed to keep pace with the growth of libraries. The skill of searching for materials will be essential for individuals wishing to access information in libraries or from their homes.
- **Interaction** with resources is the most revolutionary characteristic of the information explosion. The book is a passive learning device; the computer fosters active learning. Courseware may be used in the classroom, videotex extends this active learning environment to the home or office.

The information explosion presents new challenges to the educator. The traditional emphasis on gathering information will be replaced by new needs including:

- the analysis and selection of media best suited to effective learning, such as the choice of computer, videodisk or book
- the skill of accessing or searching for material
- the ability to select relevant materials
- the interpretation of raw data
- the organization of information for the user

For the teacher, these and other issues may be significant in both long term curriculum development and day-to-day lesson preparation


I
ON-LINE
DATA
BASES
II
RESOURCE
SHARING WITH
OTHER SCHOOLS
AND PUBLIC
LIBRARIES
STUDENT
TEACHER
ADMINISTRATOR
III
INCREASED ACCESS TO
SCHOOL RESOURCES
THROUGH COMPUTERIZED
CATALOGUING AND
SUBJECT INDEX
IV
INTERACTION
WITH TELIDON

I ON-LINE DATA BASES: Expanding the quantity and immediate accessibility of information.

It is now possible to connect computerized library databases to the school or home by a telephone equipped with a Modem. The information contained in this library is said to be "on-line". Data bases enable the searcher to access information from a wide variety of periodicals and monographs without searching through volumes of printed indexes. There are many unique databases created for a variety of users in education, business and science. When the appropriate database has been accessed by telephone, the searcher simply needs to type in the topic or combination of topics required. This search may be limited to a certain time period or may be as comprehensive as desired. Within seconds, the computer prints out an index of references; some databases provide abstracts as well. The searcher may follow up by requesting one or several articles to be printed 'on-line'. Due to the high cost of on-line printing, the searcher usually locates the article in his own library or requests that copies be mailed.

Advantages of Using On-Line Retrieval

- Speed in locating information
- Increased rate of accuracy as the computer searches abstracts as well as titles
- Up-to-date information is readily available in comparison to the long waiting periods associated with printed indexes
- Access is gained to information that is no longer printed due to high costs
- Specialized and previously unattainable sources of information are made accessible.
- Better access to information is gained because it may be stored under more than one keyword

(From Toronto Board of Education, Central Reference Library Report 1979)

Costs may be saved by reducing the amount of staff time required for manual searches and the number of printed indexes required. Perhaps more importantly, the searcher will obtain better resources in a shorter period of time. Nothing motivates as well as success; data bases may enhance the level of research performed in our schools.

> ***PLUGGING INTO COMMERCIAL DATA BASES***
>
> *By Betsy Gilbert*
>
> *Today, there are more than 600 on-line data bases in the United States, serving a variety of professional groups from farmers to attorneys And with only a personal computer or terminal and a telephone interface, anyone can access most of them*
>
> *Data base production has become a big business For every firm that compiles a new bank of information, hundreds of groups and individuals line up to access that data*
>
> *It makes sense Getting information from a data base takes only a few minutes Getting the same facts from printed sources takes hours of searching, scanning, and copying*
>
> *The convenience can still be expensive Fees for data base services are as varied as the information covered, ranging from a flat $25 per hour to $64,000 per year plus hourly rates*
>
> ***Apple: The Personal Computer Magazine and Catalog**, Vol 2, Number 1*

II SAMPLE DATA BASES

ONTERIS: Ontario Education Resources Information System

ONTERIS was founded in 1972 by the Metropolitan Toronto School Board in co-operation with the Ministry of Education. It is now located in the Ministry's Information Centre. Its aim is to increase accessibility to educational materials produced in Ontario. Three bases are included CODE, records of briefs and working papers received or produced by the Commission on Declining Enrolments, EDUC records of education research documents produced in Ontario, and CURR, records of curriculum guides and support documents produced by the Ministry, and by local school boards

Sample Search

Problem: To retrieve all stories about the assembly of Ford's new Lynx and Escort models in Canada

you type in: ford & assembly & canada & lynx escort

In seconds you have all the relevant stories available. They are displayed in the following format.

FORD & ASSEMBLY & CANADA & LYNX ESCORT
RANK 1 OF 9 PAGE 1 OF 2

1. 8034701.8 FRI DEC 12 1980 PAGE B1 (ILLUS)
2. BYLINE KEN ROMAIN
4. CLASS ROB
5. DATELINE ST THOMAS Ont WORDS 350

6. ***Ford*Canada*starts the conversion of*assembly*plant at St**
*Thomas**
By KEN ROMAIN
Globe and Mail Reporter

7. ST THOMAS Ont *Ford*Motor Co of*Canada*Ltd Oakville Ont has begun the [illegible] conversion of its St Thomas*assembly*plant with the installation of new automated equipment to produce the first front-wheel drive cars in*Canada*

[illegible] *Canada's*new*Ford*EXP and Mercury LN 7 two seater subcompacts will begin [illegible] production line Feb 2 The plant will be the sole source in North America for the sports coupe vehicles with a production rate of 130 000 a year

[illegible] welders are being installed to weld front end panels A new body framing unit [illegible] completely surrounds the car [illegible] automatically to about 70 spot welds [illegible] more than a minute

As a move to further improve quality hourly workers have been selected with union consent as quality upgrade operators at the*assembly*level They will reject vehicles that come off the line if the work is not up to standard

These guys are not there to rat fink or point the finger for poor work at their fellow workers They are there to help should any work station run into trouble in*assembly* said [illegible] Gorman plant manager The selected workers have been specially trained in quality work at*Ford's*plants in Dearborn and Wayne Mich

Mr Gorman said the need to maintain quality units and finishes to meet foreign competition was explained to the plant's 4 000 workers in October by both company representatives and representatives of the United Auto Workers The plant was closed Dec 5 for the [illegible] and will reopen Jan [illegible] reaching full work levels by Jan 26

[illegible] Canadian companies are sharing in up to $16 million of the $36 2 million to [illegible] and improvements at the plant

Another $[illegible] million will be spent for special tooling new equipment and new model launch [illegible]

The new two seaters are [illegible] *Ford's*Escort*and*Lynx*models which went into production [illegible] distinctly different in appearance They will go on sale in April [illegible]

8. ADDED SEARCH TERMS *Canada* automobile industry automobiles

Rank 1 of 9—There are nine articles that meet your search criteria. Rank 1 is usually the most recent article, although you can choose to have the articles displayed with the oldest article first

Page 1 of 2—A page is 23 lines, or the amount of text that fits on a standard 80 character video screen (Here on our sample, we show both pages of a printout)

Each article is divided into 8 sections containing the following information

1. **Document Number**—a unique identifier for each article
   Date—The date the article appeared in The Globe and Mail
   Page—The page on which the story appeared
   Illus—If an illustration accompanied the article, it is noted
2. **Byline**—The name of the person who wrote the article, e.g. Richard Needham, Geoffrey Stevens, if the name was published
3. Unused
4. **Class**—The section of the paper that the story appeared in, e.g. News, Science, Report On Business, etc
5. **Dateline**—The name of the place in which the story was written.
   Words—The number of words contained in the story
6. **Headlines** are centered and set off by asterisks
7. **Text** includes the full text of the article as it appeared in the paper.
8. **Added Search Terms** are general subject terms added by our library staff.

INFO GLOBE

the online information division of Canada's National Newspaper

The Globe and Mail
444 Front Street West, Toronto, Ontario M5V 2S9 (416) 598-5250

Info Globe

In 1977, *The Globe and Mail* introduced computerized text editing machines. Articles were set by computer and could also be stored for future access. This system was developed for journalists needing background information on current issues. It was soon marketed to schools, businesses, and individuals with similar information needs. Info Globe uses everyday vocabulary in its search terminology. Article titles, dates and pages are listed from the most recent article back. The full texts are usually located in the library or sent to the searcher. There is no subscription fee; only a code number, a telephone and a telephone-compatible terminal are necessary. (See Sample Search).

Aurora High School conducted a successful Info Globe experiment from March to November, 1980. With the assistance of Globe and Mail employees, three senior history and geography classes learned effective search strategies.

Dialog and Orbit

There are two main commercial information services which link the user to a wide variety of specialized data bases. Orbit is marketed by Infomart, and Dialog is marketed by Micromedia. Each data base is a commercially viable unit of its own, specializing in topics such as agriculture, energy or business. The prime educational bases are ERIC, the American precursor of ONTERIS, Psychological Abstracts, Social Science Citation Index, and Exceptional Child Educational Resources. Charges vary according to the data base.

Criterion for Selecting Data Bases and Information Services:

Content: Select the data base with the most relevance to potential needs.

Level: Be wary of data bases which only provide commercial, technical or scientific materials which may be beyond the students' level.

Abstracts: Data bases which provide abstracts with their indexes are more useful selection tools.

Terminology for Search: Data bases such as Info Globe use "open vocabulary", every word in the articles is a searchable term. Some data bases require the searcher to use established terminology as set out in an accompanying thesaurus. ONTERIS uses PRECIS (see section on ONTERIS). Although there may be some variation in the ease of use of these 'search terminologies', none of them are as obscure as headings currently found in traditional card catalogues or printed indexes.

Cost: A few information services charge a subscription fee but most bill only for the time used. These rates vary from data base to data base. For instance, ONTERIS is currently free; Info Globe charges I2.00 per minute (or $120 per hour); ERIC charges $26 per hour. Separate charges are made for printed copies of articles or bibliographies. These rates may also vary. If costs are too prohibitive for individual schools, central board libraries may provide this service.

II RESOURCE SHARING THROUGH ON-LINE COMMUNICATION

The high cost of books, audio-visual materials, periodicals and courseware make the purchase of these resources by every school library impossible in an era of budget cutbacks. Computer tie lines can help school resource centres keep pace with constant curriculum updating. Many high school and public libraries in the Toronto Board of Education are linked to a teleprinter system. One library may request a particular title or a series of resources on a subject currently in demand from a neighbouring library. The other library searches this request and responds as soon as possible. Materials may be picked up by the borrower or sent through the board courier system.

III COMPUTERIZED ACCESSIBILITY TO SCHOOL RESOURCES

On-line data bases provide access to periodical literature, but new forms of access to book and non-book materials in the library are necessary. The search for information in the school or public library has traditionally started at the card catalogue, however, card catalogues are facing obsolescence because they tend to be incomplete, inaccurate, out-of-date and difficult to use. On-line cataloguing such as COM (Computer-Output-Microfilm cataloguing) and PRECIS (PREserved Content Index System) are replacing traditional catalogue systems. Students are demanding the same sophisticated systems they encounter in public libraries. The maintenance of these new systems will be less expensive than card catalogues but the cost of initiating them is very high.

A. UTLAS: Computerized Cataloguing Service

Since 1973 UTLAS, the University of Toronto Library Automation Systems, has provided CATSS, a CATalogue Support System for a variety of schools, public libraries and museums. CATSS is a data base containing millions of bibliographic records accessible to users through a computer tie line. If a book has been catalogued by one library, other libraries may access and revise it for their own use. In this way, large quantities of current books, monographs, serials, audio-visual materials, music, maps, and manuscripts may be catalogued in a fraction of the time. PEL, Professional Education Libraries is an UTLAS user's group which shares the cost of the original cataloguing of most elementary and secondary educational materials. The group of six libraries includes the Toronto Board of Education, the Ministry of Colleges and Universities Library, the Ministry of Education Library, York County Board of Education, York Borough Board of Education and Scarborough Board of Education. UTLAS provides card, microform or on-line catalogues; however due to the weaknesses of card catalogues, the other forms are becoming more popular.

B. Microform and On-Line Catalogues

1) The most sophisticated and expensive form is the **on-line catalogue.** Since users access the resources through a keyboard, holdings may be neither misfiled nor removed. This type of catalogue is completely up-to-date because the user may access material the moment it is catalogued.
2) An intermediate form of catalogue has been developed to take advantage of key features of the on-line system at a reduced cost. The COM, **Computer-Output-Microfiche Catalogue** is a miniature negative of the computer's information. The bulky card catalogue can be eliminated and a desk-top portable microfiche reader put in its place. As in online cataloguing, filing is eliminated. Multiple copies of the catalogue can perform a variety of functions. Every student in a class may use his own catalogue in analyses of resources. Teachers may keep a copy at home to check library resources; and neighbouring libraries may want a copy to facilitate resource sharing. A copy of the catalogue costs about 18¢ but the original is fairly expensive. Consequently COM catalogues are usually issued 2 to 4 times a year. This type of cataloguing therefore does not have the currency of the on-line catalogue.

C. PRECIS: Computerized Subject Access to Information

Resources are catalogued under subject, title and author indexes. The subject catalogue is the most commonly needed but the most difficult to use. Only a minority of library users know the author or the title of the material they wish to locate, yet even fewer have the skills to access the information through the subject headings. Users engage in the tedious and often futile search for subject headings in either the traditional "Library of Congress" or "Sears" subject card catalogues. Many fail in their first attempt to find relevant subject headings and give up their search. Many of these users either leave the library with the view that there was no material, or no 'good' material anyway; the others depend on the librarian to locate materials for them. Users should have independent access to information and the librarian's time should be freed for complex searches and training in more sophisticated research skills. The current 'Library of Congress' or 'Sears' subject access systems present too many roadblocks for any but the most persistent or highly trained users.

PRECIS, the PREserved Content Index System was developed in England in the early 1970's. It is a machine-produced index which not only reduces the cost and inconsistencies of traditional cataloguing but promises easy access to the whole breadth of library materials. PRECIS uses current, natural, comprehensible and specific terms. The obscure and general terms found in traditional catalogues often hid more information than they revealed. In PRECIS, the computer rotates "strings" of keywords in order to provide multiple access to the material, for example.

HOUSES
 Heat loss. Insulation
 Thermoplastics

HEAT LOSS. Houses
 Insulation. Thermoplastics

INSULATION. Heat Loss.
 Houses. Thermoplastics

PRECIS studies indicate that users may locate more thorough and current resources on a cost effective basis.

- The PRECIS index directs users to a greater number of sources.
- The user can determine the relevancy of the materials by the clear and specific subject headings.
- Current materials may be made available much faster.
- PRECIS eliminates the cost of maintaining card catalogues

Library users should have independent access to information through subject headings. This will be more and more important as information systems are linked to private homes and businesses

Key Canadian Applications

Aurora Project

The opening of Aurora High School in 1972 ushered in a new era for high school libraries. Audrey Taylor, librarian and Irene McCordick, Master Teacher of Libraries, York County Board of Education, were in the process of developing a manual PRECIS index for the high school level. In 1976, the Ontario Ministry of Education granted funds to this project to develop an automated cataloguing-information retrieval network for the province. The PRECIS subject data base linked to the cataloguing data of UTLAS could produce COM catalogues for Aurora and potentially any other high school linked to the system (See UTLAS and COM Catalogue). In 1978, a further Ministry grant enabled the project to expand into the elementary system.

ONTERIS: ONTario Educational Research Information System

The Ontario Ministry of Education and the Metropolitan Toronto School Board co-operated to produce a PRECIS index to abstracts of studies in education in Ontario. (See data bases.)

National Filmboard

The National Film Board uses PRECIS to assess Canadian non-print materials.

IV VIDEOTEX: THE INTERACTIVE MEDIUM

Videotex is a two way mass market information system currently in its infancy stage. A central computer network links commercial, cultural, information, and educational establishments directly to the home or business. This information is displayed on the subscriber's own TV set in the form of printed text, graphics or half tone photographs. It is 'two-way' in the sense that the user controls the flow of information with a keyboard. He may access only the information he is interested in, his responses will determine the subsequent "program". It is also two-way in the sense that the viewer may participate in opinion polls, or order goods or services from his home. Subscribers may also input their own information and avoid the high costs and lengthy delays associated with traditional publishing.

News, weather, "bulletin boards", school lessons, stock listings, and transportation schedules have already been programmed. Any subscribers will be able to access stores, theatres, or airlines, select purchases from the goods available, and charge it to their computerized bank account. "Let your fingers do the walking" may soon become associated with the videotex terminal.

Advantages of Videotex:

Currency: As soon as the information is input by the concerned establishment, any user may access it. Stock prices, theatre seat availability and weather which change significantly will be available instantaneously.

Visual Form: Videotex presents information in a dynamic coloured form. This will motivate many to seek information which they may currently find too oppressive in traditional print mediums.

Appeal to Specialized Audiences: A TV or radio producer must direct his program to the 'average' viewing audience. Many of the items, for instance in a news broadcast, have little or no relevance to the individual's taste; other items may be perceived as too superficial. Videotex can eliminate hours of passive viewing, while providing more satisfying, active viewing.

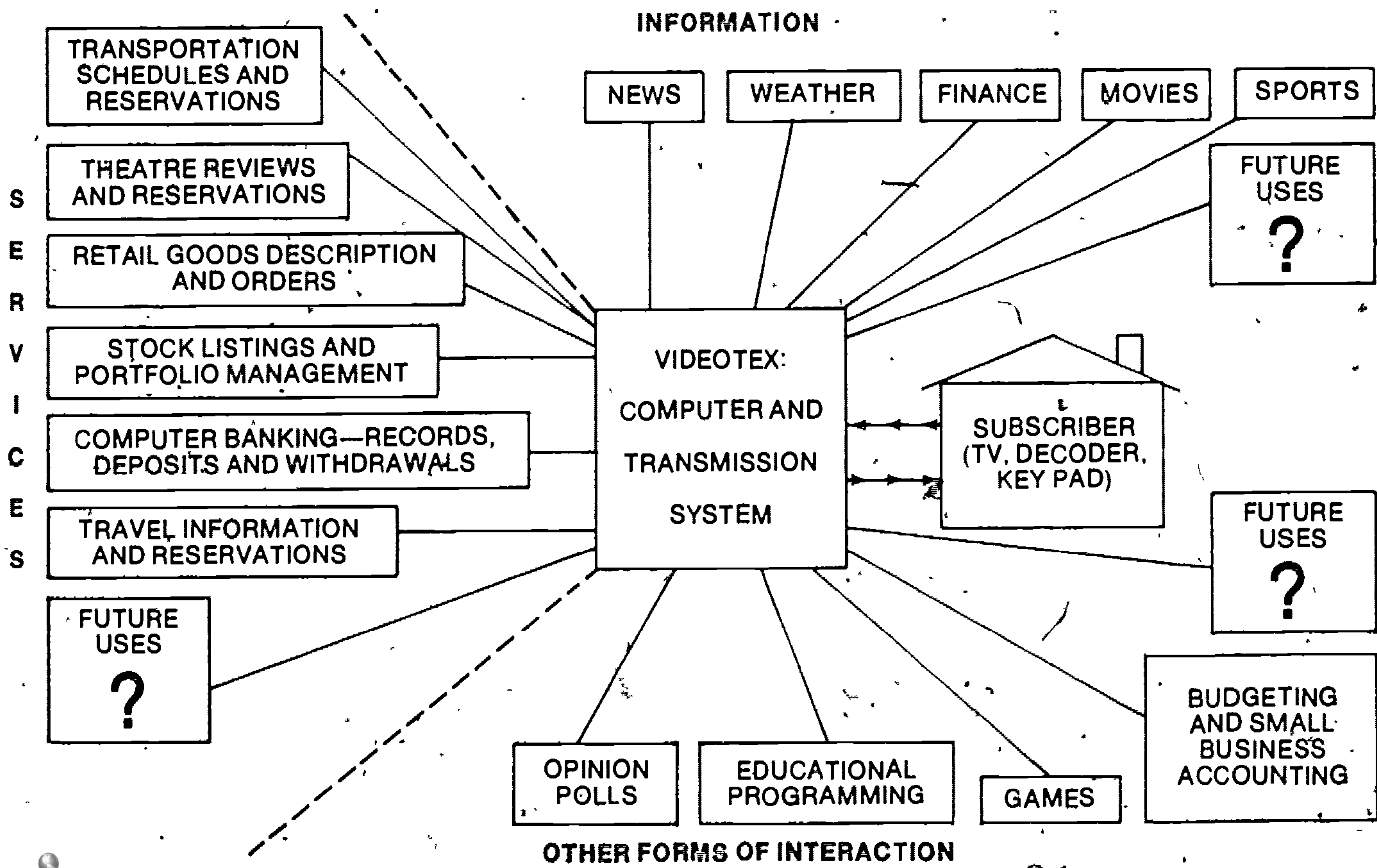
Conservation of Materials: Videotex eliminates the distribution of paper and the costs associated with producing and printing it.

Electronic Movement of Information: Videotex may eliminate the need for the huge quantities of printed newspapers, magazines and brochures now in distribution, most of which are only partially read. Paper, as well as printing and distribution costs, will be saved.

Telidon

Telidon is the Canadian videotex system competing against the British, French, and Japanese systems for international acceptance. Telidon's superior graphics capability has given it a competitive edge. It can also generate more than one version of text simultaneously in order to accommodate a variety of language groups, or levels of comprehension. Both the international and classroom advantages of this capability are clear. International Telephone and Telegraph have recently adopted Telidon as their standard.

A preliminary test was conducted in Markham District High School, York County Board of Education. This involvement shows Telidon's potential interest in, and sensitivity to, the educational market. Other field tests are being conducted by OECA.



TV ACADEMY

The Ontario Education Communications Authority has developed the "TV Academy", a new form of television programming with back-up computer assisted instruction. An academy consists of:

- a series of **television programs**, usually 13 in number
- **a learner's guide.** This is a back-up text with multiple choice questions at the end of each section
- accompanying **reading materials** and lists of resources
- **computerized RSVP letters.** RSVP stands for Response System with Variable Prescriptions; it acts as a surrogate instructor in diagnosing and responding to the quizzes and queries of individual academy members. As many as 5,000 academy members send in their quizzes and receive a computer print-out response according to their needs. These RSVP's repeat and clarify key points with some practical 'how to do' or 'how to find' information
- follow up **newsletters**: up-to-date information and expert responses to common problems comprise the highlights of periodical mailings

TV Ontario has already produced and aired the Music Academy and the Parents Academy. They were both advertised well in advance so that interested parties could send in the small fee ($6-$15) for the test and other materials. There was widespread participation in the programs. A third academy on computers for the classroom teacher has been proposed. Draft scripts have been written, but at the time of writing this book, production was pending final approval and additional funding.

MINISTRY ACTIVITIES

Current Ministry of Education programs are exploring the potential role of computers in the total education system, all levels from individual classroom instruction to province-wide information retrieval and administration are being considered. Although few final conclusions have been reached, two firm directions are apparent.

The Ministry rejects the notion that a centralized computer network can or should fulfill all the educational needs of Ontario's students. School boards must develop autonomous computer policies suited to their local needs and means. Centralized and local policies should aim at compatibility.

A mainframe computer at Queen's Park can provide financial and statistical services that cannot be performed by less powerful machines at the local level. However, centralization is limited by the high cost of tie lines and the diverse requirements of schools across the province. A supplementary network of midsize computers operated by school boards and the ministry on a co-operative basis is partially operative. Therefore, this centralized network is complemented by micros owned and operated by schools on an autonomous basis. Micro computers give school boards and individual teachers wide freedom to adapt the technology to their own needs. They also put a heavy onus on local training and development; schools cannot allow themselves to be totally dependent on a central source in the computer era.

The Ministry is supporting a number of research projects in computerized education but it is not inclined to assume this task alone. Organizations such as the Educational Computer Organization of Ontario (ECOO) are essential in providing leadership in this field.

The Ministry is supporting research concerning such issues as the use of new technology, hardware compatibility, criterion for evaluating software, data base standards and computer assisted instruction. (Refer to the more detailed descriptions of these projects in the following sections). The lead in many of these areas has already been assumed in Ontario by other organizations, companies and individuals. Certainly, the Educational Computer Organization of Ontario stands out in its ability to fill the vacuum left by other organizations. The Ministry encourages these activities while engaging itself primarily in the development of standards such as hardware compatibility, subject indexing and criteria for evaluating software.

The description of Ministry activities which follows should be read with this "decentralized and co-operative" theme in mind. Other regions such as Province of Manitoba and the state of Minnesota have taken a stronger lead and a more centralized role but other provincial governments are taking a more passive, wait-and-see position. There is considerable policy study underway in B.C. and Alberta. The Ontario position points to the need for local experimentation and training as well as province-wide co-operation

POLICY DEVELOPMENT

An Advisory Committee on Computers in Education was formed January 31, 1981 to develop policies concerning a computer network and computer-related learning materials. The committee members represent the following interest groups and areas of expertise. teachers' federations, teacher training, special education, Circular 14, Secondary Education Review Project, elementary education, senior and continuing education, Ministry of Information Systems, Educational Computing Organization of Ontario, television, OISE, supervisory officials and publishers. The committee will meet about six times before June 1982 to propose policy according to its mandate as follows.

- To advise the Ministry, school boards and the schools on the current uses and future potential of computerized learning materials and instruction, including a plan for effective participation by the Ministry in the development and supervision of computerized learning materials.
- To assist the Ministry, school boards and the schools in determining criteria for appropriate computerized equipment and networks.
- To advise the Ministry on a survey of learning materials used in schools and a survey of research on learning materials.
- To liaise with pilot or demonstration schools or centres using computer assisted learning and to assess the results of the pilot project.
- To maintain continuous liaison with the Curriculum Development Division relative to computer assisted learning and other divisions as appropriate.
- To report to the Assistant Deputy Minister Education Programs by June 1982

COMPUTER NETWORK

Since the late 1960's the Ministry has developed a computer network which caters to both central and local needs. There have been three major stages in this development.

The 1960's and early 1970's:

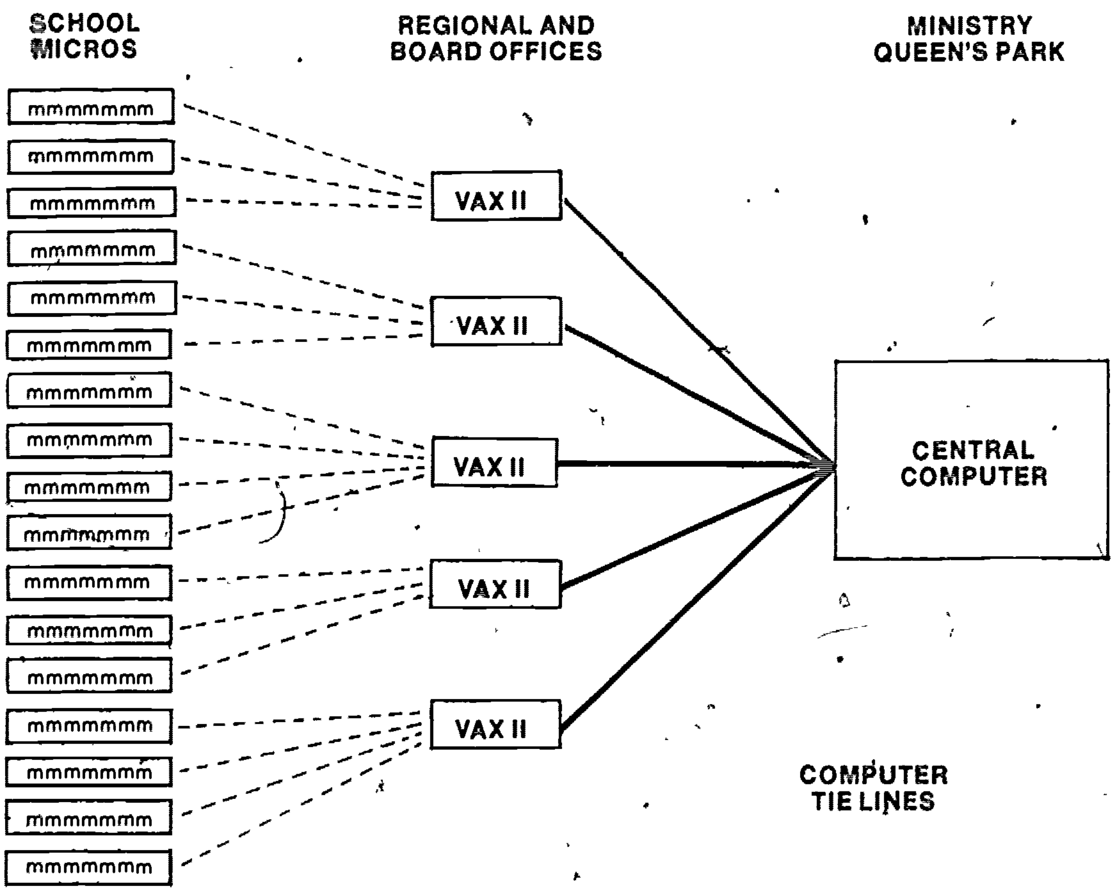
Queen's Park operated a mainframe computer with sufficient memory to handle financial statistics, and teacher and student records for the province The variety of educational functions now performed by micros were beyond the technical capacity of the period The mainframe computer was connected to computers located with co-operating school boards or ministry offices These machines are now being replaced by Vax II's These new midsize computers extend the educational benefits of the mainframe in several ways they can perform administrative functions, they can provide student guidance information, and they can handle the ONTERIS data base

Since 1975:

The micro explosion opened the way for autonomous computer activities within the schools Until this time, mainframes were too expensive and technically sophisticated for widespread use at the local level Micros made computerized administration and computer managed instruction possible at the local level, it also added the new dimension of computer assisted instruction Since the mid 1970's, the ministry has tried to distinguish between those functions most efficiently accomplished by mainframes and those most effectively performed by the new micros It has encouraged both levels of computer activity

Future:

The new micros may be used as terminals to the mainframe This will open up interaction between the Vax II at the regional levels and the micros at the local level It appears that guidance information and a wide variety of data including Ontario Assessment Instrument Pool will be obtainable from micro terminals within each school This will only be possible however, if the micros purchased by the schools are compatible with the Vax II's This will be an important hardware requirement in the future



Use of new micros expands as they may now serve as terminals for the VAX II's only if compatible.

CURRICULUM DEVELOPMENT

The Ministry is developing a curriculum guideline related to the computer in order to encourage computer awareness and computer literacy, as well as programming capability. An introduction to computers is considered essential but no consideration is being given yet to compulsory courses. There are four curriculum areas currently under review:

Computer Science

Elements of Technology — A guide for teaching computer electronics.

Data Processing

Informatics — This new guideline will contain an introductory course. This will be a multi-disciplinary credit at the Grade 9 or 10 level. The course emphasizes computer awareness and information.

The proposed curriculum should be in the schools by September, 1982. Programs will be implemented in September 1983 at the earliest.

INFORMATION AND CONSULTATION

Education officers at the Ministry will provide advice for school personnel on policy with respect to aspects of computers in education. Computer Co-ordinators will be in each Regional office with special responsibilities for computerized learning materials, with computer committees formed in each of the ministry's six regions across the province.

COMPUTERIZED LEARNING MATERIALS

The Ministry of Education may begin a practice of approving learning materials for computers in the same way that they have done for printed texts. Computer courseware will be approved in Circular 14 when the criteria for evaluating these materials has been determined. The Advisory Committee on Computers in Education is responsible for proposing such criteria, partly on the basis of the results submitted by four School Project Committees. There are two Anglophone School Project Committees: the North Addington Education Centre in Cloyne consisting of 470 students from K to 13, and the Dundalk-Proton Community School which includes elementary grades only. Being based on rural areas, they are isolated from the access to materials and computers which urban schools might experience. The two francophone school project committees are isolated from the dominantly English courseware. Ecole St. Anne is an elementary school of the Ottawa Separate School Board. Ecole de la Salle is a secondary school with the Ottawa Board of Education. The Committees have hired students under Experience '81 grants to assess computerized learning materials and then classify the materials according to current courses of study. The committee's mandate stipulates that they must protect the interests of the students and preserve the integrity of the course. They must also design a set of criteria for evaluating computerized learning materials.

COMPUTER MANAGED INSTRUCTION: DISTANCE EDUCATION PROJECT

Three schools in Lake Superior Board of Education are too small for a full curriculum and too far apart to share facilities. The Ministry's "Distance Education Project" is an experiment in Computer assisted and managed instruction which may solve the problems of such restricted curriculum. Three courses are currently being developed.

Grade 13 Physics: Due to low enrollment. Grade 12 Physics students wishing to continue with Grade 13 courses were often forced to take correspondence courses The 98% drop-out rate in these correspondence courses proved that this was not a viable alternative Grade 13 Physics students are now being "taught" by a micro-computer with accompanying manuals, texts and video tapes A guidance teacher acts as a 'teacher-facilitator' and the science department provides necessary equipment and back-up expertise This experiment is not affecting the general pupil-teacher ratio A marker in Toronto is hired by the Ministry, not the Lake Superior Board of Education

Life Skills: The second phase of the Distance Education Project will also be launched in the fall of 1981. A Grade 10 course in life skills will be offered as the computer assisted school portion of a work experience program Students select four of the twelve possible units on general citizenship topics such as law or nutrition This course will aim to improve social skills and knowledge among students who tend to leave school early Again the P T R will not be affected

Electronics: In January 1982 a computer managed electronics course will be introduced at the Grade 11 and 12 levels. These courses will be directed towards acquiring skills which are in the highest demand in these 'company towns' with a strong micro electronics orientation

The need for such programs in an isolated Northern community is clear. The gains made in Lake Superior may benefit other school systems as well.

Ontario Institute for Studies in Education: The Ministry of Colleges and Universities has funded a computer assisted remedial mathematics course "Can 8": originally for remedial work at the colleges of applied arts and technology but now adapted to the grade seven, eight and nine levels. This program runs from OISE and could become part of the educational computer network. These programs may be adapted to micros.

INFORMATION RETRIEVAL STANDARDS

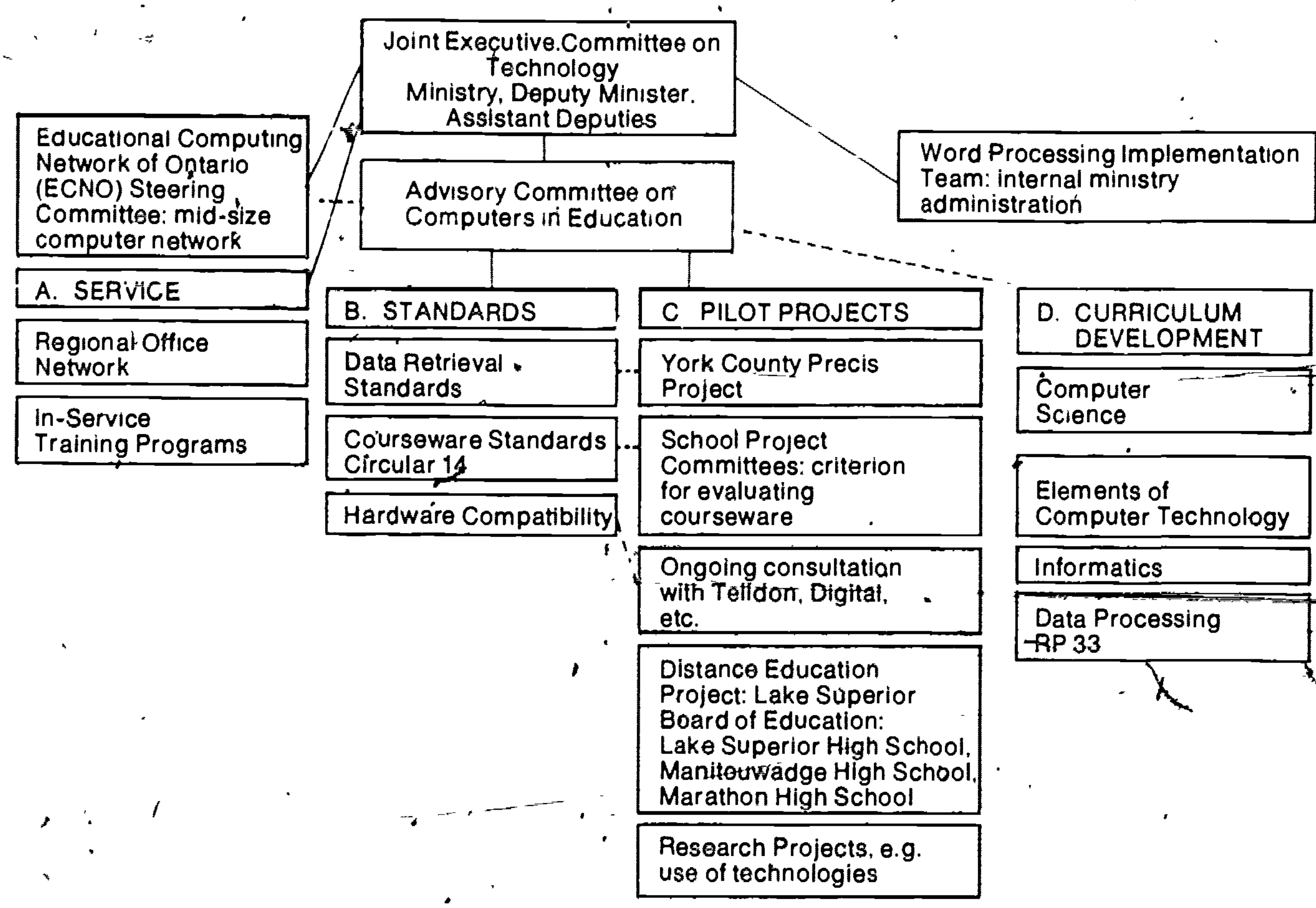
The Ministry has been funding the York County project in keyword indexing known as PRECIS since 1976. Librarians are still debating the virtues of the PRECIS system. The Ministry hopes to provide a guiding role for this debate in Ontario to ensure co-ordination and co-operation among school libraries. The main goal is to set arbitrary specifications for compatibility and for simple access.

RESEARCH

The Ministry is investigating the types of technologies which teachers actually use Computers are included in a long list of more traditional technologies such as films and books.

INTERNAL MINISTRY DEVELOPMENT

The Ministry is updating its own computer technology in order to provide more efficient services and more experienced guidance. Word processing has been introduced to the administration, a number of micro-computers have been purchased for various departments, in-service programs largely consisting of the opportunity for "hands-on" experience with a computer are underway for ministry personnel



ONTARIO MINISTRY OF EDUCATION — COMPUTER ACTIVITIES 1981

"MINISTRY ECNO NETWORK GOES INTERACTIVE: SELECTS DIGITAL'S VAX"

The Educational Computing Network of Ontario (ECNO) is expanding its services into interactive administrative systems. This move is the result of a year and a half, in-depth study which standardized the equipment that boards may use in conjunction with the new Ministry services.

Digital Equipment of Canada (DEC) has been selected as the supplier of record for equipment to be purchased by boards. Their VAX-11/750 will be used for smaller and medium installations and the VAX-11/780 will support the larger board operations. The Ministry's contract with DEC will be negotiated in conjunction with a large purchase of DEC equipment by a consortium of Colleges of Applied Arts and Technology (CAATCON), and will provide discounts of 14-16%. Under the terms of the agreement, interested boards will purchase or lease equipment directly from the company.

The common equipment will permit ECNO to develop on-line applications for board use. It also has the capability to support student programming language compilers.

According to Dennis Wicary of the Ministry of Education's Management Information Systems Branch, the first application will be a Financial Accounting System (FAS). This will be a commercial package to be acquired and modified to the common requirements boards have in the areas of accounting, purchasing, and budget control. Additional features will be provided including fixed asset control, energy management, revenue control and cash management. The systems should be operational in January, 1982.

The next system will be the Student Administration System (SAS). Initially this will provide registration, marks reporting and analysis, attendance, and related maintenance of student data for grades K-13. The system is expected to be available in September, 1982, with timetabling features added in 1983.

An Integrated Payroll Personnel System (IPPS) will be added in January, 1984.

The Ministry will continue to offer its batch applications from the Queen's Park Data Centre.

These include the Integrated School Service (ISS — a marks gathering and reporting application), the Payroll Personnel Administration Service (PPAS), the Personnel Employee Management Information Service (PREMIS), the Route Management and Update Service (ROMUS — school bus route management) and the Student Guidance Information Service (SGIS). The first three will also be converted to run on the VAX equipment in board offices for January 1982.

The distributed software network approach has been a joint development between the Ministry and board personnel. The Network Steering Committee consisted of Ministry personnel, Peat, Marwick and Partners (Project Managers), and board personnel. John Bramwell (London), Bill Britton (Renfrew), Jack Buchanan (East York), Blair Butler (Wentworth), Dan Cousineau (Carleton), and Rick Gelinas (Windsor).

Each application will be developed cooperatively with board personnel. An example is the Financial Accounting System, which is being specified by a steering committee composed of John Hall (Renfrew), Ken Kovosi (Windsor), Don Perry (Lakehead), Gary Schlueter (Waterloo), Ron Trevail (London), and Dennis Webb (Wentworth).

Further information about ECNO can be obtained from Dennis Wicary, manager, Customer Services Section, Management Information Systems Branch, Ministry of Education, Queen's Park, Toronto M7A 1L2 (416) 965-6669.

ECOO Newsletter Vol. 2, No. 2. June, 1981 p. 14

PROFESSIONAL ISSUES

HEALTH HAZARDS OF VIDEO DISPLAY TERMINALS

Many studies have been conducted on adults using video display terminals in offices for a normal eight hour day and five day week. These results tend to be contradictory and inconclusive, but some of the findings may have significant educational implications. Although radiation appears to be the most alarming of all cited effects, other hazards such as eye strain, fatigue and stress are more widespread. Any of these effects could potentially cause permanent physical damage to students and teachers using video display terminals. However, most studies agree that known effects may be controlled by strict manufacturing and maintenance standards, appropriate lighting and room design, and variable task structures. Fear of short term effects have been calmed to some extent, but long term effects cannot yet be determined. This issue has become a great concern to government, labour and corporate health officials.

EYESTRAIN, HEADACHES, FATIGUE

Cause	Prevention
Glare and reflection from windows or lighting that may be too bright or incorrectly placed in relation to the display terminals.	Machines should be positioned to avoid glare. Lighting should be adjustable to suit the task at hand, preferably at each work station.
Contrast glare from bright walls and windows.	Glare can be reduced by blinds and neutral colour schemes. Brightness controls on individual machines should be used to adjust to the viewer's visual capacity.
Flicker effect — If the light emitted by the screen is refreshed at too slow a rate, the letters appear to flicker or jump.	The refresh rate should be set at a minimum of 60 'hertz' or 60 times per second. The user should be able to adjust this rate with the brightness controls.
Character size — Small screens may display characters which are too small for easy viewing.	Large screens with a viewing distance of 2 feet and a character height of at least 3/16 of an inch are recommended by NYCOSH, (New York Committee for Safety and Health Inc.). The viewing distance may be adjusted if the screens are not attached to the keyboards.
The **sharpness** of the character depends on the 'Matrix' of the dots.	NYCOSH recommends a matrix of 7 wide by 9 high for each character.
Screen and character colour — Research is being conducted to determine the combination of colours which will produce the least eye strain.	Dark green screens with lighter green or yellow characters, OR black screens with white letters are preferred combinations at this time.
Blurriness — This may be caused by poor maintenance or an old cathode ray tube.	Terminals should be checked at least twice a year.
Task design — Long periods of concentrated focusing will cause visual strain.	V.D.T. users should vary their tasks in order to rest their eyes.

BACKACHE AND FATIGUE

Poor posture is often caused by the inappropriate height of chairs or screens, or poor viewing angles and distances. Adjustable models of screens and stands can accommodate the variety of users which any school machine would have.

RADIATION

Government and industry testing for radiation has been challenged by labour and independent health specialists. Acceptable standards of radiation are being debated while many models have not been tested for radiation frequencies at all. In theory, all radiation is contained within a properly designed and maintained machine.

Two types of radiation hazards have recently become public concern in Ontario. Neither of them has been conclusively linked to video display terminals but concern persists.

Birth Defects — The most publicized case occurred when four women of the advertising section of the *Toronto Star* gave birth to defective babies in 1980. The studies conducted by the *Star* and government officials have rejected the video display terminals as the cause; alternative explanations have not yet been offered. Some companies such as Bell Canada are now offering alternative work, or leaves of absence without pay to pregnant employees using video display terminals.

Cataracts may be caused by low levels of non-ionizing radiation. These cataract conditions differ from the kind associated with the degeneration of the eye in old age. Mrs. Weiss, an employee of the Ministry of Transportation and Communications in Thunder Bay claimed compensation for her recent cataract condition. Although the evidence failed to prove her claim, studies are being watched carefully, especially those conducted by Dr. Milton Zaret, an independent New York ophthalmologist.

ALIENATION

Alienation and depression have been major problems for adult workers using video display terminals. This may not be a severe problem for adolescents who have grown up with this medium. The quality of the programs will likely be a greater determinant of their receptiveness and motivation.

TEACHING STYLES

The computer introduces another medium to the teacher's already diverse repertoire of teaching methods. At one extreme the computer can eliminate much of the routine drill and practice, and free the teacher for individual instruction and enrichment. At the other extreme, the computer can provide simulations that enable the teacher to introduce new concepts. Even though teachers may not have to program, they will have to learn how to use a computer and to become familiar with the new resources. Teachers will need to practice a variety of computer assisted methods and then select the ones which suit their style, their objectives, and the learning patterns of their students.

STAFFING

The education system needs new teachers with computer skills as well as a competent feeling for the medium. Many potential teachers with computer skills are attracted to higher salary levels offered by industry. This puts greater pressure on the system to upgrade its experienced teachers. Immediate programs should be launched by boards to either provide their own-in service training or to provide incentives to teachers taking external computer courses.

TEACHER TRAINING

WHO?

Boards should make upgrading courses available to computer science and data processing teachers. Other teachers should be instructed separately with less emphasis on programming.

WHAT?

Courses should balance theory and practice. Key components include:

- history of computers
- parts of the computer
- computer vocabulary
- capabilities of the computer: what it can and can't do
- administrative uses
- computer as vehicle for instruction: drill and practice, tutorial, simulation, problem-solving, gaming, creative exercises in music or writing
- teaching strategies
- evaluating computer learning materials
- modifying computerized learning materials
- learning a programming language
- producing learning materials
- resources

COURSE DESIGN

Courses should be offered in modules so that teachers can enter at their own skill level and avoid repetition. Sufficient terminals and instructors should be supplied to enable a large percentage of teachers to obtain training in the near future. They should gain hands-on experience on a variety of CURRENT models. Futuristic approaches should be avoided.

COPYRIGHT

Two poles of opinions divide the educational software world. One advocates the mass sharing and distribution of programs for maximum educational benefit. The other polarity is more concerned with the economic realities of developing and marketing high quality programs. There is room for both poles but teachers are advised to make a sharp distinction between the two. Copying and sharing programs will speed the development of banks of locally produced programs. Although a purchaser is permitted and encouraged to make one **back-up copy**, the general practice of copying and sharing commercially produced programs must be prohibited for legal and economic reasons. Teachers or students could find themselves in the midst of a legal battle. The profits lost by the producer on sales and legal fees will discourage future educational software development.

The lack of high quality commercial programs is in large part due to their inadequate legal protection. Companies spending millions of dollars in developing sophisticated educational programs may be vulnerable to mass copying without any clear legal redress. The legal ambiguities have not been resolved in Canada but some progress has been made in the United States with the Computer Software Copyright Act of 1980. The United States may provide legal precedent for Canada, more importantly, the United States is a prime source of many of our programs. Consequently, teachers and students should be aware of the legal and financial ramifications surrounding the copyright issue.

There have been four standard methods of protecting software, none of these is both fast and sure enough to provide adequate protection.

A **COPYRIGHT** protects the expression of an author. It does not necessarily protect the underlying idea or algorithm. Many copyright battles have been lost in Canada and the United States because the new computer medium does not conform to legal definitions of "literary or artistic works". Copyright is an easy and inexpensive method of protection but it is also quite weak. Recent legislation in the United States and proposals made in Britain may put teeth into their legislation. In the meantime, copyright may still be the best method of protecting programs which teachers write themselves. A copyright notice (©, date . . .) on the program provides **common law protection**; the more formal method of registering copyright in Ottawa may be too involved a process for most school programs. Anyone who reproduces, distributes, copies or prepares derivative works of copyrighted software would be infringing upon the copyright. Persons utilizing or displaying such materials publicly could also be liable.

A **PATENT** grants the exclusive right to produce, use or sell an invention for a certain period of time. Patents may provide excellent protection if they can be obtained. Some have been refused on the grounds that mathematical principles are laws of nature which cannot therefore be owned by an individual. The process of obtaining patents is a lengthy and expensive one which must be repeated in every nation in which the program is marketed. This makes it highly impractical in a field changing as fast as computers. The making, use or sale of patented software constitute infringements.

Many top companies have registered programs as **TRADE SECRETS**. This is only feasible when a relatively small number of programs are being distributed. If the secret is disclosed, no legal protection is provided. Trade secrets would work against the principles of mass distribution necessary in a public educational system. Anyone improperly obtaining a trade secret could be liable to penalties.

A **SALES CONTRACT OR LICENSE** may include a clause prohibiting copying and distribution of the program. Any individual who is party to the contract would be required to obey its terms or be liable for damages. This could be a difficult agreement to maintain in a school environment where many individuals have access to the materials.

Considering the weaknesses of the legal remedies, commercial producers have introduced three alternative methods of preventing copying. First, discs can be locked to prevent copying. Secondly, programs can be put on ROM chips rather than on discs or ~~tapes~~; the ROM is then inserted directly into the machine. Thirdly, copying "bombs" can be built into the programs; these bombs are programs which will erase or destroy the main program if copying is detected. None of these methods are totally foolproof and they all add to the cost of the program.

OBSOLESCENCE

Many educators want to stand back until the pace of change has slowed in hopes that their money will not have been 'wasted' on obsolete technology. However, the pace of change is unlikely to slow down significantly in the near future. Obsolescence is a way of life in the computer era. Even if the machinery changes, the concepts learned on a computer never become obsolete. The 'real world' is already computerized; if educators continue to wait, they may be jeopardizing their students' abilities to compete in the job market.

BUDGET STRUCTURES

Huge capital investments are necessary for computers but these can be justified by the educational gains made. Traditional budget structures rarely provide enough flexibility for the implementation or updating of computer programs in schools:

- The traditional division between capital expenditures and supplies may not allow enough flexibility to purchase sufficient hardware or software.
- Historical divisions of school budgets are extremely difficult to change. Math departments used to requesting very small sums for graph paper may now be demanding thousands for computer equipment. Conflicts of interest may diminish faster as all departments implement some form of computerized instruction.
- If school budgets cannot provide for computer equipment, Boards will be responsible for making special allocations.
- The normal time delay between approval and purchase may date the equipment.

CAREER PLANNING AND COMPUTER LITERACY

Ten years ago, only students planning to be programmers would consider taking computer science courses. Today, a wide variety of careers are demanding computer or computer-related skills. Computers are becoming essential components of medicine, law, journalism, teaching, engineering, commerce and industry. Individuals working in any of these areas will have to be able to use a computer and understand its power. For instance, it is predicted that most business will be conducted from 'integrated electronic offices' in the near future, communication will be conducted entirely through computer networks. The skills that will be required in a computer society differ from the traditional reading, writing and arithmetic skills. Students will need these skills for employment.

SEXISM

Because there is such a demand for skilled programmers, computer companies tend to be non-sexist employers. However, many girls are not acquiring sufficient programming skills to qualify for the jobs available. There is a disproportionately high enrollment of males in computer science courses. Several explanations **have been proposed:**

- Girls may not be as interested or capable of computer science in the same way that they have tended to avoid mathematics and science specialities.
- There is a tremendous peer pressure from the male computer hobbyists to include only their own kind. In this sense, the computer has been called the 'hot rod of the 1980's'.
- There is an insufficient number of female computer science teachers to provide role models for girls taking the courses.

The strengths and weaknesses of these explanations may be debated ad infinitum. It is perhaps more important to look for solutions to this imbalance in order that girls have competitive skill levels in this area.

HAVES AND HAVE-NOTS

The computer is producing new kinds of social and economic inequalities between 'haves' and 'have-nots'. The ability to retrieve, and program data gives any individual, corporation, or nation a key competitive advantage over others. This is a matter of concern to educators.

- **Evaluation:** Students with outside access to data retrieval systems can easily produce superior research projects. Others working just as hard or harder in traditional libraries may only produce second rate material by comparison. School boards have a responsibility to provide all students with access to this technology.
- **Quality of Education:** Boards or schools with superior computer facilities and data retrieval systems will be able to provide superior education. Learning all subjects may be more effective. Advanced computer and programming skills will give students a distinct competitive advantage in their higher education and the job market.

PSYCHOLOGICAL BARRIERS: THE GENERATION GAP REDEFINED

Both parents and staff members may clutch to books and paper copy as the only medium that provides security and meaning to them. The electronic medium consisting of video display terminals and computer programs tends to terrify and intimidate them. However, students who have grown up in the electronic era are equally comfortable with a variety of media. They are able to select the medium that suits their purposes more easily and adjust to their varying rates of information flow. Both the style of learning and the pace differ.

The electronic generation gap must be realized and addressed. Parents and teachers must gain an understanding of the process as well as the content of computerized learning. Parents should be included in school workshops or demonstrations to help them gain this insight

THE COMPUTER

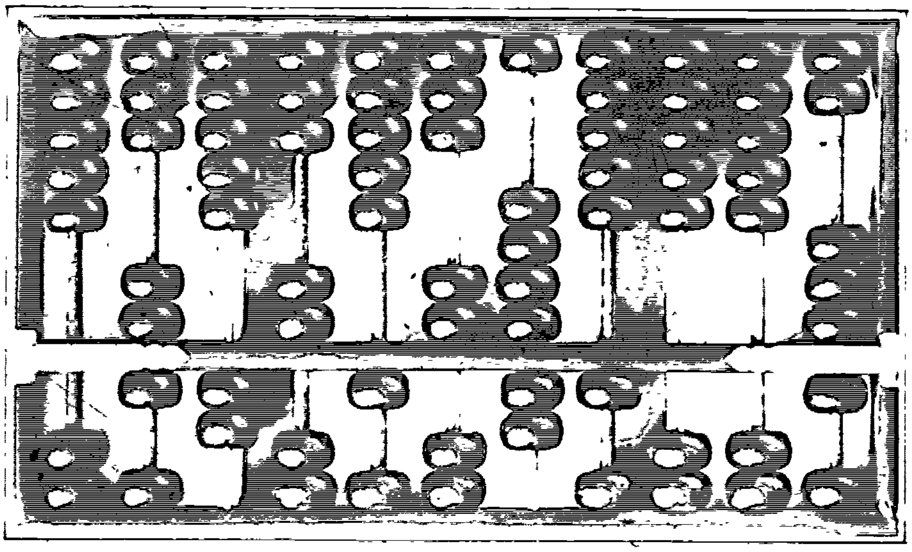
HISTORY

The significant progress in electronics in the 1940's represented a turning point in the quest for an effective computing device. Several mechanical devices had been invented with many of the essential features of a modern computer but they were too slow, expensive and inaccurate for practical use

THE PRE-ELECTRONIC ERA

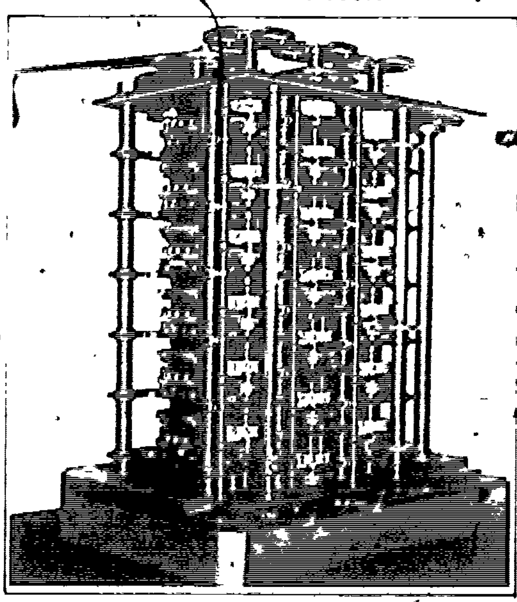
Abacus: China over 2,000 years ago

The abacus is a primitive counting device traced back over 2,000 years. The relative positions of the beads denote their value, computations are conducted according to the levels of the frame and an established set of rules or 'programs'



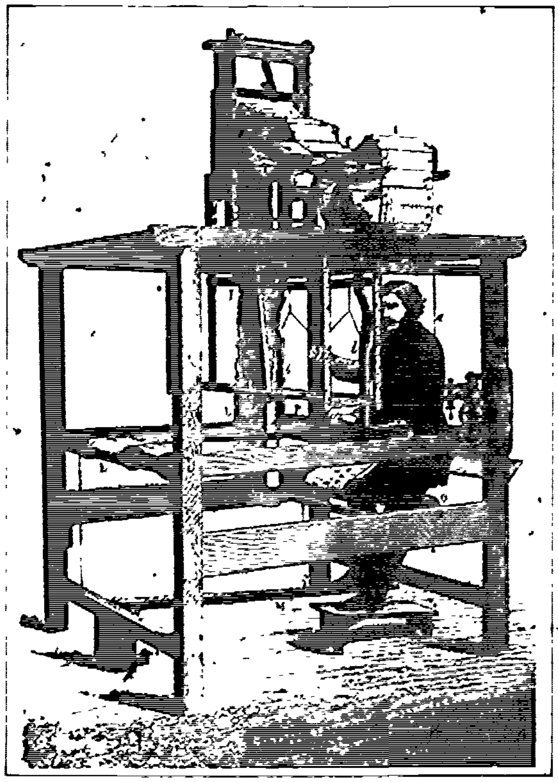
The Difference Engine: England 1822

The Difference Engine was the inspiration of Charles Babbage and his mistress Ada Lovelace. It was a tribute to nineteenth century British wealth and inventiveness. The mechanics failed but the concept of a programmable calculator had been conceived. This scheme won the first gold medal of the Royal Astronomical Society and £17,000 of government funding. However, the "tons of brass and pewter cogwheels, sprockets and other knick-knacks" amounted to mechanical disaster



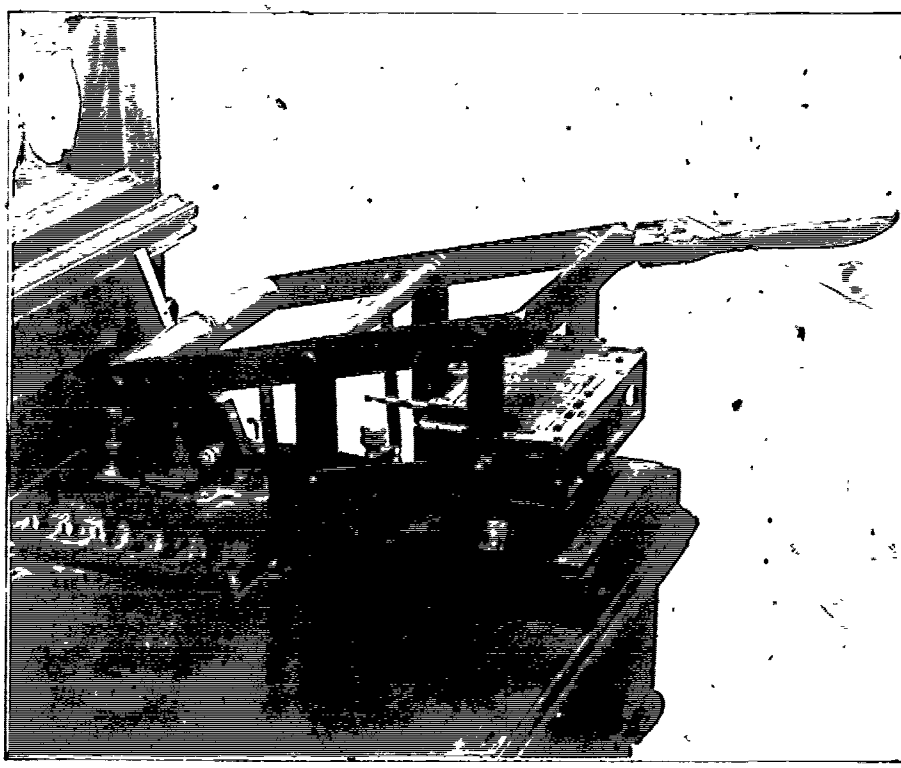
The Punched-Card Loom: France 1804

This was one of the first industrial applications of calculators Woven patterns were controlled by punched cards These "Jacquard" patterns have acquired the name of their inventor



The Hollerith Tabulating Machine: United States 1890

Herman Hollerith developed a new calculator for the 1890 American census The punched cards used as counting devices were so fast that the 1890 census was completed in 6 weeks as compared to the 7 years required for the 1880 count This success established Hollerith's company, International Business Machines (IBM), as a forerunner in the twentieth century



THE ELECTRONIC ERA: THE ELEPHANT

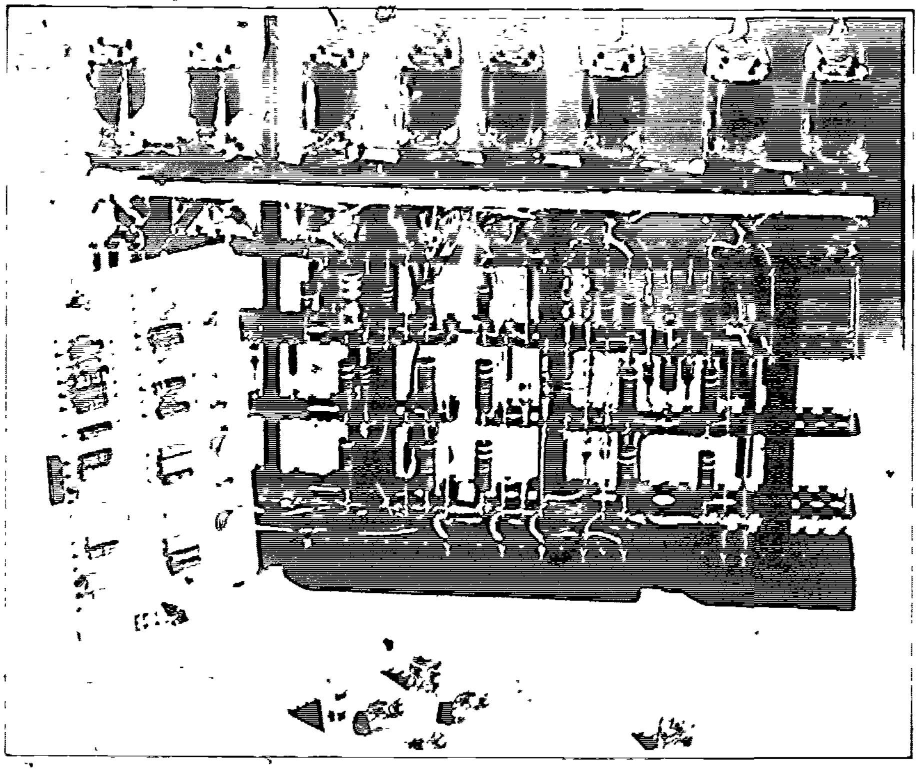
Perhaps the computer should be placed along side atomic science in any analysis of the World War II As the world was absorbed in the struggles of tank, plane and submarine warfare, World War II was being won on a secret front Intrepid, a Canadian secret agent, headed up a network which succeeded in capturing the German code machine, Enigma, from behind German lines. A team of top Allied scientists gathered in Bletchley Park, outside London, to decode the German messages The advantage of anticipating enemy strategies is obvious, but the team of cryptographers had to develop the first functional electronic computer in order to handle the volumes of data Photo electric readers scanned data at an unprecedented speed of up to 5,000 characters per second Vacuum tubes were introduced as the basic computing device These were significant milestones, but the 'Collossus' was still a single-purpose, non-programmable machine (Christopher Evans, *The Micro Millenium*, pp 34-35)

The American military developed a more general purpose machine, the **ENIAC** or Electronic Numerical Integrator and Calculator In theory, it was programmable but this required a complex rewiring of the machine, progams could not yet be stored The 140 kilowatts of power which this machine required made a sophisticated cooling system essential It weighed over 50 tons, filled 2 rooms and yet was less efficient than today's desk-top micro-computer It truly was an 'elephant'

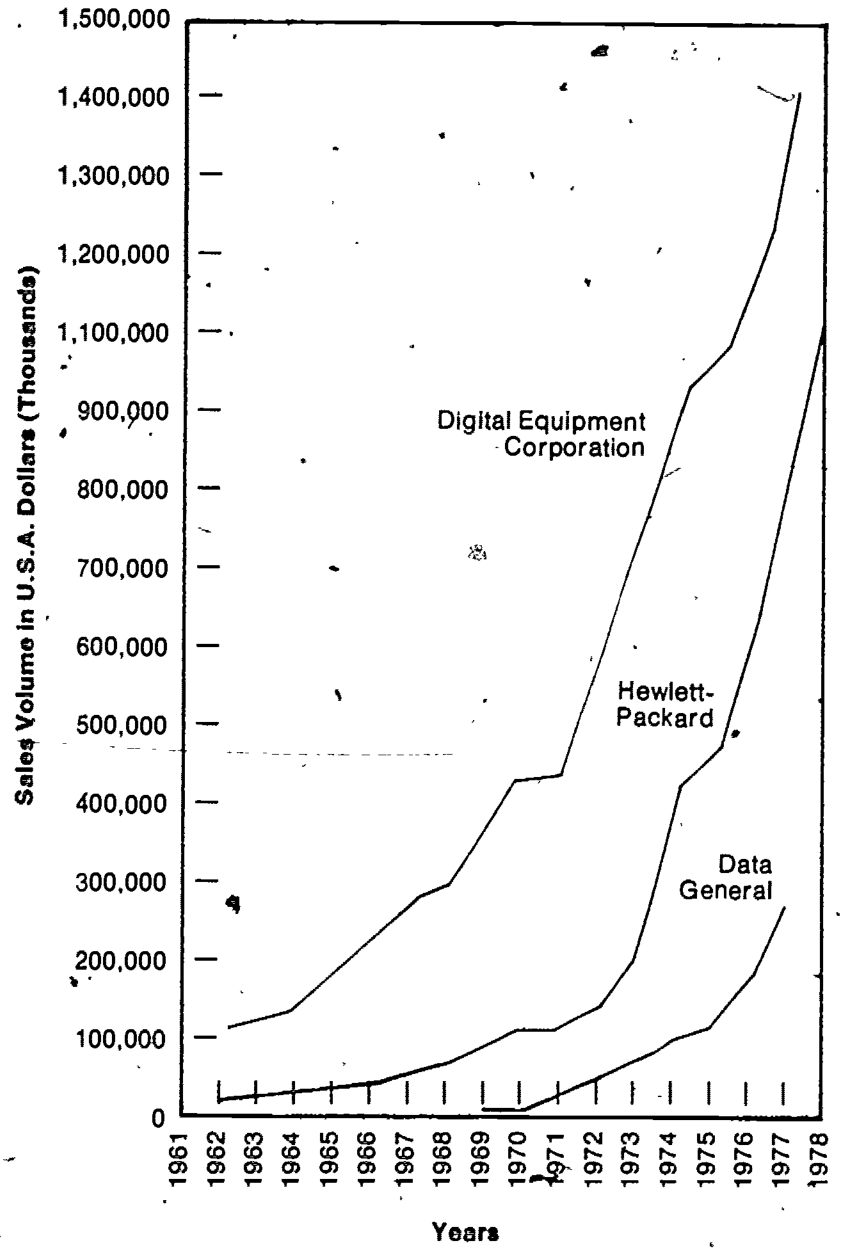
THE ELECTRONIC ERA: THE MOUSE

The invention of the transistor in 1948 led to the development of the computer 'mouse' Action within the silicon crystals of the transistor provides powerful electronic amplification, heat is not required to drive electrons This meant that computers could be removed from their air-conditioned cells and placed in any office or scientific environment The original transistor was about 1/100 the size of the vacuum tube while performing faster and more reliably Since the development of the first integrated circuit on a chip in 1959, the reduction of size and increase of power has about doubled each year In 1969, a chip of silicon, 1 square centimetre in size could hold 1,000 transistors, by 1978, 65,000 transistors could be packed into the same space This meant that smaller computers with larger memories could be built at less cost than their predecessors, the micro-computer era had begun

This photograph shows the miniaturization of computer circuits from the 1940's to the 1960's



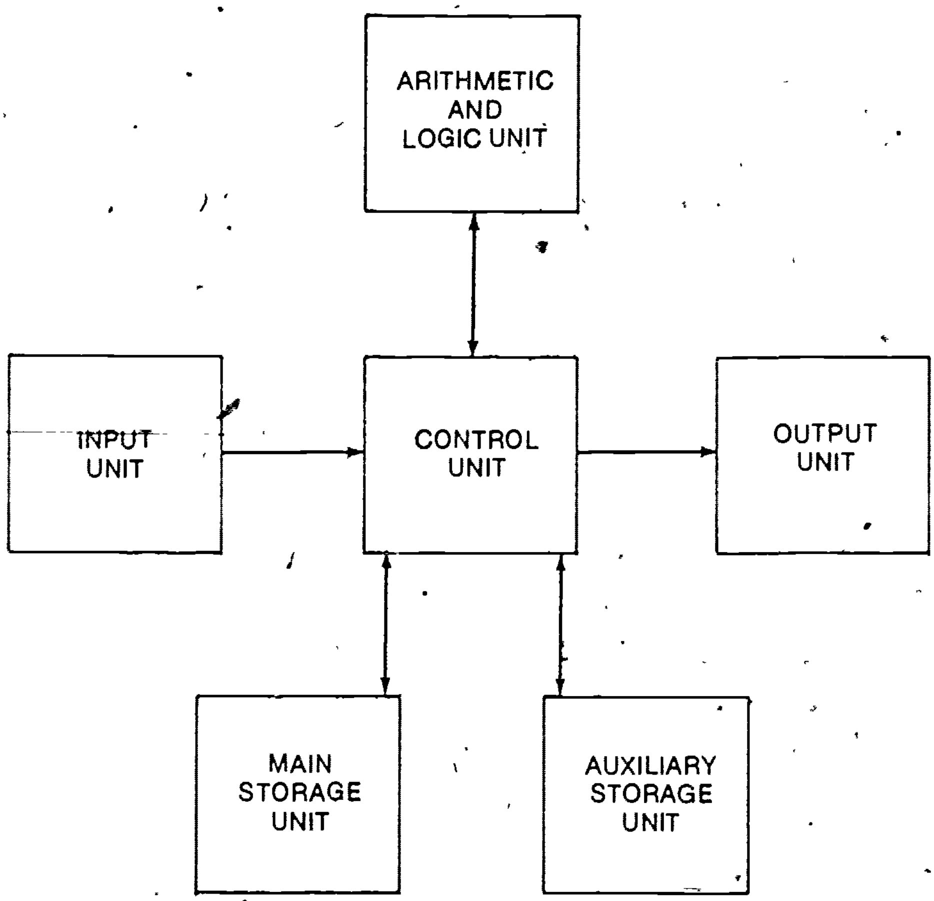
The significant drop in the price meant that the micro-computer was ripe for the consumer market by the mid 1970's Since then the market has truly "run wild" with sales multiplying as indicated in the graph below More people are using more computers for more varied functions Businesses and industries operating in a competitive environment have quickly adopted computers to increase efficiency and productivity By comparison, schools have been slow to respond. This may be explained by the lack of true competition as well as the quagmires of the political process rigid budget structures and pedagogical debate



GRAPHS OF NET SALES FOR THE THREE LEADERS OF THE MINICOMPUTER INDUSTRY, Hewlett-Packard, Digital Equipment Corporation, and relative latecomer Data General. (Sources: Hewlett-Packard Annual Reports (1962-1967), Data General Annual Reports (1969-1977), Digital Equipment Corporation Annual Reports (1962-1978).) From: A. Osbourne. *Running Wild: The Next Industrial Revolution.* p. 7.

COMPUTER TECHNOLOGY

MAJOR SUBSYSTEMS OF A COMPUTER (A SCHEMATIC DIAGRAM)



"A picture is worth 1K of 16-BIT words"

INPUT: allows a computer to accept information from the outside world. The input device might consist of a card reader, teletype, magnetic tape or console.

CONTROL: manipulates the activities of all the other subsystems. It controls the sequence in which operations are performed as well as actually fetching and decoding the instructions from main storage.

ARITHMETIC AND LOGIC: contains all the electronics which perform the arithmetic operations, comparisons and other data transformations.

MAIN STORAGE: or computer memory, holds information for the job a computer is doing. This information could be in the form of instructions to the computer or just data. It provides the fastest access to information. Any program being executed resides in main storage. Examples are RAM, ROM, and PROM. Because main storage was originally designed using small ferrite cores, it is commonly referred to as "CORE".

AUXILIARY STORAGE: devices which increase the storage capacity of main storage, yet are physically distinct from main storage. Such common auxiliary devices are magnetic tape and disc storage. Programs and data must be copied from auxiliary storage into main storage in order to be executed or used.

OUTPUT: allows a computer to give information to the outside world. This information may be written onto such media as paper on a printer, punched cards, magnetic tape or disc, punched paper, the screen of a computer console, or some audio device.

The control, arithmetic and logic, and main storage subsystems are usually placed physically together in the same computer unit. The distinctions made among the functions of the various components is for pedagogical reasons and is not clearly as separate in the actual electronic circuits which perform these functions.

PERIPHERAL DEVICES: "One machine can do the work of fifty ordinary men. No machine can do the work of one extraordinary man."

— Hubbard: The Philistine XVIII

There are many add-on devices available for computers, especially micros. They generally enhance the input and output functions of the computer.

ACOUSTIC COUPLER: See Modem.

CARD READER: An input device; a punched card reader, reads data from a card by shining light through card holes to a light sensing receiver. Mark-sense cards cause the light to be reflected back by the pencil marks, to the light sensing receiver. Card input to computers is becoming less common.

CASSETTE TAPE RECORDER: Commonly used on microcomputers as auxiliary storage devices. They are virtually the same as the devices cassette music tapes are played on. Transmission speeds of data to and from are extremely slow and random access of data is not possible.

DISC: Discs may be categorized according to a number of characteristics. The large discs about the size of an LP record are called HARD DISCS. These may be enclosed in a plastic case allowing them to be removed from the drive or they may be fixed inside the disc drive.

FLOPPY DISCS: are flexible and may be bent without damaging them. They also come in 5¼" and 8" diameter sizes, with the larger size providing more information storage.

SOFT/HARD SECTORED DISC: Soft sectored and hard sectored discs refer to the way in which information is set up and referenced on the disc. Information on hard sectored discs is referenced by holes placed in the disc. Soft sectored discs reference information by electrical codes placed on the surface of the disc. Information is stored on a disc in concentric circles called tracks, which are, in turn, subdivided into sectors.

DOUBLE/SINGLE DENSITY DISC: Refers to how information is packed on a given track. Double density means 256 bytes per sector, single density means 128 bytes per sector. As an auxiliary storage device, the disc offers the advantage over tape storage of random access to files. Also the speed at which information is copied is much greater. For example on a typical floppy disc system a 13000 byte program takes only 20 seconds to copy, whereas on a cassette it takes 3.5 minutes.

DISC DRIVER: The disc fits on a spindle inside the drive which rotates the disc at a very high speed. A special read/write head inside the drive moves across the disc, without touching it, to read and write information on the disc. Some disc drives may accommodate more than one disc, and may be enclosed in an air-tight case. There may also be two read/write heads for each disc allowing data to be stored on both sides of a disc.

GRAPHICS TABLET: A 40 cm square plastic tablet connected to a computer. When the surface of the tablet is touched with an electric pen, information is transmitted from the tablet to the computer which in turn displays it on its monitor. It is an input device which is very useful in graphical work.

INTERFACE BOARDS: Extra electronics attached to a circuit board which, when plugged into a computer, expand the power of a computer. They may provide more memory or allow other devices to be attached such as printers, disc drives, etc.

JOY STICK OR PADDLE: An input device the size of a cigarette package with a lever attached. Movement of this lever or stick causes a corresponding movement of the computer cursor. The joy stick is a very popular device in electronic games.

LIGHT PEN: An input device the size of a large fountain pen. It is used in retail stores to scan bar codes on merchandise. Information may also be transmitted and displayed on the computer screen by touching the screen with the pen tip. It is a very useful input device for graphical design work or in special education in allowing a student to put information into a computer.

MAGNETIC TAPE UNITS: Similar to cassette tapes, however much larger, and faster, consequently allowing greater amounts of information to be stored on them. "Mag. Tapes" are usually found on mini systems and larger computer installations. They are auxiliary storage devices.

MODEM: A combination input/output device similar in size and shape to a hand-held telephone which allows information to be transmitted over a telephone line.

MONITOR: A television-like device connected to a computer. High resolution allows for good graphics displays. A monitor is often called a CRT (cathode ray tube).

PRINTER: A high speed output device providing information printed on paper. Line printers print one entire line of information in one stroke, whereas serial printers print one character after the other. Impact printers, such as a dot matrix printer, print by pressing a carbon ribbon against paper like a standard typewriter Non-impact printers such as thermal or laser printers use a chemical or heat process to place characters on the paper. Friction feed and tractor feed printers refer to the way paper is pulled across the printing mechanism. For teachers, friction feed printers have the advantage of allowing dittos to be easily inserted for fast reproduction later.

COMPUTER LOGIC

BINARY NUMBERS

The human hand is the basis of the ten digit decimal system, but computers have only two 'fingers': 1 and 0. These are electronic fingers which count according to the "Base-2" or BINARY system. As the computer is an electronic device, the process of counting is expressed by a variety of electronic functions such as the following:

0	1
• no current flowing	• current flowing
• area not yet magnetized	• area magnetized
• switch is off	• switch is on
• light is off	• light is on
• low voltage	• high voltage
• hole not punched	• hole punched

The two digits may be combined in innumerable ways to represent data or to perform programmed functions.

Consider a computer that uses eight electrical lines. There are 256 combinations in which we can apply current to these lines. Some of these combinations may represent letters or numerals, others may be special characters such as periods or commas and still others may represent commands which control the functioning of the computer.

A specific combination of currents flowing in the right lines may be represented by the digits 1 or 0. Where current is flowing a '1' is used and where it is not, '0' is used.

electrical lines	representation
current	1
no current	0
current	1
current	1
no current	0
current	1
no current	0
current	1

The presence or absence of current is represented by '1' and '0'.

This number representation, using only the digits '1' or '0' is called the **BINARY** number system (see chart) and all information stored by computers is in this form.

Each binary digit is called a **bit**, and eight binary digits one **byte**. One byte of storage is sufficient to store one character such as one letter, hence the number of bytes available in memory is a measure of the amount of information or the size of a program, which the computer can store. This measure is usually expressed in thousands of bytes, represented by the letter K, for 'kilo' (actually 1K = 1024, not 1000; ($2^{10} = 1024$).)

11011101
00111001
10011001
11001101
00011011
11010110
11101110
11001100
11001100
00101101

A section of internal memory organized into units called 'bytes'.

Most student programming could be accomplished with 4K to 8K bytes of memory, but more sophisticated uses such as Word Processing or record keeping would require machines with 32K, 48K or more.

Values 1 to 20 written in four different number systems.

DECIMAL	BINARY	OCTAL	HEXADECIMAL
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10
17	10001	21	11
18	10010	22	12
19	10011	23	13
20	10100	24	14

NUMBER SYSTEMS

The following information would be of value to those who wish to be able (or at least understand how) to convert from Binary, Octal or Hexadecimal back into our Decimal system. This is only necessary if you plan on reading or using machine language. It is not necessary to know these skills if you plan to program only in High Level Languages such as BASIC.

When communicating with the computer at a machine language level, binary representation becomes too cumbersome. To enter the number 214, for example, would take the eight binary digits 11010110. When entering many values as binary numbers, it is also obvious that numerous errors could occur. The use of the hexadecimal system is a workable compromise between our use of the decimal system and the computer's binary system.

When computers display the contents of their memory locations, instead of printing binary numbers, 1's and 0's, the values are converted to the hexadecimal system as follows. One byte of memory is grouped into two four-bit units. Each unit is then converted to one **hexadecimal digit.**

[11010110]	**internal storage** (one byte)
[1101] [0110]	**grouped into fours**
[D] [6]	**converted to hex** (see chart)

Hence our decimal number 214 is stored as 11010110 internally, but when communicated at a machine language level the hexadecimal number D6 is used.

A similar technique is used if the computer has been designed to group bits into groups of three's instead of fours. In this case the **octal** system is used and each group of three is converted to an octal number.

The computer's memory is grouped into units of three bits and each is converted to one octal digit.

[11010110]	**internal storage**
[011] [010] [110]	**grouped into threes**
[3] [2] [6]	**converted to octal** (see chart)

Hence our decimal number 214 is stored as 11010110 internally, but when communicated at a machine language level the octal number 326 is used.

internal storage	hex code	actual character
01000011	43	'c'
11001000	C8	'h'
11000001	C1	'a'
11001001	C9	'i'
11010010	D2	'r'

example of the PET® ASCII character representation for storage of the word "chair".

PLACE VALUE SYSTEMS: The value of our numbers depends on the digit and the position that digit is in.

Decimal — each position represents a power of ten, the digits used are 0-9. e.g.

2 8 5

$5 \times 10^0 = 5 \times 1 = 5$

$8 \times 10^1 = 8 \times 10 = 80$

$2 \times 10^2 = 2 \times 100 = 200$

285 result in decimal system

52

Binary — each position represents a power of two, the digits used are 0-1. e.g.

1 0 1 1 0

$0 \times 2^0 = 0 \times 1 = 0$

$1 \times 2^1 = 1 \times 2 = 2$

$1 \times 2^2 = 1 \times 4 = 4$

$0 \times 2^4 = 1 \times 16 = 16$

$0 \times 2^3 = 1 \times 8 = 0$

$1 \times 2^4 = 1 \times 16 = 16$

22 result in decimal system

Octal — each position represents a power of eight, the digits used are 0-7. e.g.

2 1 3

$3 \times 8^0 = 3 \times 1 = 3$

$1 \times 8^1 = 1 \times 8 = 8$

$2 \times 8^2 = 2 \times 16 = 32$

43 result in decimal system

Hexadecimal — each position represents a power of 16, the digits used are 0-F. The letters A, B, C, D, E, F, are used to represent our decimal numbers 10, 11, 12, 13, 14, 15. e.g.

2 E 7

$7 \times 16^0 = 7 \times 1 = 7$

$E \times 16^1 = 15 \times 16 = 240$

$2 \times 16^2 = 2 \times 296 = 592$

839 result in decimal system

Assembly-language subroutine for the Z80 processor illustrating the use of the hexadecimal system.

Hexadecimal Address	Hexadecimal Code			Label	Instruction Mnemonic	Operand	Commentary
7B60	F5				PUSH	PSW	Save accumulator and processor status
7B61	3A	02	80	REST	[illegible]	$8003	Sample count line
7B64	17				RAL		Rotate bit 7 into carry
7B65	OA	61	7B		JC	REST	Jump if carry set
7B68	3A	02	80	AGANE	LDA	$8003	Sample count line
7B6B	17				RAL		Rotate bit 7 into carry
7B6C	O2	68	7B		JNC	AGANE	Jump if carry not set
7B6F	37				STC		Set carry
7B70	3A	03	7F		LDA	$7F03	Load least significant 8 bits
7B73	OE	01			SBI	01	Subtract one
7B75	32	03	7F		STA	$7F03	Store result
7B78	3A	04	7F		LDA	$7F04	Load most significant 8 bits
7B7B	OE	01			SBI	00	Subtract one if borrow occurred in previous SBI
7B7O	32	04	7F		STA	$7F04	Store result
7B80	21	05	7F		LXI	H,$7F05	Load H L registers
7B83	3A	03	7F		LDA	$7F03	Load least significant 8 bits
7B86	BE				CMP	M	Compare
7B87	C2	61	7B		JNZ	REST	Jump if not equal
7B8A	21	06	7F		LXI	H $7F06	Load H L registers
7B8O	3A	04	7F		LDA	$7F04	Load most significant 8 bits
7B90	BE				CMP	M	Compare
7B91	C2	61	7B		JNZ	REST	Jump if not equal
7B94	F1				POP	PSW	Restore accumulator and processor status
7B95	C9				RET		Return

COMPUTER ARITHMETIC

Computers can perform the four basic arithmetic operations of add, subtract, multiply and divide, but it does not require four different circuits to perform the four functions.

All arithmetic may be performed by addition.

Addition $2 + 5$
obviously we add $2 + 5 = 7$

Subtractions $6 - 4$
we add the negative $6 + (-4) = 2$

Multiplication 3×8
we add a required number of times $8 + 8 + 8 + 8 = 24$

Division $20 \div 5$
we count the number of times 5 may be 'subtracted' from 20
$20 + (-5) + (-5) + (-5) + (-5) = 0$. Hence $20 \div 5 = 4$

The important consequence of this fact is that computers can accomplish all the arithmetic functions by having one circuit that does addition:

ADDITION OF BINARY DIGITS

Suppose we wish to add the contents of two bytes of memory:

```
0 1 0 0 1 0 1 1      byte 1
0 1 0 1 1 0 1 1      byte 2
```

—starting from right to left, as in normal arithmetic we add the first column ($1 + 1 = 2$), remember a '2' is written as 10 in binary, hence the result is zero, with a '1' to carry.

```
              1 carry
0 1 0 0 1 0 1 1
0 1 0 1 1 0 1 1
---------------
              0
```

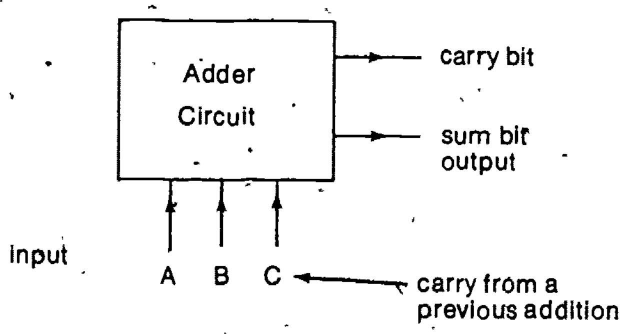
—now we add the second column ($1 + 1 + 1 = 3$) but a '3' is written as 11 in binary so the result is 1, again with a '1' to carry.

```
                1 carry
0 1 0 0 1 0 1 1
0 1 0 1 1 0 1 1
---------------
            1 0
```

—this process is continued for all eight bits until the result is computed.

```
1 0 1 1 0 1 1 1   amount carried each time
0 1 0 0 1 0 1 1
0 1 0 1 1 0 1 1
---------------
1 0 1 0 0 1 1 0
```

A computer must be able, therefore, to not only add each pair of binary digits, but also keep track of any digits carried from a previous addition. It must also pass any value to carry from its sum to the next. This is repeated until all the digits have been added.



The actual construction of this type of circuit is explained in the next two sections on logic gates and transistors.

LOGIC OPERATORS

George Boole, in the mid 1800's, devised a system for the evaluation of the 'truth' or 'falseness' of statements using the English operators 'AND', 'OR', and 'NOT'.

AND

e.g. "I am over 21 **and** I am a Canadian citizen."
True — since both parts are true.

e.g. "I was born in Hamilton **and** I am a millionaire."
False — because both parts are false.

e.g. "I was born in Toronto **and** I teach for the Toronto School Board."
False — although I was born in Toronto; I do not teach in Toronto.

AND • both statements must be true for the entire statement to be true.

OR

e.g. "I live in Toronto **or** I teach in Ottawa.
True — since I do live in Toronto.

e.g. "I live in Kingston **or** I am an American citizen.
False — since both parts are false.

e.g. "I live in Toronto **or** I teach in York County".
True — since both are true.

OR • at least one part must be true for the entire statement to be true.

NOT

e.g. "I was **not** born in Bracebridge."
True — since "I was born in Bracebridge" is false.

e.g. "I do **not** teach in York County."
False — since "I do teach in York County" is true.

NOT • changes a false statement to true and vice versa.

A convenient structure for expressing the functions of the logical operators is with a **truth table.** These tables show the result of the logical operation on all the different possible conditions.

AND

statement 1	statement 2	result
False	False	False
False	True	False
True	False	False
True	True	True

OR

statement 1	statement 2	result
False	False	False
False	True	True
True	False	True
True	True	True

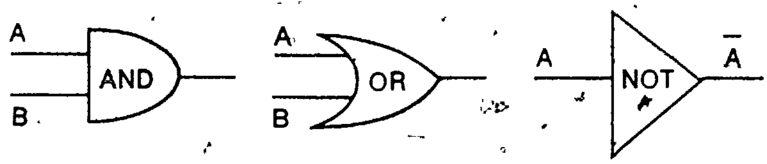
NOT

statement	result
False	True
True	False

LOGIC GATES

All of the arithmetic and control functions performed by a computer are accomplished with the use of these same logical operators. The circuits are composed of three elementary 'gates'. They are the 'AND', 'OR', and 'NOT' gates. Thousands of these simple gates may be combined to produce the complex electronics necessary for computing. The three basic gates:

	(1) AND gate	(2) OR gate	(3) NOT gate
Diagram Symbols			



	(1) AND gate	(2) OR gate	(3) NOT gate
Functions	Both input lines must have a high voltage (1) present to produce a high output (1), otherwise output is low voltage (0).	At least one of the input lines must be high (1) to produce a high (1) output. If both inputs are low (0), the output is low (0).	The output is low (0) if the output is high (1), and high (1) if the input is low)0).

TRUTH TABLES

The functioning of these gates is often described in a Truth Table. The table shows what the output of the gate would be, for each possible combination of inputs. Remember the 1's and 0's are represented by high and low voltages in the circuit.

And

Input		Output
0	0	0
0	1	0
1	0	0
1	1	1

Or

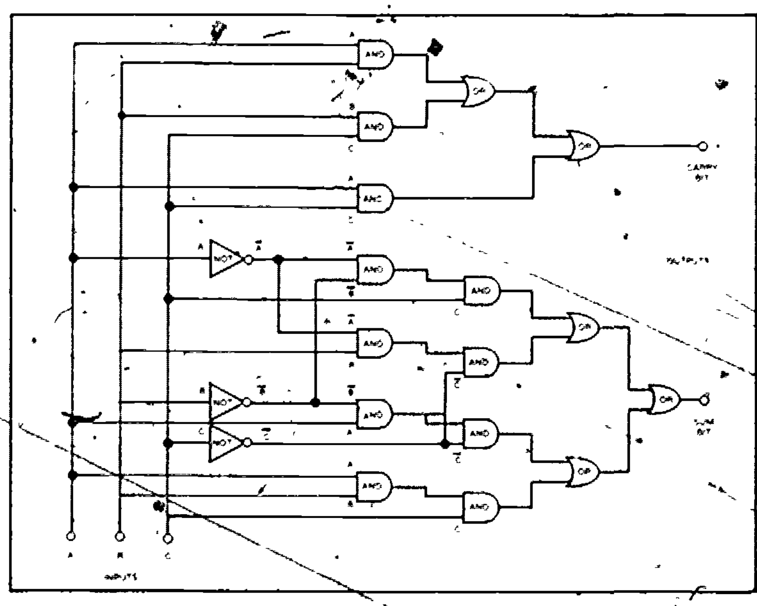
Input		Output
0	0	0
0	1	1
1	0	1
1	1	1

Not

Input	Output
0	1
1	0

The following diagram shows how these gates are combined to perform the addition of two binary digits for the **Adder Circuit** discussed earlier.

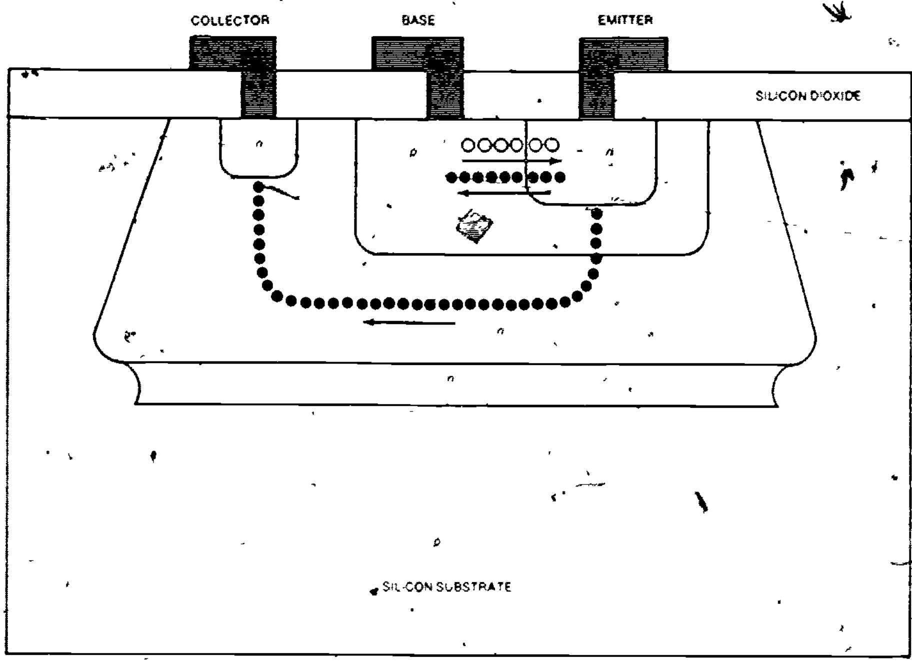
An 'adder' circuit for two binary digits with a carry digit.



'A' and 'B' represent the binary digits being added and 'C' represents the value carried from the previous sum (if any). The result is the 'sum bit', a '1' or '0' and any amount to be carried to the next addition.

TRANSISTORS

Silicon is not a conductor of electricity; but when impurities are introduced currents can be induced. Two different impurities, phosphorous and boron are used to produce what is called n-type and p-type silicon. These are then sandwiched to form an 'npn' transistor.

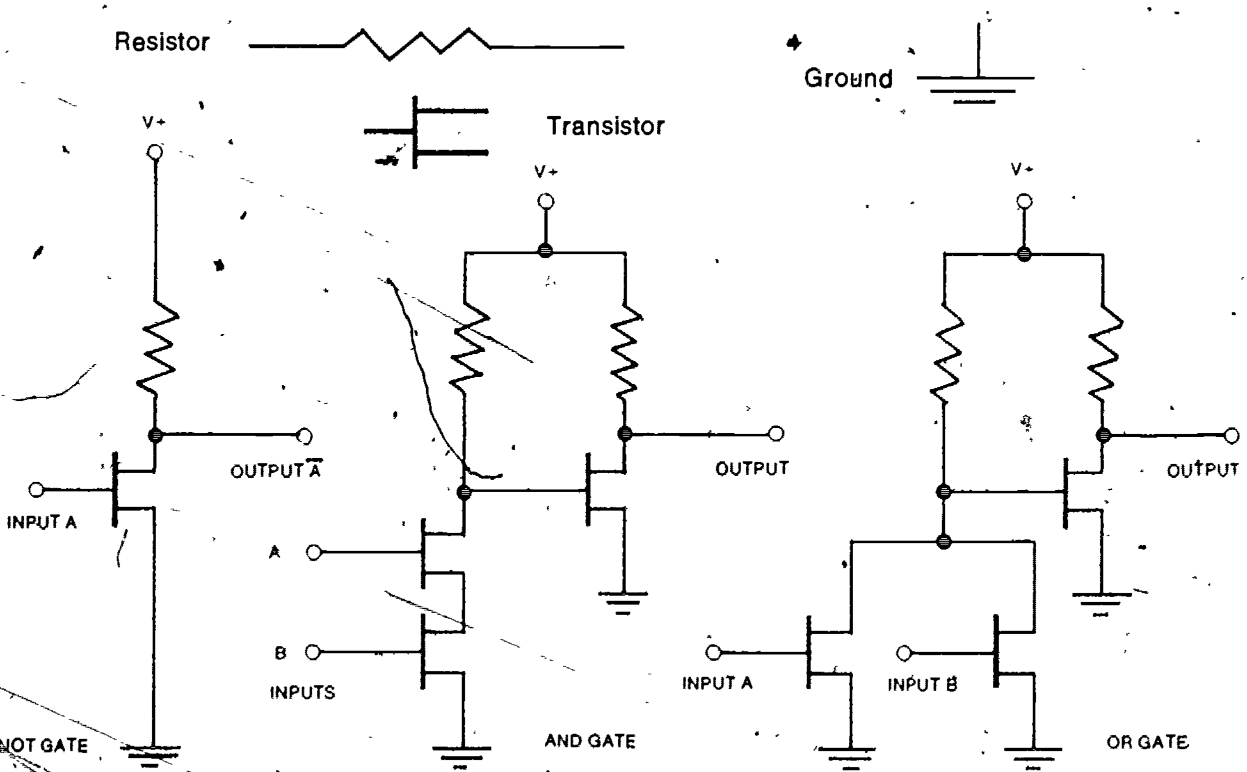


●●●●●● shows a flow of electrons
○○○○○ 'holes' or the absence of electrons

A single transistor in a silicon chip. There may be thousands in one micro circuit.

Current will not normally flow through, but by applying a small current to the base of the transistor, current is able to flow from the emitter to the collector.

Transistors may be combined to perform the functions of the 'AND', 'OR', and 'NOT' gates of the micro circuits as shown in the following diagrams.



The electronic circuits which perform the 'NOT', 'AND', and 'OR' logic functions in the computer.

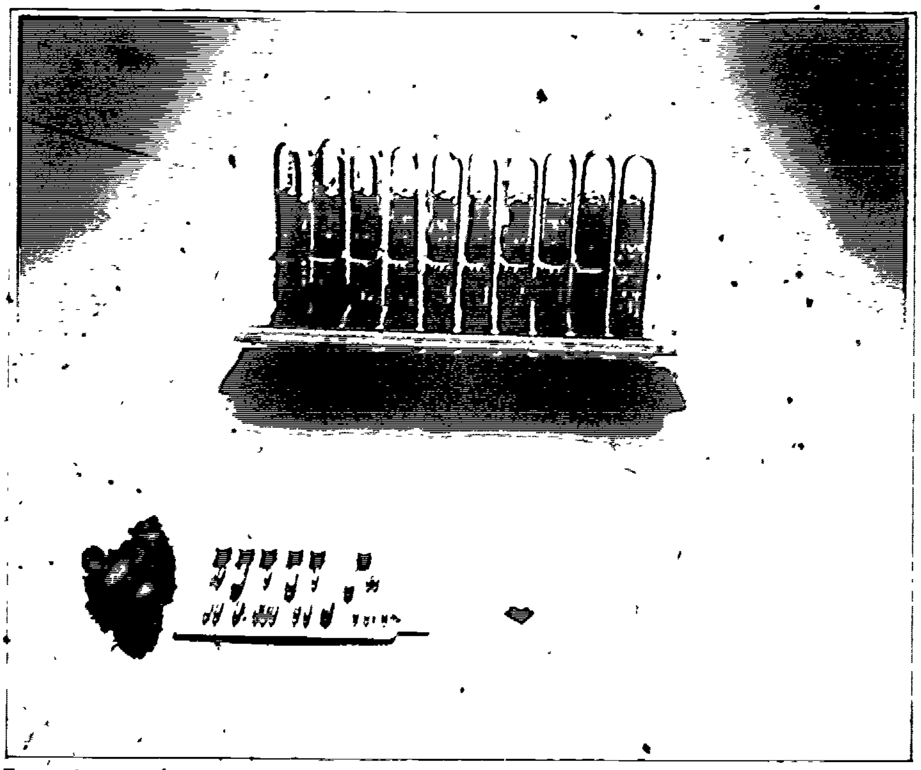
LARGE SCALE INTEGRATION

Until recently, electronic components required for a computer circuit were separate or 'discrete' elements which were wired together on circuit boards These required a great deal of costly labour to produce

The development of integrated circuits changed that An integrated circuit is one in which all the components are combined on a silicon wafer

The original circuit design is reduced photographically many hundreds of times and all components and their connections are created by building up different layers of silicon through a process of photo-lithography Once the master circuit has been designed, thousands of the micro-circuits may be produced at a relatively low cost

It was through this process that the 'computer-on-a-chip' or 'micro-processor' came into existence, thereby making available computing power at a cost low enough for mass consumption



Four stages of computer circuits—from tubes to micro chip.

THE HIERARCHY OF DATA UNITS

The following scheme organizes the data units commonly referred to from smallest to largest

BIT	0 or 1
BYTE	usually 8 bits = 1 character
WORD	often 2 bytes
ARRAY	a series of continuous words
RECORD	one or more arrays
FILE	a collection of records
DIRECTORY	a collection of files
STORAGE DEVICE	several directories may be stored on a storage device such as a disc

'A hen is only an egg's way of making another egg "
— Butler Life and Habit —

PROGRAMMING LANGUAGES

"God save the King, that is Lord of this language". Chaucer: The Astrolabe.

There are several ways of categorizing languages. One is to designate them as either compiled or interpreted languages. Another, is to designate them as either structured or unstructured.

COMPILED LANGUAGES: (FORTRAN, ALGOL, PL/1, COBOL, Pascal)
The entire program will be translated into the machine language (consisting of 0's and 1's) of the computer before execution is performed.

INTERPRETED LANGUAGES: (BASIC, APL, SNOBOL4)
The program is translated into an intermediate form which is more easily executable, yet is still not machine code. The actual execution is completed by other programs; the program is executed more slowly, but less memory storage is required.

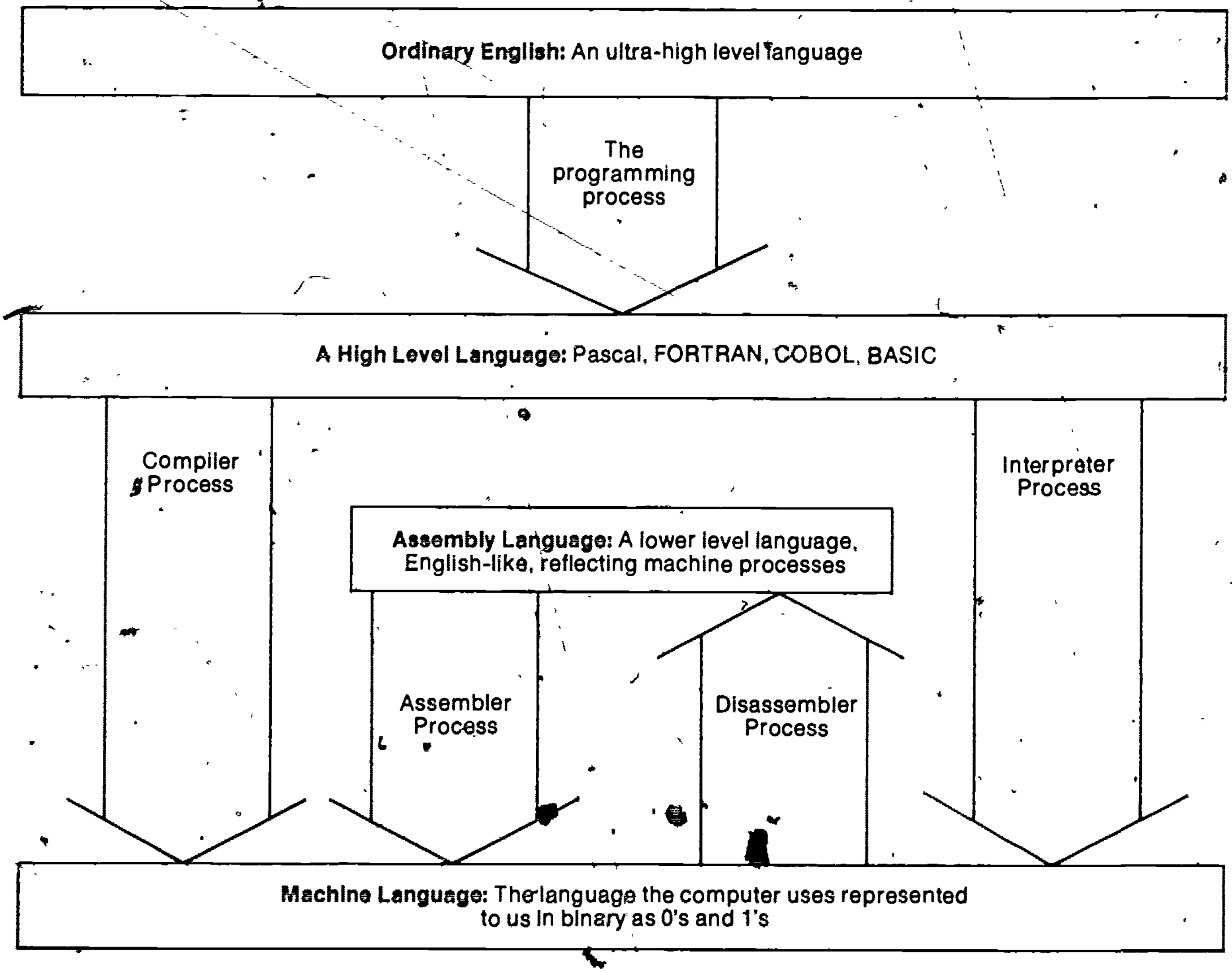
The Flat Tire Analogy

The distinction between compiled and interpreted languages may be explained by these contrasting approaches to changing a flat tire.

When Robin got a flat, he pulled his new Porsche over, reached for the car manual, and quickly read all the instructions. He compiled the procedure in his mind, got out of the car and changed the tire.

When Pat and Chris had a flat, Chris reached for the car manual and they both got out of the car. As Chris read an instruction, Pat performed the step, pausing and waiting for the next instruction to be interpreted by Chris.

LANGUAGE RELATIONSHIPS



STRUCTURED PROGRAMMING LANGUAGES
(Pascal, ALGOL, PL/I, Waterloo BASIC)

Structured programming languages provide greater readability and clarity to a program by using modular constructs in the language. They greatly reduce errors in logic and also decrease the time and cost in writing programs.

For example, the begin. . . .end construction acts as a set of brackets around a sequence of statements. This structure may be illustrated by the following program segment written in some imaginary structured language:

```
IF RADIUS > 10
     THEN
          BEGIN
               statement 1
               statement 2
          END
     ELSE
          BEGIN
               statement 3
               statement 4
          END
```

UNSTRUCTURED LANGUAGES
(FORTRAN, BASIC)

"Programs in BASIC acquire so labyrinthine a structure that in fact only the most motivated and brilliant children do learn to use it for more than trivial ends." Papert: *Mindstorms*

The simplest way to understand unstructured languages is to contrast them with structured ones. Unstructured languages are more difficult to read and may pose difficulties in terms of clarity. They are often difficult to correct (debug). Problems may be naturally divided into smaller parts using structured programming. A structured program will reflect the logical divisions of the problem whereas a program written in an unstructured language may not.

An example of an unstructured form has been left to either your imagination or to sample programs written by a novice student programmer available from any computer science teacher.

The following is an alphabetical listing and brief description of some of the common computer languages:

ADA

In 1975, the United States Department of Defence initiated a project to define requirements for a higher order language. The language created by Jean Ichbiam, was derived to some extent from ALGOL, PL/I and Pascal. The language is an attempt to provide a standard throughout the world for writing programs. Its compilers are designed to run on microcomputers and very large machines and offers many sophisticated constructs. The ability to take advantage of the processing power of more than one computer at one time, is an outstanding feature.

The actual program code for ADA is very similar in appearance to Pascal. Please refer to the Pascal sample program listed in this Section. It is felt that ADA has an excellent chance of becoming "The Language".

ALGOL

(Algorithmic Language)

ALGOL 60, a compiled language, was designed by an international committee in the late 50's and early 60's. Although it has not become a popular language itself, it has had much influence on the design and definition of subsequent computer languages.

The outstanding characteristic of ALGOL is that it was the first block structured language. It provided clarity in design and program analysis, and is primarily used for scientific calculation. An example of an ALGOL program follows:

```
COMMENT: An ALGOL program to list the numbers from 1 to 10.

        Begin; Integer N;
               Open (1, '$TTO");
               for N: = 1 step 1 until 10 do
               output (1, "###",N);
        End
```

APL (A PROGRAMMING LANGUAGE)

This language was designed by Kenneth Iverson in 1962. The language itself uses many unique symbols and different notational conventions. It was implemented in the late 1960's on an IBM System 360 computer. As an interpreted language, APL has two distinguishing characteristics:

- It is designed to be an interactive language allowing a programmer to sit at a terminal, program directly, and get his desired result quickly
- With few symbols, it allows for the direct processing of entire arrays making the language a powerful programming tool

An example follows:

This APL program prints out the numbers from 1 to 10

```
     ∇numberscount
[1]  count ← 1
[2]  count
[3]  count ← count + 1
[4]  → 2 x count < 11
[5]  ∇
```

BASIC (BEGINNERS ALL-PURPOSE SYMBOLIC INSTRUCTION CODE)

BASIC was developed at Dartmouth College in the early 60's, and is suitable for beginning programmers who have a varied educational background. BASIC is usually offered on micros as an interpreted language; however Radio Shack on its TRS-80, offers a compiled basic for greater speed. The University of Waterloo is now offering a structured BASIC which takes advantage of some of the structured language concepts. BASIC is very easy to teach and to learn quickly. However, because it is an unstructured language, it does not lend itself to writing readable code where large programs are involved.

The following is a program sample:

```
10 REM   This program prints out numbers from 1 to 10
20 FOR I = 1 TO 10
30 PRINT I
40 NEXT I
50 END
```

COBOL (COMMON BUSINESS ORIENTED LANGUAGE)

COBOL, a compiled unstructured language, has been widely used in business since the early 60's. The first COBOL standard was defined in 1968, and updated in 1972. Because business applications are often concerned with large volumes of input and output, COBOL allows for specification of input and output file structures. The syntax of the language is very close to English, making the programs quite readable. COBOL is used at the Grade 12 level in teaching Data Processing and is now available in microcomputers.

A COBOL program is divided into four divisions:

- **Identification:** names program and author, etc.
- **Procedure:** contains the executable instructions
- **Data:** describes the data
- **Environment:** specifies the machine-dependent aspects of the program

FORTRAN (FORMULA TRANSLATOR)

FORTRAN is an unstructured language initially designed for scientific computing. It was the first widely used language, having been developed in the mid 1950's. A standard version was defined in 1966 (FORTRAN 66) with a later version standardized in 1977 (FORTRAN 77). A FORTRAN program consists of a main program and a set of subprograms compiled separately. These programs are then linked and loaded into the memory after compilation. In FORTRAN 77, the additions to the *if* statement constructs has greatly improved the ease of reading and writing FORTRAN programs. The University of Waterloo has developed a structured FORTRAN which is used in educational settings.

An example of FORTRAN code is:

```
e.g     C     This is a comment line
        C     A program to sum numbers from 1 to 20
              ISUM = 0
              DO 10 J = 1, 10
              ISUM=ISUM+J
           10 CONTINUE
           20 WRITE(12,20)ISUM
              FORMAT (1X,I3)
              STOP
              END
```

"The experienced FORTRAN programmer will usually say that he finds it perfectly satisfactory for his purposes, and doesn't see the need for anything else. (The same remark was probably made about the horse-and-buggy as a means of personal transport at the turn of the century.)

FORTRAN is a very powerful and useful tool. But viewed dispassionately it is a pretty revolting language to use. (The trouble is that, as with parents and their offspring, we are rarely dispassionate in these matters.)"

— D W Barrow *An Introduction To The Study of Programming Languages*

PASCAL

Named after the French mathematician Blaise Pascal. The language was invented by Niklaus Wirth of Zurich, Switzerland in 1973. Wirth based his language on ALGOL 60, and wrote it with two objectives in mind:

- to provide a language suitable for teaching programming as a systematic discipline
- to implement it reliably and efficiently on existing computers.

The language has fulfilled these objectives and is now gaining popularity as a block-structured language. The University of California at San Diego has developed a Pascal compiler which runs on microcomputers such as Apples.

Example:

A program written in Pascal to output the numbers from 1 to 10.

```
Program   count (input, output);
          VAR n: INTEGER;
             BEGIN    n:=1;
                REPEAT    WRITELN (n); n:=n+1
                UNTIL n=10;
             END.
```

PL/I (PROGRAMMING LANGUAGE I)

In the mid 1960's, IBM decided to design an all-purpose structured language which would be a successor to FORTRAN. They produced PL/I which can be used in scientific and business applications as well as systems programming. There has been considerable debate as to whether the language designers attained their goals of generality, flexibility, execution efficiency and ease of use for the novice programmer.

PL/C is a subset of PL/I and is used as an introductory language in education. SP/K is a further subset used as a beginning language in secondary schools. PL/I and its subsets are compiled languages.

The following is a PL/I program:

```
/* THE FOLLOWING OUPUTS THE NUMBERS FROM 1 TO 10 */
     SAMPLE: PROCEDURE OPTIONS (MAIN);
               DECLARE    NUM    DECIMAL FIXED (2);
               NUM = 0;
     AGAIN: NUM = NUM+1;
               PUT LIST (NUM);
               IF NUM < 10 THEN GO TO AGAIN;
               END SAMPLE;
```

RPG (REPORT PROGRAM GENERATOR)

RPG is a compiled, unstructured programming language originally designed for writing programs which produce printed reports. It can, however, be used for other types of processing, such as file creation and maintenance. RPG is a popular programming language for the IBM SYSTEM/360 in industry. Part of an RPG program follows:

```
SEQ NO  PG LIN    SPECIFICATIONS COL 6 - 74

        01 010    H
        01 020    F*
        01 030    F* UPDATE STUDENT FILE WITH MARKS
        01 040    F*
 0001   01 050    FMARKS    IPE F       80             READ01
 0002   01 060    FSTUDFILEUC   F       98R13KI      1 DISK
 0003   01 070    FSTOUT    O   F      120      OF     PRINTER
 0004   02 010    IMARKS    AA  01
 0005   02 020    I                                                1  13 NAMEC
 0006   02 030    I                                               14  20 C1
 0007   02 040    I                                               21  27 C2
 0008   02 050    I                                               28  34 C3
 0009   02 060    I                                               35  41 C4
 0010   02 070    I                                               42  48 C5
 0011   02 080    I                                               49  55 C6
 0012   02 090    ISTUDFILEBB  02
 0013   02 100    I                                                1  98 RCRD
 0014   03 010    C             NAMEC     CHAINSTUDFILE              1010
 0015   03 020    C   N10       C2        COMP ' '                       21
 0016   03 030    C   N21N10    C3        COMP ' '                       22
 0017   04 010    OSTOUT    H  201    1P
 0018   04 011    O         OR        OF
 0019   04 012    O                                          27 'SELECTIVE STUDENT LIST'
 0020   04 013    O         D  1      01 10
 0021   04 020    O                                NAMEC     15
 0022   04 030    O                                          30 'NO MATCH IN FILE'
 0023   04 040    O         D  1     N10 21
 0024   04 045    O                                NAMEC     15
 0025   04 050    O                                          28 '1 SUBJECT ONLY'
 0026   04 060    O         D  1     N10 22
 0027   04 065    O                                NAMEC     15
 0028   04 070    O                                          29 '2 SUBJECTS ONLY'
 0029   04 120    OSTUDFILED          01
 0030   04 130    O                                C1        63
 0031   04 140    O                                C2        70
 0032   04 150    O                                C3        77
 0033   04 160    O                                C4        84
 0034   04 170    O                                C5        91
 0035   04 180    O                                C6        98
```

The preceding descriptions of languages are intended to be a brief introduction for the beginner. For greater detail, any computer language manual should help. Two texts which make a comparative study of programming languages are:

BARRON: *An Introduction To The Study of Programming Languages,* Cambridge University Press.

PRATT: *Programming Languages: Design and Implementation* Prentice-Hall Inc.

"Our speech hath its infirmities and defects, as all things else have. Most of the occasions of this world's troubles are grammatical."
— Montaigne: Essays II —

BUYING A MICRO-COMPUTER

The following is a check list of things **to consider** when buying computer equipment.

- **OBJECTIVES IN ACQUIRING COMPUTER EQUIPMENT**
  - — To teach programming
  - — To teach general computer literacy
  - — To provide learning through simulations and games
  - — To teach subject matter such as language, social studies, science, mathematics
  - — To re-enforce computation, spelling, vocabulary skills
  - — To teach general "computer literacy"
- **NUMBER OF COMPUTER WORK-STATIONS NEEDED**
  - — Number of students involved
- **TYPE OF CONFIGURATION**
  - — A single compact unit with monitor and storage in one case is easy to move around
  - — A modular system, separate keyboard, CPU, monitor, auxiliary storage — less easy to move from class to class
- **TYPE OF PROCESSOR USED**
  - — Z80, 6502, MC6800, 8080
  - — 8-bit processor or 16-bit
  - — relative addressing capability
  - — processing speed
- **TYPE AND SIZE OF MEMORY**
  - — RAM only or RAM and ROM
  - — How much work space is left after the operating system is loaded?
- **BASIC LANGUAGE VERSION**
  - — Integer or floating point
  - — Extensions available: file I/O, graphics
- **OTHER LANGUAGE AVAILABLE**
  - — FORTRAN, COBOL, Pascal, Assembly language
- **GRAPHICS AND COLOUR CAPABILITIES**
  - — Graphics characters
  - — Effective resolution: Number of Pixels
  - — Number of colours
- **TEXT TYPE AND SIZE**
  - — Number of lines on screen
  - — Number of characters per line
  - — Upper and/or lower case

- **AUXILIARY STORAGE**
  - — Cassette — BAUD rate
  - — Disc — size of disc storage
  - — Number of disc drives per unit
- **AUDIO CAPABILITIES**
  - — Internal device — Number of voices
  - — External device
- **INTERFACE CAPABILITIES**
  - — Number of expansion slots
  - — Types: cassette, RAM, joy sticks, printers
- **TYPES OF PERIPHERALS**
  - — Acoustic coupler, cassette, disc drives, printer, joy sticks
- **OUTSIDE HARDWARE, SOFTWARE**
  - — Companies other than the one selling the computer, selling software and hardware devices compatible
  - — Software portability
- **DOCUMENTATION**
  - — Complete, readable, organized
- **SERVICE**
  - — Return to manufacturer
  - — Available from dealer
  - — Service contract
- **USER GROUPS**
  - — Company supported
- **STUDENT-PROOF CHARACTERISTICS**
  - — Auto-start or bootstrap
  - — Easy program load and store capabilities
  - — Hard copy availability
  - — Ease of insertion and removal of cassette tapes and discs
  - — Ease of program editing and storage
- **PROGRAM PORTABILITY**
  - — Capability of sharing programs with others
- **FUNDING**
  - — Amount of money available for purchasing equipment

RESOURCES

BOOKS

COMPUTERS IN SOCIETY

Baer, R.M. *The Digital Villain.* Addison Wesley; Reading, Mass., 1972.

Evans, Christopher. *The Micro Millenium.* Viking Press; New York, 1980.

Osborne, Adam. *Running Wild: The Next Industrial Revolution.* Osborne/McGraw-Hill; Berkeley, 1979.

Toffler, Alvin. *The Third Wave.* William Morrow and Company Inc.; New York, 1980.

COMPUTERS IN EDUCATION AND APPLICATIONS

Doerr, C. *Microcomputers and the Three R's: a Guide for Teachers.* Hayden Book Co.; Rochelle Park, New Jersey, 1979.

Ellis, A.B. *The Use and Misuse of Computers in Education.* McGraw-Hill, New York, 1974.

Goldenberg, E.P. *Special Technology for Special Children. Computers to serve communication and autonomy in education of handicapped children.* University Park Press; Baltimore, 1979.

Rushly, N.J *Computers in the Teaching Process.* Wiley Press; New York, 1979.

Sandals, L.H. *Computer Assisted Learning with the developmentally handicapped.* University of Calgary Press, 1973.

Zaks, Rodnay. *Your First Computer.* Sybex; Berkeley, California, 1981.

COMPUTER PROGRAMS, APPLICATIONS AND ACTIVITIES

Ahl, David H. *BASIC Computer Games.* Creative Computing, Morris Plains, New Jersey, 1979.

Ahl, David H. *More BASIC Computer Games.* Creative Computing; Morris Plains, New Jersey, 1979
[TWO VERSIONS MICROSOFT AND TRS-80 BASIC]

Buyer, T.A. *BASIC and the Personal Computer.* Addison Wesley, Reading, Mass. 1978.

Mateosin, Richard. *Inside BASIC Games.* Sybex; Berkeley, California, 1981.

Ragsdale, Ronald G. *Programming Projects Across the Curriculum: Ten Prototype Exercises.* O.I.S.E. Publications; Toronto, 1977.

Smith, Robert E. *Simulated Gaming.* Computer Explorer Series, Control Data Corporation; Minneapolis, Minnesota, 1973.

Sternberg, C.D. *BASIC Computer Programs for the Home.* Haydon Book Company; Rochelle Park, New York, 1980.

COMPUTER PROGRAM CATALOGUES

Friedman, P. *Computer Programs In BASIC.* Prentice Hall; Toronto, 1981
— a listing of the publication of 1600 programs.

Sadlier, J. and Stanton, J. *The Book of Apple Computer Software 1981.* The BOOK Company; Lawndale, California, 1981.
— a listing and review of programs available for the Apple computer.

PERIODICALS

The following is a partial list of the more important computer magazines reviewed by Ron Adams in the June issue of the ECOO Newsletter:

BYTE ($21) Box 590, Martinsville, NJ, USA 08836

Byte is McGraw Hill's monthly attempt to imitate the worst features of Scientific American and the Sears Catalog. The articles are highly technical and frequently devoted to arcane subjects that will bewilder the small systems user that the magazine is supposed to serve. Interesting material is buried in a blizzard of advertising. But it is the leading microcomputer journal and will keep you abreast of the latest developments in the field, not to mention all the new hardware. I buy it for two columns: Bytelines, which is Sol Libes' fascinating analysis of news and rumors in the microcomputing industry, and the Education Forum, which reports CAI projects at various US universities and colleges.

COMPUTE! ($18 US) Box 5406, Greensboro, NC, USA 27403

One of the few magazines that carries separate sections devoted to specific computers (6502-based machines in this case): the Apple, Atari, OSI, PET, and single-board 6502 microcomputers (AIM, KYM, SYM). It contains regular columns on the social impact of microcomputers, applications for the handicapped, and BASIC programming tips, together with a selection of reviews and printed programs for the Apple user. The bulk of Compute!, however, is devoted to other microcomputers.

COMPUTER AGE (34 pounds 20) 4 Valentine Place, London, SE1, Great Britain

This British monthly, is, in my opinion, the leading microcomputer journal in the English language. It is comprehensive, well laid out, and written in a brisk, erudite, jargon-free style that ordinary mortals can understand. Topics discussed in recent issues include the office of the future, computer literacy, computer assisted instruction, ergonomics, voice synthesis, the use of microcomputers in medicine and special education, bubble memory, and artificial intelligence, to name but a few. The magazine has also been featuring excellent tutorials in programming languages like PILOT, FORTH, and APL. There's only one problem. the subscription price is seven pounds 20 which is $20 and very reasonable, but the British Post Office charges a king's ransom to airmail it to Canada—27 pounds—which brings the cost to nearly $100 per year. No magazine is worth that much.

COMPUTING TEACHER, THE ($15 US) Computing Centre, Eastern Oregon State College, La Grande, Oregon, USA 97850

Edited by one of the leading CAI educators, David Moursund, this journal focuses on teacher education, computer assisted instruction, and the impact of computers on curriculum. Apart from the usual articles and software reviews, The Computing Teacher features reports on CAI projects, articles on instructional design, and an assortment of calculator and microcomputer programming assignments that can be adapted for classroom use. No microcomputer-using teacher should be without it.

CREATIVE COMPUTING ($24 US) Box 789-M, Morristown, NJ, USA 07960

If you plan to purchase only one microcomputer magazine, this is it. It has all the articles, reviews, program listings, and columns of the other general microcomputer monthlies, plus a sense of humor. it's sprinkled with cartoons, delightful pen-and-ink drawings, satirical pieces, short stories, puzzles, and even the occasional poem. Moreover, it's not limited to computer topics. Recent issues contain an excellent series on effective writing techniques that any writer can use. Don't miss an issue.

ECOO NEWSLETTER ($10 membership) c/o Sue Moont, OISE-MECA, 252 Bloor Street West, Toronto, Ont. M5S 1V6

The lively quarterly of the Educational Computing Organization of Ontario, a group of educators dedicated to promoting computer literacy and computer assisted instruction in Ontario schools. They've given Ontario a year's lead over other provinces like B.C. that are flirting with microcomputers in the schools. Unlike B.C., however, the Ontario ministry of education has not had the foresight to select a province-wide system.

MICROCOMPUTING ($27 US) Box 997, Farmingdale, NY, USA 11737

A comprehensive magazine on microcomputing noted for excellent articles on technical topics as well as for regular features on the industry, educational projects, new products, and book reviews. Editor Wayne Green's trenchant monthly analysis of the microcomputer industry is worth the price of the magazine. Recommended.

NIBBLE ($22.50 US) Box 325, Lincoln, MA, USA 01773

NIBBLE is a bi-monthly magazine dedicated to Apple users. It is geared to programmers. Each issue features at least two major program listings for home, small business or entertainment use that can be typed into Apple. It also contains a selection of programming tips, hardware construction projects, and product reviews. The major listings may also be obtained on diskettes for $15 or less. People who enjoy programming swear by it and no Apple owner should be without a subscription. Highly recommended.

PERSONAL COMPUTING ($22 US) Circulation Department, 1050 Commonwealth Avenue, Boston, Mass., 02215

A monthly containing articles on a variety of topics and regular columns on computer chess, computer bridge, and the future of computing. It is biased toward the TRS-80 and is not high on our recommended list for Apple owners.

RECREATIONAL COMPUTING ($20 US) P.O. Box E, Menlo Park, California, USA 94025

A brief but excellent bi-monthly magazine published by the People's Computer Company, an organization created in 1972 by enthusiasts dedicated to taking computing to the people. It contains concise articles on the use of microcomputers in education, medicine, music, and the home, as well as regular columns on programming techniques, programming problems, and games. It is not overwhelmed with glossy advertising, and each issue contains program listings that can be typed into the microcomputer. Recommended.

CLOAD Magazine ($42 US) P.O. Box 1267, Goleta, California, 93116

A monthly "magazine" of programs distributed on cassette tape for TRS-80 Model I and Model III owners.

CURSOR ($27 for 6 months) The Code Works, Goleta, California 93116

A monthly "magazine" of fine programs on C-30 cassettes designed for the PET, to run on Old, New and 4.0 ROMS.

THE TRANSACTOR VOL. 3 ($10 Can.) Commodore Business Machines, 3370 Pharmacy Ave., Agincourt, Ontario, M1W 2K4

A collection of articles and programs which will improve your understanding and ability to program the PET computer.

AUDIO-VISUAL

• **FILMS**

THE SILICON FACTOR: This is an excellent series of three 40-minute films on the silicon chip, how it is made, how it is used and its effect on our technology. It is produced by the BBC and is available through the Toronto Board of Education.

NOW THE CHIPS ARE DOWN: An impressive 50-minute BBC film on computers and the socio-economic effects of computers on society. Also available through the Toronto Board of Education.

• **VIDEO TAPES** (Available from TV Ontario)

SERIES TITLE: BEYOND OUR DECADE

BPN 184603 — **Science and Medicine**
30 min./Col./Aug. 31'84/Adult

Hosts Elaine Simmons and Paul Rogers talk with Dr. Maurice Milner, director of Rehabilitation Engineering, Ontario Crippled Children's Hospital, and other medical experts. They discuss the use of myoelectric ("bionic") limbs, the development of support systems such as special wheelchairs, and the benefits and dangers of genetic engineering.

BPN 184604 — **Media**
30 min./Col./Aug. 31'84/Adult

Alternatives to television as we know it, such as pay TV, Telidon, and home video recording devices, are discussed by host Paul Rogers and representatives from the television industry. Regulations for these new developments, and programming trends in the 1980's are also considered.

BPN 184604 — **Communications**
30 min./Col./Aug. 31'84/Adult

Host Elaine Simmons investigates modern communications technology. Her guests—Bill Buckland from Bell Canada, Tony Alsop from CN-CP Telecommunications, Nick Hamilton-Piercy from Canadian Cable Systems, and John Lowry from Digital Video Systems—all demonstrate electronic communications equipment their companies are now using.

BPN 184607 — **Education**
30 min./Col./Aug. 31'84/Adult

Hosts Rogers and Simmons investigate future trends in education with Bette Stephenson, Ontario's education minister, and Ian MacDonald, Walter Pitman, and Gordon Wragg, presidents of York University, Ryerson Polytechnical, and Humber College respectively. They discuss potential uses of Telidon, career counselling, for changing educational needs.

SERIES TITLE: COPE

BPN 183621 — **The Future, Part 1**
29 min./Col./Sept. 13'81/Youth, Adult

Cope talks with British futurist James Robertson, author of The Sane Alternative: A Choice of Futures. Host John DeLazzer helps illustrate Robertson's theories by introducing a group of young people applying creative problem solving to a local eye sore. Also Kathy Hamat and Ian MacKay, students in the Ontario College of Art's photo electric department, show the flexibility of the individual in dealing with a computer.

BPN 183622 — **The Future, Part 2**
29 min./Col./Sept. 13'81/Youth, Adult

Examines the future as it relates to technology and as it relates to the family. John DeLazzer hosts the program with 22 young people, Craig Ivory, a member of the World Futures Society and Nancy Smale, a counsellor at the University of Waterloo, discussing the problems and possible solutions.

SERIES TITLE: THE EDUCATION OF MIKE McMANUS

BPN 155832 — **Teletext**
29 min./Col./Sept. 19'82/Adult

Mr. Norman Green, Coordinating Engineer for British Independent Television, describes a remarkable new technique now in use in the United Kingdom. Teletext is a method of sending up to 800 pages of information along with the normal TV signal, so that the viewer can have an electronic newspaper at the turn of a switch.

SERIES TITLE: FAST FORWARD

BPN 166401 — **The Microprocessor Revolution**
29 min./Col./Sept. 22'83/Adult, Youth

The real star of this program is the microprocessor, the tiny electronic marvel that we can talk to and train to do whatever we want it to do. Various specialists explain and illustrate their own involvement with electronic technology.

BPN 166402 — **Towards an Ultimate System**
29 min./Col./Sept. 5'83/Adult, Youth

A look at today's internationally competitive market-place for total information networks and their technological components: colour TV, computer, and telephone.

BPN 166403 — **Personal Computing**
29 min./Col./Sept. 16'83/Adult, Youth

Computer owners—adults as well as children—talk about the fascinating challenge of learning to program their machines to provide them with fun and games.

BPN 166404 — **Global TV Politics**
29 min./Col./Sept. 22'83/Adult, Youth

Experts analyze the increasingly complex aspects of international electronic news gathering, satellite microwave transmittal, signal piracy—and the chaotic proliferation of videotape formats.

BPN 166405 — **Humanizing the Technology**
29 min./Col./Sept. 2'83/Adult, Youth

Specialists demonstrate current achievements in robotics; responsive machines that interview hospital patients, teach deaf children to speak more clearly; industrial robots, composed of hydromechanics and computer-brains, that perform monotonous, health-hazard jobs.

BPN 166406 — **Bio-Medics**
29 min./Col./Sept. 22'83/Adult, Youth

Designers demonstrate their remarkable achievements in bio-medical engineering, voice synthesizers for the speechless, Braille without paper for the blind, wheelchairs operated by voice signals, easy to use prostheses that respond to electrical impulse signals from muscles or nerves.

VPN 166407 — **The Information Flow**
29 min./Col./Sept. 22'83/Adult, Youth

Experts explain existing and future refinements, such as fibre optics, multiplexing, package switching, etc. of the vast, competitive data market in which the machinery stands still and only the information moves—at lightning speed.

BPN 166408 — **New Perspectives**
29 min./Col./Sept. 22'83/Adult, Youth

Specialists discuss the interpretation and dissemination of global monitoring data provided by satellites.

BPN 166409 — **Computer Simulations**
29 min./Col./Sept. 22'83/Adult, Youth

A look at the design and functions of computer-created projections of real-life conditions which permit the safe training of pilots and the economical testing—without prototypes—of new instruments.

BPN 166410 — **Electronic Medicines**
29 min./Col./Sept. 22'83/Adult, Youth

Experts demonstrate their latest achievements, including painless injection devices, pocket-size heart monitors, electronic painkillers and a revolutionary process that stimulates the healing of fractured bones.

BPN 166411 — **Memory and Storage**
29 min./Col./Sept. 22'83/Adult, Youth

Computer experts demonstrate revolutionary methods of dealing with today's information explosion, including a device the size of a postage stamp whose tiny magnetic bubbles provide access to three million bits of stored data.

BPN 166412 — **Music**
29 min./Col./Sept. 22'83/Adult, Youth

This program examines the pervading impact of electronic technology on music today. Electronic instruments, electronic recording, and electronic playback have made possible a whole new range of sounds. Computers are providing the composer with better ways to control these sounds and express himself musically without being frustrated by technology.

BPN 166413 — **Television**
29 min./Col./Sept. 22'83/Adult, Youth

Shows the current explosion of television for monitoring, surveillance, training and educational purposes as well as a look at the newest television production techniques and future technologies. The possibilities for a future of decentralized, completely accessible interactive television are outlined in functioning systems.

SERIES TITLE: FAST FORWARD 2

BPN 179102 — **Games**
29 min./Col./Sept. 15'85/Adult, Youth

This introduction to the world of micro-electronic computer games looks at computerized pinball machines, video games, spelling games, and challenging board games, such as chess. Once gigantic, expensive, and therefore inaccessible to most people, computers can now belong to everybody, and are revolutionizing our leisure activity.

BPN 179103 — **Lasers**
29 min./Col./Sept. 15'85/Adult, Youth

A glance at some of the many astonishing abilities of laser energy, a form of amplified light, ranging from bloodless micro-surgery to pollution measurement, from satellite image transmission to holography. Experts explain what lasers are and how they work, and speculate on future refinements of laser technology.

BPN 179104 — **Education**
29 min./Col./Sept. 15'85/Adult, Youth

Academics, computer technologists, and teachers discuss the growing prominence of computers in modern education systems. Demonstrating some of the vast possibilities of these complex, but individualized and patient learning tools, these experts maintain that computers will improve the quality of education.

BPN 179105 — **Electricity/Energy**
29 min./Col./Sept. 15'85/Adult, Youth

Stressing that there is no real shortage of energy in the universe, but rather a shortage of our traditional ways of harnessing it, this program looks into some of the new ways of converting solar energy into convenient, storable forms. Photovoltaic and atomic fusion methods, and some of their potential benefits and dangers, are investigated.

BPN 179106 — **Transportation**
29 min./Col./Sept. 15'85/Adult, Youth

Experts explain the many ways in which computers are being used in air traffic control, traffic signals, information systems, bus navigation instruments, and personal rapid-transit facilities. Although rapidly depleting fuel supplies are hindering the growth of traditional transit methods, the new resource—information—is expanding the horizons of innovative technological development.

BPN 179107 — **Space**
29 min./Col./Sept. 15'85/Adult, Youth

No other technology has generated as many discoveries in other fields as space technology. This program looks at the wide variety of technological applications in space research, including possible habitation and manufacturing in space.

BPN 179108 — **Business of Information**
29 min./Col./Sept. 15'85/Adult, Youth

New communications techniques and systems of interaction are causing a revolution in the business world. This program examines how computers and computer technology are changing the ways of doing business.

BPN 179109 — **Security**
29 min./Col./Sept. 15'85/Adult, Youth

As we move further toward becoming the information society, our most important resource becomes information itself. The micro-electronic revolution has provided powerful new tools for securing persons, property and information.

BPN 179110 — **Medicine**
29 min./Col./Sept. 15'85/Adult, Youth

This program looks at genetic engineering, microsurgery, and diagnostic medicine. It will explore the new machines' possibilities for improved feedback, communication, and control.

BPN 179111 — **Military Communications**
29 min./Col./Sept. 15'85/Adult, Youth

An exploration of computers, lasers, "smart" weaponry, and sensors, and their effect on the military's command, control and communication.

BPN 179112 — **About Computers**
29 min./Col./Sept. 15'85/Adult, Youth

The computer is becoming a part of daily life. This program examines how computers work, shows applications for consumers, and explores the future potential of "intelligent" machines.

BPN 179113 — **State of the Arts**
29 min./Col./Sept. 15'85/Adult, Youth

New technologies have great impact on the arts, including the creation of new art forms such as electronic music and video synthesis.

BPN 179114 — **Implications**
29 min./Col./Sept. 15'85/Adult, Youth
The implications of the technological changes stemming from the micro-electronic revolution are examined in the final program in **Fast Forward 2.**

SERIES TITLE: FROM BOOKS TO BYTES

BPN 197501 — **From Books to Bytes**
60 min./Col./Nov. 13'84/Adult
From Books to Bytes was one of the highlights of TV Ontario's 10th Anniversary programming activities. The special was telecast from the convention site of the Ontario Association of Curriculum Development. Host Laurier LaPierre and panelists (Gordon Thompson, Communications Studies, Bell Northern Research, David Mitchell, Educational Technology, Concordia University in Montreal; and Boris Mather, Canadian Federation of Communications Workers) joined the OACD delegates, exchanged views on the impact of technology on education.
The special also featured an abridged version of the **Fast Forward** program on education.

SERIES TITLE: PERSONAL COMPUTING: ADVENTURES OF THE MIND

BPN 184301 — **The Personal Touch**
15 min./Col./Oct. 14'84/Adult, Gr. 7-13
Host John Hertzler takes viewers on a tour of NASA, a microelectronics lab, and the applied-physics lab at Johns Hopkins University to demonstrate that computers are invaluable in space technology and medical research He points out that in the future, personal computers will become assets to everyone's daily life.

BPN 184302 — **Hardware and Software**
15 min./Col./Oct. 14'84/Adult, Gr. 7-13
Hertzler traces the history of the computer and discusses its hardware—the physical components that make up all computers: input, control, logic, memory, and output components. He defines software—instructions to the computer—and differentiates between programs that the operator invents and pre-programmed instructions that interpret and translate programs for the machine.

BPN 184303 — **Speaking the Language**
15 min./Col./Oct. 14'84/Adult, Gr 7-13
Guest Nikki Barthen teaches Hertzler a few words of basic computer vocabulary on her home computer, and they run a few simple programs, using the words enter, run, print, and data. She runs a program, using a simple loop to illustrate the enormous potential of the machine.

BPN 184304 — **Data Processing, Control, Design**
15 min./Col./Oct. 14'84/Adult, Gr. 7-13
Hertzler explains that different kinds of computers fulfill different functions. Data-processing computers keep track of numbers of names; control computers are sensitive to changing situations, and can maintain building temperatures or report weather conditions for small airports, and design computers run theoretical simulations to predict the outcome of events.

BPN 184305 — **For Better or For Worse**
15 min./Col./Oct. 14'84/Adult, Gr. 7-13
Nicholas Johnson, a consumer advocate in the field of electronic technology, explains that because 50 to 75 percent of North American homes will be equipped with microcomputers within a few years, it is important to begin learning about their potential problems and benefits. Gary Glass, an executive in the grocery business who uses microcomputing, describes the way it has benefited his business.

BPN 184306 — **Extending Your Reach**
15 min./Col./Oct. 14'84/Adult, Gr. 7-13
To illustrate the potential benefits of a personal computer, Ed Skellings uses a microcomputer to teach poetry, a paraplegic uses microcomputer-based devices to operate the radio, read books, and talk on the telephone; and students share information through computers tied in with their telephone lines.

SERIES TITLE: SINGLE PROGRAMS

BPN 153002 — **Let's Play Technology**
20 min./Col./Mar. 21'82/Teacher Ed.

This animated film explores some of the issues involved in the increased dependence on technology, both in the schools and in society at large. The critical choices that teachers have to make are dramatized in the context of an unusual game-show set in the near future.

BPN 153003 — **The Electric Curriculum**
40 min./Col./Mar. 23'82/Teacher Ed.

Host, Lister Sinclair, talks with Sister Bede Sullivan, professor of educational media at the University of Victoria, and Gordon Thompson, manager of Communications Studies for Bell Northern Research. Their conversation explores a wide range of issues relating to the use of media in the curriculum.

SERIES TITLE: UNDERSTANDING BEHAVIOUR IN ORGANIZATIONS

BPN 137606 — **Coping with Technology: Beyond Bureaucracy, Towards a New Democracy**
27 min./Col./Unlim./Adult

Prof. Warren Bennis, President of the University of Cincinnati, and futurist Buckminster Fuller discuss industrial and organizational change. They explain why organizations must stop trying to hold on to the past, focus on the world around them, and follow technological change through to its logical end.

SERIES TITLE: VISTA

BPN 151207 — **Billion Dollar Bubble**
89 min./Col./June 3'82

Stanley Burke hosts a dramatization of the Equity Funding Insurance Company fraud, the biggest computer fraud of our time. To meet the expectations of their auditor, Equity management provided him with a fictitious annual-income figure, based on projected income calculations. The gap between reality and fact widened into a $2 billion fraud when the company began inventing policy-holders to sustain the deception. Afterwards, Burke discusses computer fraud with a panel of experts.

BPN 151211 — **Dawn of the Solar Age**
59 min./Col./Nov. 8'82/Adult

Vista examines several projects to harness solar energy, including the use of photocells, satellite and microwave systems, methane made from fast-growing plants, wind, waves, and the spectacularly effective OTEC (Ocean Thermal Energy Conversion), a process first developed in the 1930s.

BPN 151217 — **The Entertaining Electron**
59 min./Col./Jan. 23'84/Adult

This British documentary, based on the 1975-76 Faraday Lecture, explores modern television technology, explaining how television works, and outlining some of the medium's amazing capabilities for instant information transfer. Stanley Burke, who introduces the program, discusses Canada's Telidon project with John Madden of the Department of Communications

Many thanks to Kathryn McFarlane and Barbara Peck of TV Ontario for providing this list.

ORGANIZATIONS AND USERS' GROUPS

ECOO (EDUCATIONAL COMPUTING ORGANIZATION OF ONTARIO)
ECOO
c/o Sue Moont
OISE-MECA
252 Bloor St. W.
Toronto, Ontario
M5S 1V6

ECOO is providing leadership for educational computing in Ontario. We highly recommend joining ECOO for newsletters and conferences.

CEAB (THE COMMODORE EDUCATION ADVISORY BOARD)
Supplies educational software to Commodore dealers who are to make it available to teachers for copying.

APPLE-CAN
Box 696, Station D
Willowdale, Ontario
M2K 2P9

PET PRIME
c/o Guy Leger
Metropolitan Separate School Board
146 Laird Dr.
Toronto, Ontario
M4G 3V8

TRS-80 USERS' GROUP
Eastern High School of Commerce
16 Phin Ave.
Toronto, Ontario
M4J 3T2

TORONTO PET USERS' GROUP
Membership Secretary
Chris Bennett 783-1645

CONTINUING EDUCATION

Although post secondary school institutions in Ontario offer excellent courses in computer science and data processing, ~~we feel the following~~ meet the specific needs of teachers who wish to learn to use computers in the classroom. Due to the high demand for teacher training many other colleges and universities are developing such courses, and readers should check with their local institutions as well as the faculties of education.

SIR SANDFORD FLEMING COLLEGE (Peterborough)

Two courses may be of interest: (1) An Introduction to Word Processing, (2) Introduction to Programming in BASIC (on the PET 2001 microcomputer).

BROCK UNIVERSITY (St. Catherines)

"Computer Science for Teachers" is the first of a planned three year course designed for the beginner.

LAMBTON COLLEGE OF APPLIED ARTS AND TECHNOLOGY (Sarnia)

Management Development Seminars are offered for many areas. "Microcomputer Programming" is a three-day seminar (cost $150) which may be a good introduction to programming

OISE (Toronto, and regional locations)

Three of the many courses offered include 1503 "Introduction to Computer Applications in Education", 1515 "Computers in the Curriculum", and 1517 "Personal Computing in Education" The latter course requires some elementary knowledge of programming.

YORK UNIVERSITY (Toronto)

"Introduction to Computer Science I" uses Pascal, a language implemented on some microcomputers to introduce programming concepts. A new course, planned during the winter of 1981, was designed specifically for teachers. Interested readers should contact Atkinson College for information.

THE UNIVERSITY OF WESTERN ONTARIO (London)

Two courses are of interest to educators: (1) Data Processing I and II and Specialist deals with microcomputers for computer science and data processing teachers; (2) Secretarial offers a full component in word processing using Commodore microcomputers.

A complete literacy course is offered in any location in the province. The course is of one month duration. Lectures are given one day per week and microcomputers are provided to practise skills learned. (Cost is $225, including the rental of the microcomputer). Contact J. Walsh, Coordinator of Business and Computer Studies, for more information

UNIVERSITY OF WATERLOO (Kitchener-Waterloo)

The Waterloo Computing Seminars Department offers three workshops for teachers interested in microcomputing.

(1) Structured Programming and Microcomputers. A three week course designed for teachers with some knowledge of programming. A one day lecture is followed three weeks later with a final two day course. During the three week period the student is given a PET microcomputer for writing of course programs.

(2) Computer Concepts is a 2 week course designed for the beginner. Three lectures are given during the two weeks. Between classroom sessions they are given a PET to experiment with problems, games and sample programs.

(3) Hardware Design and Interfacing Techniques for Microcomputers is a three day course intended for teachers with programming experience. A special interfacing board is used to teach internal structure of the computer and input and output devices.

GLOSSARY OF COMPUTER TERMS

". . . it's useful to the people that name them, I suppose. If not, why do things have names at all?"

Lewis Carroll: *Through the Looking Glass*

This glossary attempts to expose the major buzz words which computer people use to impress their friends and misuse to confuse their enemies. It is neither a definitive nor exhaustive list. At the very least, it should enable a beginner to "interface" with any computer cogniscenti.

ACOUSTIC COUPLER	See also MODEM. A device which allows you to send and receive information over a telephone line.
ADA	A new computer language developed by the U S Department of Defense It is a structured language similar to Pascal. It was named after Ada Lovelace. Lord Byron's daughter who was a major intellectual inspiration and patron of Charles Babbage's Analytical Engine
ADDRESS	Memory locations are systematically numbered These numbers are the addresses or names of each memory location
ALGOL	(ALGORITHMIC LANGUAGE) A computer language developed in the late 50's and early 60's It is primarily used today as a standard for developing more modern languages
ALGORITHM	A step by step procedure for performing some function A program in an algorithm.
AND	A logic operator used in formal logic The result of an AND operator is true if all connected statements are true, otherwise it is false. The concept is also found in logic circuits See also NAND. OR. NOR.
ANALOG COMPUTER	Represents numbers in continuously variable states such as voltage as opposed to digital computers which represent numbers in discrete form. See also digital computers
APL	(A PROGRAMMING LANGUAGE) A programming language invented by I.B.M.'s Ken Iverson. Array manipulation is very easily performed with APL. It is also a very symbolic language. It is primarily used in education and science
ARRAY	An ordered collection of numbers or letters which can be referenced by their position in the collection.
ASCII	(AMERICAN STANDARD CODE FOR INFORMATION INTERCHANGE) A standard code for storing and transmitting data.
ASSEMBLER	A program which takes assembly language and translates it into the computer's machine language consisting of numbers It is in a sense a special compiler
ASSEMBLY LANGUAGE	A low level language which represents very closely the computer s machine language. It uses English-like short forms which make it somewhat easier to read
AUXILIARY MEMORY	Refers to disc or tape storage as opposed to main memory storage
BASIC	(BEGINNER'S ALL-PURPOSE SYMBOLIC INSTRUCTION CODE). A computer language most commonly used in educational settings
BATCH	A Batch System allows for the processing of many programs one after the other without any operator assistance It is often found in systems where card input is used.
BAUD	The number of bits transmitted per second, thus it is the rate at which information is transmitted The average typist types at about 100 BAUD. Computer terminals transmit at rates ranging from 15 BAUD to 20,000 BAUD.

BENCH MARK	A fixed point of reference, i.e. amount of time to process a problem on a specific computer. This time can be used to compare speeds of other computers on the same problem.
BINARY	Pertaining to two. Binary numbers use only digits 0 and 1.
BIT	Contraction of Binary digit. The smallest unit of information in a computer, having only two states and usually represented by either 0 or 1.
BOOTSTRAP	Literally to pull oneself up by the boots. In computers, a short program loaded manually or automatically into the computer's memory which starts the computer working.
BUBBLE MEMORY	A recently developed device which stores data at the molecular level. It provides more memory at less cost as well as reducing size requirements.
BUG	A error in a computer program
BUS	An electrical connector used to transmit signals from several devices to several devices within a computer
BYTE	A group of 8 Binary digits. One Byte stores one character of information.
CENTRAL PROCESSING UNIT	See CPU.
CHIP	A thin piece of silicon about 1 square centimetre in size. It contains up to thousands of electrical circuit elements. Chips are located in an IC and have made miniaturization of the computer possible.
COBOL	(COMMON BUSINESS ORIENTED LANGUAGE). A computer language which has been used in business since the early 1960's. It is a system designed to handle large volumes of data.
CODE	Refers to the program a person has written Used in such sentences as "This code is a bunch of garbage."
COMPILER	A sophisticated program which translates a program written in "English-like" words into machine words i.e. code that a computer can understand. The code produced by the compiler is called object code.
CORE	Refers to the main memory of a computer. In the 1960's and 70's computer memory was made out of thousands of little do-nut shaped cores each of which stored one bit of information
COURSEWARE	Programs written specifically to be used by students to aid in learning and understanding some course or subject being studied.
CPU	Central Processing Unit or the guts of the computer. It contains the arithmetic unit and logic units which perform the computing functions.
CRASH	A crash occurs when a computer malfunctions and stops running. Computer operators and programmers appear very flushed after a crash and invariably deny any responsibility.
CRT	(Cathode Ray Tube): the T V. terminal by which the computer displays information.
CURSOR	A symbol placed on the screen to indicate where the next character you type will appear.
CYCLE TIME	The amount of time a computer takes to fetch and decode an instruction (instruction cycle time) and then to execute the decoded instruction (execution cycle).
DATA	The material a computer uses to calculate with. Usually consists of collections of numbers e.g. student marks or words e.g student names
DEBUG	To correct errors (BUGS) in a program. The process of debugging a program often consists of replacing incorrect code with other code which is not as obviously incorrect until the user tells you.

DIGITAL COMPUTER — A computer which processes data stored in discrete form such as binary digits. In contrast with an analog computer which processes data in continuous form such a fluctuating voltage. This difference is best illustrated by contrasting the digital clock to the traditional wind-up clock.

DISASSEMBLER — A program which translates machine language code into assembly language. See also ASSEMBLER.

DISC (DISK) — Similar in shape to a musical record but without grooves, used for storing information. The metallic oxide coating allows information to be stored magnetically.

DISKETTE — (Also FLOPPY DISC) A small 8 inch or 5¼ flexible disc normally used with microcomputers.

DISK DRIVE — Hardware which rotates the disc while reading information from or writing information onto the disc.

DOS — (DISC OPERATING SYSTEM) A collection of programs stored on disc which when executed allow the computer to access the disc.

DOWN — Opposite of Up. The state of a computer when it is not functioning. Computer Science students will confirm that computers go down only on the day assignments are due.

EDITOR — A program which allows the operator to edit textual information e.g. change letters, insert and delete lines etc.

EPROM — (ERASIBLE PROGRAMMABLE READ-ONLY MEMORY) A memory chip which may be reprogrammed after erasing the memory with ultra-violet radiation.

EXECUTE — To make computer carry out the instructions indicated in the program.

FILE — The organizational unit by which information is stored on a disc or tape. Information may be accessed from any part of a random access file. A sequentially accessed file allows for access only sequentially starting at the beginning and processing to the end similar to a cassette tape.

FIRMWARE — Is software which attempts to perform functions which would otherwise be done by a hardware device.

FIXED POINT ARITHMETIC — Arithmetic involving only whole (integer) numbers—no ractions. This may be a restrictive feature of a micro-computer language e.g. integer BASIC. It is used often in programming games.

FLOATING POINT ARITHMETIC — Arithmetic involving decimal fractions. This is a necessary feature for scientific and business applications.

FLOPPY DISC — See DISKETTE.

FORMAT — To specify the form in which data is to be stored or written.

FORTRAN — (FORMULA TRANSLATOR). A computer language originally designed for scientific use, but has many other areas of application now.

GATE — An electronic device which has only two states e.g. it is either open (allowing current to flow) or it is closed depending on input to the gate.

GLITCH — An error caused by noise or interference on the line when data is transmitted to or from a computer.

HACKER — A person who spends all his time programming a computer. He is usually capable of fixing any computer problem you might have but is unable to communicate to you how he did it.

HARD COPY — Information printed on paper.

HARDWARE — The physical equipment such as electronic, electrical and mechanical devices which make up the computer (see SOFTWARE)

HEX — Short for Hexadecimal Arithmetic. Counting using base 16. Counting in groups of 16. The letters A, B, C, D, E, F are used as unique symbols for 10, 11, 12, 13, 14, 15.

HUNG — As in "the computer is hung". The computer although not stopped appears to be doing nothing and does not respond to command. Usually caused by the processing of an infinite loop.

I/O — (INPUT-OUTPUT DEVICES OR DATA). A device which is strictly input would be a card reader. A line printer is solely output. A video display unit could be both input and output device. As data: information going into or out of the computer.

IC — (INTEGRATED CIRCUIT). A very small 2 to 3 cm. black plastic or ceramic device which contains a chip. Many metal connectors extend from the IC and they allow the chip to be connected electrically to other devices. See also CHIP.

INITIALIZE —
1) In programming, to give a variable a first value.
2) To initialize a disc: to set up a disc so that information may be stored and found on it.

INSTRUCTION — A syntactical unit in machine language programming. It specifies an operation to be performed. It contains an operator or command and one or more operands or objects to be worked on.

INSTRUCTION SET — All those machine language commands which a computer is capable of executing.

INTEGRATED CIRCUIT — See IC.

INTERACTIVE — A computer system which responds immediately to the user s keyboard input. Microcomputers are interactive. Contrast to Batch process.

INTERFACE — A shared boundary.
As a verb: To join together in order to work as one unit.
As a noun: A device which allows a computer to communicate with some external device.

INTERPRETER — A computer program that translates and executes each source language instruction before going on to the next instruction, i.e. BASIC is usually an interpreted language.

K — Is a symbol for 1000. It actually stands for $2^{10} = 1024$ It is most often used to measure units (usually bytes) of memory as in "This is a 16K memory board". This means that the memory board has 16384 storage locations.

KEYBOARD — The typewriter-like keys on a computer terminal.

KEY WORD — In programming, a word which makes up part of the computer language. In information retrieval, a word which allows access to a subject area.

LINKER — A program which connects several programs or subprograms together so they may function as one unit. In compiled languages a linker program is used to connect the main program and all its subroutines together.

LOAD — Usually means to copy a program into main memory in order for it to be executed.

LSI — (LARGE SCALE INTEGRATION) refers to the process of putting a large number of electronic circuits on a very small chip. (Also VLSI).

MACHINE CODE — The language written in binary numbers which a computer understands. All programs written in high level language must be translated into machine code to be executed.

MACHINE LANGUAGE — See MACHINE CODE.

MACRO — As in macro instruction, refers to a single instruction which is equivalent to many smaller instructions. e.g. A multiplication instruction might require the computer to fetch, subtract, shift, and add, etc.

MAINFRAME	Usually refers to the central processing unit and central memory of a large computer.
MEMORY	A device which stores information. Memory is broken up into a number of locations each capable of storing one unit of information. These locations have numbers associated with them called addresses which allow a computer to locate a particular unit of information.
MENU	A list of options usually given at the beginning of a program.
MICROCOMPUTER	A computer which is not significantly larger than a bread box. An innovation of the mid 1970's made possible by the miniaturization of the chip.
MICROFICHE	A photographic negative film containing miniaturized photos of pages of information. This film is read with the aid of a machine.
MICROPROCESSOR	The chip found in a microprocessor which contains the CPU. e.g. Z80 processor 6502 processor
MICROSECOND	One one millionth of a second or 10^{-6} seconds
MILLISECOND	One one thousandth of a second or 10^{-3} seconds.
MINICOMPUTER	A computer whose word length is between 8 and 16 bits and at the same time is larger than a bread box but smaller than a telephone booth.
MODEM	(MODULATOR-DEMODULATOR). A device which allows you to send and receive computer information over a telephone line
MONITOR	1) A program which supervises and verifies the execution of a program. An operating system may be referred to as a Monitor. 2) A television set specially designed to be connected to computer (no channel selector).
NAND	A logical operator which is the opposite of an AND operator.
NANOSECOND	10^{-9} seconds or one one thousand millionth of a second.
NOR	A logical operator which is the opposite of an OR operator.
OBJECT CODE	The original program (source code) written, say in FORTRAN, is translated into machine language code called Object Code.
OCTAL	Base 8 Arithmetic. counting in groups of 8 rather than in groups of 10.
ON-LINE	To be connected directly to a computer allowing for an interactive mode of computer communication.
OPERAND	Somewhat like the object in an English sentence. the number being operated on. e.g. In the process of finding the square root of 9, the operand is 9, the operator is "square root".
OPERATOR	Somewhat like the verb in an English sentence. e.g. In adding 2 and 3, the operator is addition, the operands are 2 and 3.
OPERATING SYSTEM (OS)	Sometimes referred to as a monitor in small computers. An operating system is a collection of programs which allow a person to use the computer.
OR	A logical operator connecting two statements. If either or both statements are true the result is true, otherwise the result is false.
OUTPUT	See I/O.
PAGING	The process of dividing up a program into segments so that part of it will fit into memory in order to be executed.
PARALLEL	(As opposed to serial). Two or more things happening at the same time. For example, a parallel interface handles several electrical signals simultaneously.

PASCAL — A structured programming language developed in the early 1970's. It is available on most microcomputers.

PERIPHERAL — Devices connected to a computer for storage or communication, e.g. line printer, card reader, disc drive.

PICOSECOND — 10^{-12} seconds, one one-billionth of a second.

PIXEL — Short for picture element. This is the elementary dot displayed on a T.V. screen. Letters when displayed are made up of a combination (matrix) of pixels.

PL/1 — (PROGRAMMING LANGUAGE I). A structured programming language developed and supported by IBM.

PORT — The part of a computer to which a peripheral device may be connected.

PRINTER — A device which prints characters on paper.
A line printer prints an entire line of characters at once.
A serial printer prints one character at a time. Printers may be tractor fed (paper with holes along the sides) or friction fed (unpunched paper).

PROGRAM — A series of steps for solving a problem written in some programming language. See also ALGORITHM.

PROGRAMMER — A person who writes computer programs which work.

PROM — Once the instructions are programmed into this chip, they may not be changed. It is then used only to read instructions from. Data may not be stored in PROM.

PROMPT — A symbol appearing on a computer's screen indicating a response is required from the operator.

QUEUE — In large computer systems handling many programs, programs are placed in a queue to await processing.

RAM — (RANDOM ACCESS MEMORY). One may read and also store information in this memory.

RANDOM NUMBER GENERATOR — A program, when executed, produces numbers which can not be easily predetermined. These numbers in turn may be used in computer games, for example, to provide random outcomes.

RECORD — If a data file is considered to be a page of foolscap, each line on the page is a record. Records are referred to by number and are essentially a collection of related data elements.

REGISTER — A special memory location set aside for particular operations such as holding the memory address of the next instruction to be executed.

RESERVED WORD — A word which may not be used as a variable name, because it is part of the computer language.

RF MODULATOR — (RADIO FREQUENCY). A device which allows you to use an ordinary TV set as a display terminal for a computer.

ROM — (READ-ONLY-MEMORY). Instructions are permanently imbedded in the chip One cannot write or store other information on the chip

RUN — To execute a program.

SAVE — To copy a program from memory, and store it on disc or cassette tape.

SCROLL — To move all text on the screen up to allow more to be inserted at the bottom.

SERIAL — One after the other. A serial interface handles one bit of information at a time. (See also PARALLEL).

SOFTWARE — Any program or set of programs which run on a computer. (See also COURSEWARE).

SOURCE CODE The original program written by the programmer. (See OJBECT CODE).

SPAGHETTI CODE Any program whose logical flow traces out a path which resembles a bowl of spaghetti.

STRING A sequence of symbols consisting of either characters, letters or numbers.

SUBROUTINE A Subprogram or procedure.
Programs are often made up of sets of previously prepared routines. These subprograms may be called upon many times to be executed thus providing efficiency in programming.

SYNTAX The rules of grammar of a language. If the rules are not followed then get you a syntax error.

TELIDON The brand name of a Canadian videotext system.

TERMINAL A typewriter-like device usually with a TV screen attached. It allows you to communicate with the computer. A computer may have more than one terminal.
A "dumb" terminal has no internal memory; it is simply and input-output device. An "intelligent" terminal has an internal memory; it may be a micro-computer capable of performing functions of its own while still being attached to a larger computer.

TEXT Data other than numeric

TIMESHARING In a large computer system where many programs are competing for computer resources each program is moved in and out of memory for a short time in order to be executed. Thus many users can use one computer simultaneously.

UP Opposite of Down. The state a computer is in when everything is working properly. When a computer has gone from down to up, some programmers have been known to smile.

USER'S GROUP A group of people using the same computer equipment. User groups are encouraged by computer manufacturers to promote exchange of programs, information and ideas.

VARIABLE A name for some quantity which might change in value during program execution.

VIDEOTEXT A video text system transmits and displays textual and graphical information to and from a central computer and a TV in the home.

V.L.S.I. (VERY LARGE SCALE INTEGRATION). A design technology for computer chips which allows for extreme miniaturization of many electrical circuits on a chip.

WORD A sequence or group of bits treated as a unit and capable of being stored in one memory location.

"The question is", said Alice, "whether you can make words mean so many different things."
"The question is", said Humpty Dumpty, "which is to be master—that's all."
Lewis Carroll: Through The Looking-Glass
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