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COMPUTER ASSISTED LEARNING IN THE CANADIAN FORCES:

TRAINING THE TRAINERS

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Computer Assisted Learning in the Canadian Forces: Training the Trainers" submitted by Margo J. Mayo in partial fulfillment of the requirements for the degree of Master of Science.

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ABSTRACT

Training in the military is, and has always been, affected by changes in society, technology and education. The rapid development of technology in recent years has forced the examination of military training practices with regard to the needs of the information age and technical sophistication of equipment.

Changes to deal with these needs are required and are already beginning. The thesis examines, in detail, the current Canadian Forces Training System (CFTS), trainer training, and Computer Assisted Learning (CAL) initiatives. It then examines the need for CAL support and training within the CFTS as perceived by the Commands and Schools and in relation to external factors.

The CFTS is again examined in light of the information gained from the needs analysis and a detailed proposal outlined for the changes required in each area of the CFTS to integrate and support CAL. Required changes in trainer training courses are also outlined, and a detailed plan for a research and development unit for CAL is suggested.

Modification of the existing instructional techniques course is suggested as a starting point for these changes.

The instructional design for an interactive, multimedia 'guided discovery' CAL course with expert tutor is described, based on a model designed and programmed by the author. Comparisons between the CAL and classroom instructional technique courses are then made to determine cost benefits.

The existing CFTS gives excellent instructor support and training for classroom instruction. CAL concepts must be introduced at all levels of the system, and in all courses to ensure instructors are adequately supported and trained to deal with the new technology.

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CHAPTER 1

MILITARY TRAINING IN A CHANGING SOCIETY

Change is one of the few certainties in this world. Yet it is not the certainty of change which has become its most troublesome aspect, but the increasing speed at which it is taking place. Previously, major changes were slow to occur and slower still to spread throughout the world. An innovation that used to require decades, even millenia, to go through the stages of acceptance and adoption now completes its life cycle in quantum leaps: from conception to full implementation to obsolescence in a matter of years, or even months.

There have been at least three major changes which have occurred throughout recorded history; changes which have dramatically and substantially changed society. The first was the agricultural revolution which began around 15000 BC (Encyclopedia Britannica, vol. 18 pp. 26-27) and changed the hunter-gatherers to farmers and, later, farmer supporters such as traders, merchants, and blacksmiths. This was Alvin Toffler's "first wave" (1980, p.16). The "second wave" (ibid) was the industrial revolution in which machines took over much of the physical work formerly done by humans, and required roughly 300 years, from 1650 to

1950, to have its full effect. The current "third wave" (Toffler, 1980, p. 120), called, among other names, the information revolution or microelectronic age, has become widespread in the developed countries in the few years between 1945 and the present and is still gathering momentum.

Not all peoples experienced the changes at the same time of course, or indeed at all. Primitive hunter-gatherer societies still exist in remote areas of the earth, many countries retain a major dependence on agriculture, and still others are only now entering the industrial age. The changes and therefore the problems involved are mainly concentrated in the 'developed' nations.

With change comes conflict. Early agricultural man raised his stone axe to protect his crops from raiding hunter-gatherers, and early Canadian and American settlers relied on armies to protect their farms from hunter-gathering Indians who were understandably concerned that their hunting areas were being overtaken. As civilization progressed, the conflicts intensified, with victory almost always going to the technologically advanced. In this way, that segment of the population specializing in conflict, the military, became inextricibly tied to both general technology and societal changes. In some cases, military needs caused the development of technology (eg. improved medical treatment for trauma victims); sometimes changes in technology caused changes in the military (eg. gunpowder and rifles eliminated the knight in armor); and in still other cases, changes in society influenced military operations (eg. guerrilla warfare).

With change also comes a need for education to ensure that the new information is passed to others. During the agricultural revolution, knowledge, skills and culture were handed down from generation to generation by stories and demonstrations. As trades became more specialized, a craftsman would take on an apprentice who would work with him and learn the craft. Similarily, soldiers would learn their trade from their superiors. With the invention of writing, knowledge could be recorded and read by people far removed from the original source. The recorded knowledge was, however, restricted to a small number due to the lack of reading ability in the general population and the specialized skills involved and the time required to produce a document.

The apprenticeship system with its personal approach decreased considerably during the industrial revolution. Machines took over many tasks previously performed by a skilled craftsman (for example, spinning and weaving). The operators of these machines required few skills. Children were often employed in factories and remained at the same job for life. Learning to operate the machinery became a matter of economic survival. The machinery of war required a similar approach. The soldier learned his weapons and tactics for physical survival.

The early industrial age had two levels of society: the educated elite who were able to read and write and who had access to the few printed or handwritten manuscripts available; and the uneducated masses who learned how to run the machines and/or perform a skilled craft. The military reflected these levels with their officers and men.

The invention of the printing press increased the availability of information to a wider circle and made mass education possible. Basic skills (reading, writing, arithmetic) were taught to large numbers of children at one time in a production-line type of environment. The individual approach of the pre-industrial days was gone, to be replaced by an average amount of knowledge transmitted to several children in a fixed period of time, mainly by one teacher lecturing to several students. The basic soldier therefore, had a basic education on entry, and could be taught any additional information in the same manner.

This served to level the education gap by the beginning of the post-industrial or information age. Although higher university education remained predominantly the province of the intellectual elite, the majority of people in developed countries had a basic education that allowed them access to a multitude of information sources.

The information age, although still in its early stages, has resulted in an explosion of available information, possibly as a result of the invention of the computer, the heart of information technology. More pieces of information are now accessible than can be managed by a human. The fast processing of a computer is required to sort and classify this data to produce useful information. In place of concentration on learning how to manage machines that produced goods, more and more workers must now learn how to collect and manage data to transform it into information.

A better informed population is causing other changes in society. An uninformed population could be easily controlled as a mass through the manipulation of information: knowledge was power. An educated and informed population, one with almost unlimited access to computerized data banks via the media, requires a different approach. People must be persuaded and involved in decision making (Cleveland, 1985, p.p. 118-119). This is contrary to traditional military control, where discipline is all. Discipline remains critical (nobody who really thought about it would be willing to stand up and be shot at), but it can no longer be achieved by brute force. Education is required.

The education system has adapted little in response to these changing needs. Computers are becoming more available in schools, but are still not wholly integrated in the curricula. Their speed, branching capabilities and infinite patience allow a return to individualized learning, but require a different teaching paradigm from the standard classroom lecture. In other words, teachers must learn how and where it is appropriate to use them. This will be as much of an adjustment as the idea of standing in front of a class and lecturing must have been to the craftsman who had previously relied on a one-to-one relationship with his apprentice, or to a scholar who previously discussed handwritten manuscripts with a selected handful of students.

If the basic education system and its teachers must change, so too must the military training system and its instructors. The basic education system cannot and should not be expected to produce an individual fully trained for any specific job. This is true for most occupations (electronics, engineering, nursing, and hotel management, for example) which require that their incoming personnel receive advanced instruction in skills, knowledge and attitudes specific to their line of work. It is also true for the military. Even a private soldier must receive education in the military ethos in addition to training on weapons or trade skills.

The military is inseparable from the society in which it operates. Education is similarly linked to society. All must respond to changes in technology if they are to survive and progress. Change is more easily implemented if it can be encompassed within an existing system: social system, bureaucratic system, educational system or training system. If computers are the cause of the change, it makes sense to educate people in their use within their own system. If people are to be educated in the use of computers, it makes further sense to educate them by using computers. The education process should therefore begin by educating the educators by a series of computer assisted learning lessons.

Planning for change and educating people accordingly eases the transition between the old and the new. The education process must begin by educating the educators. In military training, the process must begin by training the trainers.

CHAPTER 2

MILITARY TRAINING: THE CHANGING TECHNOLOGY

Technology has been the driving force behind much of human history. If technology is to be defined as "the systematic study of techniques for making and doing things" (Encyclopedia Britannica, vol. 18, p. 24), then man the toolmaker has been involved with technology at least since the early stone age. For any advance in technology to succeed, there must be strong social involvement. If a social need is not strongly felt (better tools, energy or weapons), or the social resources (money, material, personnel) are not available, the innovation will not be supported and will fail (ibid, pp. 24-25). Once the technology has been developed, it must be transmitted to others. This can only be done by education, either formally, from master to apprentice or teacher to class, or informally by one-to-one interaction.

The military is a sub-culture of society and, as such, it is inseparable from the interacting tides between society, education, and technology. The history of the military is the history of society from a 'conflict' perspective. It is also the history of technology with a specialized focus: the tools of war. As military training reflects the educational concepts and tools of the society at large, military history is also a reflection of educational history.

Military Technology

A brief look at history reveals a multitude of examples of the relationship between technological innovations, military use of them, and the resulting changes in society. Colin McEvedy (1984), in his book The World History Fact Finder, charts significant happenings, by date, in the following areas: politics and military history; religion and learning; cities and social development; discovery and invention; and the arts. From such a perspective, comparisons can be made and the 'how' and 'why' of historical events become clearer. Some examples from the flow of history can be quoted to illustrate the impact of military technology on world events.

In the early Iron age, somewhere between 1200-1100 BC, the iron swords of the Dorians ensured a definitive victory over the bronze-sword-wielding Mycenaean principalities (McEvedy, 1984, p.16). The Greeks enjoyed sea supremacy for decades with their trireme warship (ibid, p.25), setting the standard for warships of the civilized world for the entire fifth century BC.

In early history, the time gap between the invention of technology and its use by the military could be several hundred years. Horse riding was known as early as 1000 BC (ibid, p.19), and the metal stirrup used as early as 450 AD (ibid, p.38), but it was not until 700 AD (ibid, p.44) that the combination was used by the cavalry. The stirrup allowed a mounted soldier to charge his enemy, spear in hand, without fear of being unhorsed and gave the cavalry undisputed dominance over the infantry for centuries.

As time progressed, so did the speed of change. The manufacture of gunpowder, circa 1300, was rapidly followed by the use of guns, between 1315 and 1326 (McEvedy, 1984, pp. 64-65). Ammunition for the guns quickly became heavy enough to destroy stone walls, and resulted in the end of an entire social order in less than a century (ibid, p.69). Warring lords could no longer raid and then hide behind impregnable castle walls in safety. When the castles became useless, the social order centered around them had to change.

The speed of change continued to accelerate as the centuries marched on. Emphasis shifted from who could invent the technology to who could implement it the fastest. This is illustrated by the race for the atomic bomb between Germany and the United States. The U.S. development of the atomic bomb before the Germans resulted in an allied win to end World War II (McEvedy, 1984, p.183).

This race to be the first to implement an innovation required an increase in training to ensure that the information on how to use the technology was disseminated as rapidly as possible.

The technical innovations themselves are becoming much more complex. Training a cavalry officer in the use of his equipment was relatively simple: feed and water one end of the animal, clean up after the other end, nail metal shoes on the animal's feet, polish the spear, saddle, and bridle. Additionally, at least one person in the regiment had to be able to treat the horse's injuries. This required some additional training, but was clearly not as complex as maintaining a modern tank with its thousands of mechanical and electrical components. Even the relatively simple tools of the modern infantry soldier require training to master. Cleaning a rifle or machine gun with its many tiny parts is considerably more intricate than wiping off a sword and coating it with oil.

The machinery of war now requires enormous amounts of money to acquire, use and maintain; easily into the billions of dollars. As equipment becomes more complex, costs for purchase, operation, maintenance and training also increase. The increasing sophistication and relentless march of new technology also means that the equipment becomes obsolete faster and must be replaced more often, naturally at an increased cost. This kind of expenditure by a country, such as Canada, that has enjoyed relative peace since the end of the Korean conflict is difficult to justify. The government's position is outlined in the book Challenge and Commitment A Defence Policy for Canada (1987, pp.2-3) in which it states:

> "Far too often, military force or the threat of military force has been the preferred tool for achieving political objectives...While Canadian security policy must be flexible enough to adapt to changing circumstances, some elements of our geostrategic situation are immutable. There is no external threat which is unique to Canada. Canada alone cannot assure its own security...as a country that depends on international relationships for its well-being and prosperity, if not for its survival, Canada's security ultimately requires the maintenance of a peaceful international order...The first objective of Canada's security policy is to promote a stronger and more stable international environment in which our values and interests can flourish."

Neutrality or unilateral disarmament is, then, not an option for Canada (ibid, p.3). We shall continue to maintain a standing force, but make every attempt to reduce costs for equipment, personnel and training.

According to the National Defence publication Defence 88 (1989, p.11), in 1989, 9.4 percent of the Canadian government budget will be spent on defence, approximately 11.2 billion dollars. Of this amount, it is estimated that 26.2 percent ($2.93 billion) will be spent on capital equipment, 25.6 percent ($2.87 billion) on operations and maintenance, and 38 percent ($4.26 billion) on personnel (ibid, p.11). Even though Canada spends a lower percentage of its Domestic Product on defence than any other NATO country except Luxembourg (in 1987: 6.6% for the United States, 2.1% for Canada, 1.2% for Luxembourg (ibid, p.16)), this is still an enormous amount of money, and it buys very little.

Equipment costs are escalating in all areas, and in order to fill an operational need a relatively fixed price must be paid. A fighter airplane to do a specific task will cost X million dollars and cost X dollars to operate and maintain, regardless of the type bought. Some savings can be realized by careful definition of requirements, but major cost savings can only be achieved by not buying the equipment.

Personnel costs are escalating as well. Canada can no longer meet its personnel requirements through the Regular Force alone, as the cost of an all-volunteer full-time force is simply too high. The solution, identified in Challenge and Commitment A Defence Policy for Canada (1987, p.65-66), is to increase the Reserves and have them work hand in hand with the Regular Force - the "Total Force Concept". This helps the personnel budget but makes the training problem even worse, as more people will have to be trained if they are only working part time.

As training costs increase with equipment and personnel costs, training must receive the same scrutiny as major equipment acquisition and personnel employment patterns in an attempt to reduce the cost of training while maintaining or increasing effectiveness.

Training Technology

Part of the solution to the increased cost of training due to technology may lie in the very technology that is causing the problem. Both civilian and military education and training systems are beginning to recognize that the procedures that served the needs of the industrial revolution may not apply as well to the information age. Questions are being raised about how we should organize and deliver education and training, and computers are being examined to see how they may be profitably introduced.

Changing an educational system to reflect society's changes is not new. Culture and learning was so important to the Greeks that they invented a true alphabet to facilitate accurate recording of events as early as 750-701 BC (McEvedy, 1984, p.20). It was only a matter of time until schools were founded, beginning with Plato's Academy in 385 BC and continuing with Epicuris in 306 and Zeno in 301 (ibid, p.26). Education became compulsory in France from the age of six as early as 1793 (ibid, p.128), and the British required that their children attend school until age 13 as early as 1880 (ibid, p.160), and made all elementary education free in 1891 (ibid, p.162).

Compulsory free education meant that many more children were attending schools. Some method had to be found to manage these numbers efficiently. The answer was found in the technology of the industrial revolution.

The massive technological changes of the industrial revolution demanded that a certain type of worker be produced, one who was prepared to meet the needs of the machines. The worker must be prepared to work indoors, for a specific length of time, at a single machine, performing repetitive tasks. As children tend to be taught to perform the roles they must assume in adulthood by simulation of those roles, the education systems of the time were modeled on the factories. Schools were constructed so that students reported to school prepared to work indoors for a specific length of time, at a desk, performing repetitive learning tasks. This made the education system very effective to produce the adults required for the time (Toffler, 1970, pp. 399-402). The regimented discipline of the classroom was also excellent preparation for the discipline required in the military.

As the amounts of information to be acquired by a child to equip him/her for adult life increased, the education process became longer. Increasing automation meant that the tasks left for people to do became more complex and therefore required still more training. The education and training processes responded by becoming longer still. In the prairies in 1910, a grade 8 or 9 education was considered adequate preparation for adulthood, and few students proceeded beyond this level (Charyk, 1968, p.252). By the 1980s, at least four years of post-secondary education was considered necessary for economic survival.

Change is becoming so rapid that technical knowledge is outdated in as little as five years. The requirement for lifelong training has become a reality. The graduate fresh out of college after sixteen years of education is current for less than five years, after which s/he must go back and learn again.

The present system of centralized classroom training is both inefficient and ineffective for this type of continuing education. The military has used continuing education for years: basic skills training, followed by a period of work, followed by another course, then work, and so on throughout an individual's entire career. The increasing technical complexity of the training requirements has resulted in longer and longer courses, and therefore shorter and shorter work periods between. Consequently, a search for more efficient training methods was undertaken.

As with the industrial revolution education problems, the solution was sought in the technology itself, in this case the computer. A computer can simulate the operation and maintenance of an expensive machine, such as an aircraft, and allow students to learn to perform tasks without danger of damaging either millions dollars worth of machinery or themselves. The success of simulators in early flight training is well documented. As a result, various projects using computers for theoretical training were undertaken and were likewise successful, culminating in the current Computer Assisted Learning (CAL) Project, designed to implement CAL in several Canadian Forces

Schools (Kincaid and Saunders, 1986, pp.164-166).

Training and support will be required for the instructors who will be working with the new technology. It also seems to be a good time to look at recent developments in the CAL field to see what other technology could be profitably introduced. Microcomputers and advances in communication capabilities may make distance training feasible for many military courses, both Regular and Reserve. As yet untested innovations may have similar applicability for military training. Continuous research and trainer training will be required to prepare both instructors and students for survival in the information age.

Training Trainers

The Canadian Forces has historically used subject matter experts to teach tradesmen their trades. These subject matter experts were given courses in methods of instruction to prepare them to teach their own subject matter in a classroom setting.

Prior to the integration of the Royal Canadian Navy (RCN), Royal Canadian Army (RCA), and Royal Canadian Air Force (RCAF) into the present Canadian Forces, each branch was responsible for its own training and therefore its own trainer training. The RCN Instructor Branch (Schoolies) were educational specialists employed to: teach academic subjects to officers and tradesmen; monitor quality of instruction and evaluate courses (a 'Standards' role); and run the Fleet School Instructional Training Units to teach methods of instruction to the subject matter experts who were instructing various trades courses (unsigned staff paper, 1 November 1976).

The Army, possibly because it was less technologically oriented than the Navy or Air Force in those days, did not employ educational specialists. Subject matter expert instructors were taught instructional technique at the Camp Borden Methods of Instruction Wing (ibid).

The RCAF Education Officers were also educational specialists, but were not as involved in classroom teaching as their Naval counterparts. They were heavily involved in standards work, coordinating the on-job training, and training the subject matter expert instructors at the School of Instructional Techniques.

Following integration in 1966, all instructor training was amalgamated at the Canadian Forces School of Instructional Technique (CFSIT), and the educational specialists were gone, transferred to the Personnel Development classification. The concern about the rising costs of equipment, personnel and training that prompted integration and the creation of CFSIT in the 1960s also gave birth to a systematic approach to training, the Management System for the Control of Training (MASCOT). MASCOT eventually became a designated command or organization, the Canadian Forces Training System (CFTS), and a process, the Canadian Forces Individual Training System (CFITS). The system relied only on subject matter experts to design, conduct and evaluate training (Catching Up, 31 August 1979).

The lack of educational specialists in this system was soon apparent and plans were made to redress this deficiency. The Training Development Branch was created from those Navy or Air Force educational officers who still existed as Personnel Development (Training) Officers and specially trained officers from other classifications. These Training Development Officers (TDOs) were given a mandate to "provide professional advice to those responsible for the conduct of training" (CFAO 9-65).

Shortly after the creation of TDOs, the School of Instructional Technique (CFSIT) was renamed the Canadian Forces Training Development Centre (CFTDC) and its role expanded to include in-service analysis and design, training development capability, and training research and development in addition to training on training (unsigned staff paper, 10 September 1979).

The system has continued to evolve in both instructional development and trainer training. Training in the Canadian Forces has a history of changing to meet current needs, with instructor training and support always a priority. The existing training system is the result of years of evolutionary changes, expanding and contracting to meet current demands. A detailed study of the system as it exists will assist in assessing the value of incorporating newer technologies.

Conclusions

The Canadian Forces has experienced changes in both personnel structure and equipment along with the military forces of other developed nations. The "total force concept" is the latest of several methodologies to contend with the rapidly escalating costs of both personnel and equipment to maintain an operationally ready force.

The role of a peacetime force is to train for war. The Canadian Forces Individual Training System (CFITS) was developed to ensure adequate numbers of personnel are trained for their roles as efficiently and effectively as possible. This system, developed to meet the individual training needs of the regular force, must expand to include the reserve forces if it is to meet the operational goals of the total force concept.

Like the civilian education system, military training methodology has changed little since the industrial revolution. The courses are better defined and prepared, but continue to be taught in a classroom setting. This too may have to change to meet increased training requirements and incorporate new technology.

The present training system produces competent personnel trained by subject matter expert trainers who are themselves products of trainer training courses. It may not be high-tech, the most efficient or the least costly method, but it does work, and works well. The existing system has proven its ability to change and incorporate new concepts. Creation of an entirely new training system merely to introduce technological advances and/or incorporate reserve training is neither justified nor desirable at this time. Examination of the existing system is required to determine how computer technology could be introduced to increase efficiency and effectiveness and reduce costs.

CHAPTER 3

THE CANADIAN FORCES TRAINING SYSTEM

The Canadian Forces Training System (CFTS) was formed in 1968 to provide an efficient, cost-effective method of producing a trained man or woman capable of performing tasks required in operational or support roles. Although educational considerations are a critical component of Canadian Forces (CF) training (Military Colleges, Staff School, Staff College, Command College, and portions of some occupational courses), the major effort is devoted to training personnel to perform specific tasks.

CFTS is responsible for basic recruit and officer training, and occupational training for military occupations that are common to more than one operational command: approximately 447 courses producing 28,000 graduates per year (DND, Defence 87, p.104). Additionally, more than 33,000 graduates are trained each year by a variety of courses held by the operational commands (ibid, p.104).

The process followed in designing the training, known as the Canadian Forces Individual Training System (CFITS), is currently heavily centered on instructor presentations, either lectures or skill demonstrations, with trainee participation ranging from limited in the lecture classes to extensive in skill practice classes. Most of the background documentation (Training Standards, Plans, Lesson Specifications, etc.) is devoted to the support of instructor led presentations. Current instructor training is also almost exclusively based on this instructional paradigm.

The System

The CFITS is composed of five sequential phases, moving from the analysis of job requirements, through the design of a training course and the conduct of that course, to the evaluation and validation of the course. Each phase provides the basis for the following phases and changes may be identified and made as required in any of the phases.

Analysis Phase

In the analysis phase, a military occupation is analyzed to determine the jobs, duties and tasks that make up the occupation and the amounts of skill and knowledge that are required in these areas for each level of the occupation (both rank and skill levels). Then a further analysis is done to determine training standards for each task, standards that the graduate of the training program must be able to achieve.

Specifications. The first step in the analysis phase is the responsibility of the Directorate of Military Occupational Structures (DMOS) at National Defence Headquarters (NDHQ). In this phase a military occupation is analyzed to determine what jobs are required to be performed, and to identify all component tasks required to do the job. When the task list is completed, it is further analyzed to determine the knowledge and skill requirements for each level of the occupation, from beginner to supervisor. A Training Development Officer (TDO) may be included as an advisor in this process.

The result of this initial analysis is a list of specifications for each military occupation detailing for each task: the level of involvement (assist, do, do and supervise, or supervise); knowledge requirements (basic, detailed, comprehensive, or complete); and skill requirements (limited, semi-skilled, skilled, or highly skilled). If the analysis is performed on an existing occupation, questionnaires based on the existing specifications are sent to all military members performing the job to determine if the task lists are current and the degrees of participation, knowledge and skill accurate.

The data thus collected are analyzed and the results used to update the specifications. If it is a new occupation, information on tasks, skill and knowledge is solicited from subject matter experts and a specification drafted from this information.

When the specification is complete, it is published and forwarded to whichever Command is assigned responsibility for the occupation, as determined by the Directorate of Individual Training (DIT) at NDHQ. For example, Mobile Command is responsible for infantry soldiers, Air Command for pilots, and Maritime Command for marine engineering technicians. The designated Command then becomes responsible for the second part of the analysis phase: determining standards to be achieved by the graduates of the training.

<u>Course/On-Job Training Standards.</u> The Command convenes a board of personnel who are subject matter experts for the occupation concerned, usually at the supervisory level. Often this board includes a TDO who provides training/educational expertise and, rarely, a model performer in the trade is also included.

This board examines each task listed in the specifications to determine whether or not training is required and, if so, whether it should be done on a formal course or on the job. Course and On-Job Training Standard documents are then prepared with performance objectives for each task that requires training. These objectives are operationally oriented, that is, they detail exactly what the trainee is expected to be able to do at the end of the training period, the conditions under which the task is to be performed, and the standard to which the task must be done.

Information on course management details (course capacity, estimated course length, controlling agency, loading agency, prerequisites, and qualification received) is added, as well as trainee assessment procedures (type of examination, number of supplemental attempts permitted, and grading information), and the document is published. Course Training Standards (CTS) are sent to the School responsible for conducting the training, and On-Job Training Standards (OJTS) are sent to all units which will be employing the trainees.

Design Phase

Course. To design a course, the Canadian Forces School which will be conducting the course convenes a board or team, usually composed of Standards section personnel, instructors, and a TDO, to develop a Course Training Plan (CTP). This team sequences the performance objectives (POs) in an order most conducive to training, and performs an instructional analysis to determine knowledge and skill elements of the POs. Related knowledge and skill elements are grouped and enabling objectives (EOs) written in the same three part format as the POs (performance, conditions, standard). Each EO also has other parts: lesson specifications which outline the teaching points, references, recommended method, training aids, time requirements, and test details. Performance checks (written examinations or skill check lists) are then written for each performance objective.

The POs, EOs, and lesson specifications make up the bulk of the CTP. To these are added a suggested sequence and time for the course (a sample schedule), instructor requirements, and any special instructions necessary for the conduct of the course.

<u>On-Job Training.</u> Each unit (for example, transport company, food services establishment, communications squadron, and/or repair depot) is responsible for developing its own on-job training plan. A Unit Training Officer is usually delegated this task, with advice

available from the Command Training Development Officer if required. The program must be planned to fit the availability of supervisory personnel, equipment in use, and operational requirements of the unit.

Conduct Phase

Following the analysis of job requirements and the design of a course is the 'conduct' phase, where the course plan is implemented.

Courses. In some schools, Master Lesson Plans are written for the course. In others, instructors work directly from the CTP to prepare their lessons under the supervision of the course director. One or more pilot courses are then run and analyzed to test the course and make changes where required.

On-Job Training. Units lacking essential equipment or facilities to complete on-job training objectives are responsible for ensuring that the objectives are met, either by sending the trainee to a unit where the facilities are available, or by simulating the task. Checklists detailing critical requirements for task completion are provided for the Unit Training Officers.

Scheduling. Course loading responsibility (assigning personnel to training courses) is divided between NDHQ and Command, depending on the type of course (for example, career course, upgrading, speciality), and is driven by operational requirements for trained personnel. Schools may conduct several serials of a given course, depending on physical resources, personnel availability and training requirements.

Once a School has been informed about the number and types of courses it will be running in a given year, a master schedule is prepared, taking into consideration instructor qualifications, classroom and equipment availability, and suggested sequencing of course objectives. This process is not yet automated in most schools due to the variety and complexity of the variables.

Evaluation Phase

The fourth step in the development of training in the CFITS is the evaluation phase. Both the trainee and the course itself are evaluated.

Courses. Evaluation is the responsibility of the School. All objectives must be mastered for a trainee to complete the course. Following the course, a course report is prepared describing the trainee's performance and sent to his/her home unit.

An in-school analysis is performed each time a course is run. Student results and critiques are analyzed by Standards Section personnel, usually including a TDO, to determine the efficency and effectiveness of the course. Recommendations for changes to Lesson Plans, CTP, CTS, and even trade specifications can be made at this level. Instructors are also evaluated by instructor supervisors during the courses to monitor instructional technique.

On-Job Training. Continuous evaluation of unit On-Job Training is the responsibility of the unit Commander. Student On-Job Performance Records (OJPRs) and supervisor/instructor evaluations provide data necessary for quality control reviews.

Validation Phase

In the fifth phase of the CFITS, a course is validated to determine whether or not it is meeting operational needs. Responsibility for the validation process rests with the applicable Command. This is done at regular intervals with a TDO actively involved in the process. Questionnaires are sent to all graduates of the course or OJT to determine how well they were prepared for the jobs they are performing. In addition, questionnaires are sent to the supervisors of the graduates asking how well the graduates were prepared for their jobs.

The analysis of these data serves to pinpoint areas of overtraining, undertraining, or mistraining. The validation report recommends changes required at any level of the system, from occupation specifications to lesson plans.

Current Situation

Since its inception, the CFITS has developed to the point where a large and effective system for Regular Force training is now in place. The system is flexible enough to absorb technological changes but currently has little provision for computer assisted learning. With the exception of a computerized method of recording personnel who have attended a given course, very little computer managed instruction or computerized instructional aids such as class scheduling programs are utilized.

Trainer Training

The Canadian Forces Training System is involved in training personnel for all Commands. An integral part of the system is the Canadian Forces Training Development Center (CFTDC), designed to be a focal point for training and supporting the trainers. CFTDC also has a research and development section concerned with projects involving innovative approaches to training which operates in conjunction with Training System Headquarters (TSHQ) and National Defence Headquarters (NDHQ).

Trainer training currently concentrates on preparing personnel to design, instruct, and evaluate instructor presented lessons. Training Development Center (TDC) courses are run as required to provide instructors and instructional support personnel for Training Systems and operational command (Air Command, Mobile Command, Maritime Command) schools. These courses include:

1. TDC 1 - Instructional Techniques. This course provides subject matter experts with sufficient classroom survival skills to effectively present information in a classroom setting. The trainee is required to prepare and present two short lessons during the course: one is a lecture on a theoretical subject, and the other is the practical teaching of a skill.
2. TDC 2 -Instructor Supervision. This course prepares subject matter experts to supervise instructors.

Trainees are required to critique lessons and debrief the instructor. Each trainee presents a lesson for other trainees to critique.

3. TDC 3 - Instructional Materials Design. The main focus of this course at the present time is the design, preparation and testing of paper-based, self-paced instructional materials such as Programmed Instructional Packages (PIPs) and pre-course self study packages. The course is directed at subject matter experts.

4. TDC 5 - Training Manager. This course is directed at School Commandants and other subject matter expert training managers.

5. TDC 6 - Audio-Visual Aids Production. Subject matter experts are instructed in the principles and preparation of training aids in this course. Each trainee is required to produce several training aids, concentrating on overhead projector transparencies, charts, sound-on-slide productions, felt boards, and other aids.

6. TDC 7 - Video Equipment Operation. This course has two forms: one prepares subject-matter-expert instructors to use videotape equipment in a classroom setting to integrate prepared videos into their classes (Video Familiarization); the other prepares instructors to

produce educational videos, with instruction in storyboarding, filming, and editing techniques (Video Production).

7. TDC 8 - Course Training Standard Writing. One of three courses to evolve out of an older course concerned with standards, this course prepares potential members of CTS writing boards for their tasks, either in the initial creation of a CTS, or in later revisions to that document. Instruction and practice in task analyses and writing performance objectives are the main foci.

8. TDC 9 - Course Training Plan Writing. The second of the three complementary but separate courses in training design and evaluation, TDC 9, prepares trainees to perform an instructional analysis on the Course Training Standard and create a Course Training Plan. Instruction and practice in instructional analysis, writing enabling objectives (EOs), choosing appropriate training methods and aids, and calculation of instructor productive hours enable graduates to design and maintain CTPs in a school standards section.

9. TDC 10 - Training Evaluation. This final course in the trio is again directed at school standards section personnel. It has two main sections: theory and

practice in test construction, and evaluation of a training course using test analyses, student critiques, and instructor monitoring reports.

10. TDC 11 - Training Validator Course. This is another new course designed to prepare Command personnel for their roles in the validation of courses.

11. Training Development Officer Basic Qualification Course. This course is the initial entry course for TDOs, both those who are reclassified from other occupations, and those who are new in the service. Instruction and practice in all phases of the CFITS is provided, as well as change theory, learning theory, and learning resources management. Included in the course is a three month project selected from training problems submitted by all Commands.

Current Situation

Instructor training courses are frequently examined and updated, producing a dynamic series of courses covering most aspects of instructor training. Technology is taken into consideration in all courses for training aids and adjuncts to training, however, with the possible exception of the TDC 3 course (currently under review), which addresses some aspects of interactive course design, no courses exist to prepare an individual to design, conduct or evaluate CAL courseware. Several projects have, however, been undertaken to test the feasibility of incorporating computer assisted learning into training courses.

Computer Assisted Learning

As military and training technology continue to advance, more attention is being placed on Computer Assisted Learning (CAL) as a possible resource to improve training efficiency and effectiveness. The need for expansion of training without loss of efficiency will become even more critical as the 'Total Force Concept' comes into effect with its emphasis on increased reserve training.

Projects

The CF has been involved in various CAL projects since 1973. Early major projects at Kingston, Trenton, Borden, Halifax, and Cold Lake were designed to test the technology on identified training needs. All were created for mini-computers with several work stations.

The first project, consisting of courses on basic mathematics and electrical theory for the Canadian Forces

School of Communications and Electrical Engineering at Kingston, showed an average 30% reduction in training time with equal or superior achievement (Kincaid, 1986). These results were insufficient to support a major change in training development or design at that juncture.

In the Trenton project, subject matter experts were given instruction in course design and programming for the NATAL authoring system on a Honeywell DPS 6 mini computer before creating five technical courses: Digital Computer Fundamentals, Aircraft Fuel System Servicing, Propeller Synchrophaser Servicing, Aircraft Gas Turbine Compressor Servicing, and Crash Position Indicator Servicing. Course Design instruction was given by two Training Development Officers along with a separate series of CAL programs to teach NATAL programming. Although this project had problems with the hardware and software, the results were promising enough to spark further development (Nash, 1986).

The Borden project, a self-paced CAL course for Supply Technicians at the Canadian Forces School of Administration and Logistics (CFSAL), was the first to utilize the computer for both instruction and management of a whole trade qualification level course. Evaluation data from this course indicated a decrease in group affiliation and CF identification in trainees involved in the CAL approach over those in the classroom based course. This perceived decrease was of undetermined significance (the evaluation design did not allow for quantative comparisons), but remains a concern (Holland, 1987).

During a review of naval trades training, a need for remedial mathematics and science training was identified. The Halifax project addressed this need by acquiring hardware and courseware (based on the CAN 8 authoring language) to teach these subjects. The project results were as anticipated: students improved their skills to the levels required without an increase in instructor requirements (Kincaid, 1986). The success of this project has resulted in its expansion from the Canadian Forces Fleet School (CFFS) at Halifax to the west coast school, CFFS Esquimalt.

The Cold Lake project resulted from the procurement of new fighter aircraft. Part of this procurement included courseware for training maintenance technicians based on VAX hardware (Kincaid, 1986) and conducted at Number 10 Field Technical Training Unit (10FTTU).

Smaller projects have explored other facets of CAL. At Maritime Command (MARCOM) a Voice Interactive

Maintenance Aiding Device (VIMAD) was developed for use as a job-aid for technicians performing a hot section inspection on a Solar Saturn gas turbine engine. A self contained system incorporating videodisc, graphics, sound, and voice recognition, VIMAD was designed by Honeywell (using a variety of hardware controlled by a WICAT microcomputer) to be used aboard ships and comes complete with its own authoring system, CLASS (Courseware Lesson Authoring Sub-System). Following successful shipboard trials, this system is being expanded to include a program for instructional use.

At Halifax, trials were conducted on a microcomputer based sonar acoustics fundamentals course. A Computer Based Electronic Warfare Training System (CBEWTS) was developed for Canadian Forces Base (CFB) Summerside, and CFB St. Jean is trialling a microcomputer delivered course to teach French as a second language. Several schools have had individually sponsored projects: a PLATO trial at CFFS(Halifax) on-line from the Technical University of Nova Scotia CDC Cyber computer; the Course Scheduling and Resource Management System (CSRMS) developed on a mini-computer by the Combat Training School at CFB Gagetown to automate their scheduling functions; a pre-course mathematics program to diagnose problem areas and prescribe review exercises, all done on the computers at CFFS(H) Engineering Division; and many others.

Data from the major and minor projects were combined with information solicited from all commands to culminate in the present CAL implementation project. This major capital acquisition project will provide CAL materials to meet Canadian Forces training requirements in stages suggested by a priority list determined from the collected data.

The initial implementation under this project will be Computer Assisted Electronics Training (CAET). It will provide basic electronics training at two Canadian Forces Schools in both official languages.

Training for CAL Designers

With the exception of the Trenton project and its experimental Natal Author Programmer Course (NAPC), no formal training exists for prospective CAL designers. This lack of formalized training is due to the wide variety of systems in use, the rapid changes in the technology, and the variety of acquisition strategies.

There is no standard hardware system in use, nor is there a standard authoring system, authoring language, or programming language. The Trenton project used the NATAL authoring language on a Honeywell mini-computer and created a course (NAPC) to teach course authoring to subject matter experts using this combination of hardware and software. A version of NATAL for a microcomputer has also been developed by the National Research Council.

The Halifax project purchased software based on the CAN 8 authoring language for a Honeywell mini-computer from an independent contractor. No formal course exists in the military to teach either the CAN 8 language or courseware design, so training must be obtained from outside sources, or reliance placed on the original contractors for updates to the courseware.

The Cold Lake project uses contractor-designed courseware written in the CAMIL authoring language for a VAX computer. During the initial implementation stages of this project, military personnel were trained in the system by the contractor. No formal follow-up training courses were designed for personnel to perform system expansion or updates, required after normal posting cycles replaced the existing project personnel.

VIMAD courseware is written using the CLASS authoring system, CSRMS is written in BASIC, the math diagnosis and prescription program is written in CAN 8

EAASY. Clearly, the existing systems have no standardization.

The technology itself is still far from standardized. New authoring systems are coming on the market almost weekly, computer capabilities are increasing rapidly, and whole new computer system concepts are being developed. Until recently, proprietary operating systems caused computer systems to be mutually exclusive of all other systems: an Apple would not share programs with an IBM, and often neither would share with a mini or mainframe. This is beginning to change; AppleShare allows IBM type (MS DOS) software to be run on Apple hardware, and the C programming language is close to machine-independent, to name but two examples. A recent article in FORTUNE magazine discusses this trend, fortelling a radical change in the way systems work together and even greater increases in microcomputer power (Gannes, 1988).

Current Situation

The Canadian Forces is experiencing the same difficulty as all educational/training institutions: how to implement some form of standardization and training in an area of rapid change. This problem also surfaces in contractor produced courseware. There is no option but to design and produce materials for the current hardware, despite the fact that the materials will be obsolete even as they are completed. Contractors have little motivation to support older materials, compounding the educational institution's concern for cost-effectiveness. The Trenton project perhaps came closest to solving this problem by training subject matter experts to design and produce courseware for a specific system.

Conclusions

The Canadian Forces Individual Training System is a large and effective system that meets Regular Force training needs for instructor-presented material. However, with the introduction of new training methods and increased reliance on CAL, it is becoming out of phase with current technology in preparing trainers for their roles.

Expansion of the Training System to include the Reserve Forces, required by the 'Total Force Concept', will require that trainers be prepared for distance and/or distributed training functions. These functions will include some reliance on computer assisted or computer managed learning.

An examination of the need for CAL training for trainers within the CFITS is required. Should such a need be identified, a means for integrating CAL into the existing system must be devised.

CHAPTER 4

CAL TRAINING FOR TRAINERS: A NEEDS ANALYSIS

As technology changes the nature of military operations, so too must it change the nature of training of personnel to meet these operational commitments. The present training system meets regular force needs for instructor-presented material. The Total Force Concept outlined in the white paper on defence will place a greater emphasis on integration of the Reserve Force with the Regular Force, increasing training requirements for both and requiring some compatibility of training between Reserve and Regular forces (National Defence, 1987 p.p. 65-66).

As a volunteer, part time, geographically distributed force, the Reserves have limited time to devote to training and are not able to travel to centralized schools. With the increasing complexity of military equipment and roles however, more training will be required at an increased level of difficulty. CAL could provide a possible solution to this dilemma.

CAL could also provide a partial answer to the increasing training costs in Regular force training, but if CAL is to be introduced, prospective trainers must have a means whereby they can acquire the special skills required to design and conduct training to take advantage of this specialized medium. A first step in the education process for trainers would be familiarization with self-pacing concepts. Since one of the current trainer training courses, TDC 3, concerns itself with self-pacing concepts, an examination of this course could provide data relevant to training for CAL requirements.

The Study

The TDC 3 (Instructional Materials Design) course held at the Canadian Forces Training Development Centre (CFTDC) prepares personnel to design and produce paper-based self-paced instructional packages. It is the only course for trainers which provides information on instructional design for any self-paced materials. Recent modifications to the course have introduced aspects of multi-media design.

Aim

A decrease in demand for this course despite the perceived increase in interest in CAL prompted a needs analysis. This was therefore undertaken by the author with the support of CFTDC and CF Training System Headquarters to determine whether or not there was:

1. a continuing organizational need for personnel trained in the design of paper based self-paced packages;
2. an organizational need for personnel trained in the design of computer based self-paced packages; and/or
3. an organizational need for personnel trained in the design of both paper and computer based self-paced packages.

Scope of the Study

The study examined the course with regard to the organizational training climate, relevant external system factors, and resources.

Methodology

Data Collection.

The project began with a review of relevant literature and TDC 3 course documentation. Course documentation consulted included:

1. Occupation Speciality Specification;
2. Course Training Standard;
3. Course Training Plan;
4. course materials; and
5. course loading and project completion statistics.

Following the documentation review, questionnaires were developed to gain information from the following groups:

1. Command Headquarters;
2. TDC 3 graduates;
3. CF Schools; and
4. CAL Units.

These questionnaires were then reviewed, revised and distributed. Sample questionnaires are included in Appendix A. As the CF does not currently maintain a central register of organizations involved in CAL, CAL Unit questionnaires were enclosed with CF School questionnaires accompanied by a request to have these completed if applicable. Return rates for questionnaires were 100% for Commands, 46% for Graduates, and 55% from Schools. CAL Unit return rates were not calculated due to the unknown target population numbers.

Limitations.

Final questionnaires were distributed by CFTDC without being piloted due to time constraints. This could pose a threat to the validity of the study as it is unknown if some of the questions were misinterpreted by the respondents.

Data Analysis.

Data analysis was based on the total needs categories as identified by Matheson and Garry (1987). They are:

1. expressed needs - those which have been identified and explained;
2. felt needs - those which have been identified as deficiencies or as scope for improvement;
3. unformulated needs - those which have been identified only as vague disquiet about certain aspects of competence; and
4. unperceived needs - those which are identified by observation from a detached viewpoint.

Percentages were calculated from the returned questionnaires. Comments from the questionnaires were grouped by category according to areas of concern for each set of questionnaires.

Findings

Organizational Training Climate

Expressed Needs. The general consensus among Commands, graduates and CAL units was that the course should be modified. CF Schools mainly wanted the course kept as it is (37%), with 17% suggesting modification. Both Commands and CF Schools expressed a need for self-paced learning materials for both current and future courses. The majority of Commands forsaw an increase in CAL where CF Schools did not.

1. <u>Commands</u>. One Command identified a need for from one to five, and another Command identified a need for more than 50, of each of the following types of self-paced packages:
   a. pre-course;
   b. academic upgrading;
   c. study workbooks;
   d. tutorials;
   e. CAL programs;
   f. Programmed Instructional Packages (PIPs);
   g. job aids; and
   h. On-Job-Training (OJT) packages.
2. <u>TDC 3 Graduates</u>. Although 41% of graduates were currently employed in training, only 6% were writing self-paced packages. Forty-five percent of graduates had written at least one package since graduation. Despite the few that were actually writing packages, 48% anticipated using the knowledge in the future. The majority of graduates found the following parts of the course to be essential:
   a. analyze performance objectives;
   b. construct programmed modules;
   c. edit programmed modules; and

d. evaluate programmed modules.

"Select a topic for programming" was found to be useful rather than essential.

3. <u>CF Schools.</u> The majority of schools had no staff currently writing self-paced packages. Of those that did, less than 10% of the writers had completed the TDC 3 course but those that had were sufficiently trained. More than 37 school staff were identified as requiring training in self-paced package design. Schools reported a requirement for all types of self-paced training packages, with concentration on the following:

   a. pre-course packages;
   b. study workbooks;
   c. games/exercises;
   d. tutorials;
   e. CAL programs; and
   f. PIPs.

4. <u>CAL Units.</u> Most of the courseware writers or designers at CAL units had not completed the TDC 3 course. Of those that did complete the course, none were sufficiently trained to meet the needs of the units. The gap in training was made up in one or more of the following ways:

a. informal on-job training - 33%;

b. formal on-job training - 11%;

c. in-service courses - 22%; and

d. out-service courses 44%.

CAL Units felt that their writers/designers should be prepared to deal with the following types of current courseware:

a. drill and practice - 44% of CAL units;

b. tutorials - 67%;

c. simulations - 44%; and

d. instructional games - 33%.

Future courseware requirements were as follows:

a. CAL multimedia - 78%;

b. hypermedia/hypertext - 56%;

c. CAL on-line learning style diagnosis - 33%; and

d. tutorial expert system - 56%.

The following topics were identified as required by most CAL Units:

a. frame criteria;

b. screen design;

c. interactive video;

d. windowing systems; and

e. record keeping.

The majority of CAL Units found only authoring language(s) and operating system(s) to be required knowledge in the technical areas. Most units (56%) considered that a course for CAL writers should be an on-line course on-site with tutors available on-site. A significant minority (44%) thought that it should be taught formally at a centralized school. No enabling objectives from the present TDC 3 course were found to be applicable to CAL training by the majority of CAL Units. A significant minority (4 of 9 respondents) found the following to be required:

a. apply feasibility factors;
b. apply selection criteria;
c. write branching frames;
d. write constructed response frames; and
e. write adjunct programs.

Felt Needs.

1. Commands. In the general comments section of the questionnaire a need for personnel trained in CAL courseware design and a CAL systems approach to training was identified. This expertise would be utilized in the evaluation of self-paced materials purchased or contracted as well as those developed in-house. In Commands where a majority of the courses are

group paced, little need was seen for self-pacing. Although some self-paced materials (mainly paper-based) would be designed in-house (academic upgrading, pre-course packages, workbooks, and tutorials), many more would be obtained either off-the-shelf or contracted. The need to incorporate a section on self-pacing in the CFP 9000 series (Canadian Forces Manual of Individual Training) was also mentioned.

In the section of the questionnaire soliciting comments on how the course should be modified, one Command suggested a focus on self image and confidence building using psychological building blocks. The author has no idea what this means: the comment could have been a result of misinterpretation of a questionnaire question. Another suggested altering the course to develop skills common to a wide variety of self-paced packages rather than the current focus on PIPs. A need to cater to different target populations was also identified, with the corresponding needs for determining target population characteristics and reading levels.

Comments on additional training required were that personnel with basic skills in CAL design would be required for development and staffing of trial programs.

2. <u>Graduates</u>. In the general comments section of the graduate questionnaires, most comments concerned the general value of the course to the students and were very positive. Several respondents remarked on an increased need for CAL and/or multimedia design. Several also described problems with completing the final course project.

Comments on the usefulness of the course in the future were that the self-pacing concepts were used in almost all areas associated with training: program design and evaluation, preparing job-aids for employees, advising or supervising the design of training, and in on-job training.

In the section soliciting comments on what should be changed in the course a greater emphasis on CAL was frequently mentioned, as was the requirement to look at other types of self-pacing. Another common request was to have the project completed before leaving the course.

When asked for comments on topics required to design for CAL, common responses were concerned with orienting the course more towards CAL instead of paper based packages. Programming, screen design, program flowcharting, animation, graphics and simulation were also frequently mentioned.

Suggestions on how the course should be modified included many comments on the expansion of the course to include all types of self-pacing, especially CAL. Several comments were also made on the time and place to complete the final project: some wanted it done at CFTDC, others wanted it deleted, still others wanted a specific time set aside at their home units to complete the project.

3. CF Schools. Many Schools commented on the extensive time requirements for the design and production of self-paced learning materials. The potential use of these materials for study packages and pre-course packages was highlighted. Several respondents mentioned an increasing need for CAL, and also identified a need for some standardization of CAL materials.

Most of the comments on how the course should be modified suggested an increased focus on CAL with some emphasis on student study manuals. A decrease in the length of the course was also suggested.

Comments on additional training requirements were concerned with CAL, either designing for CAL or evaluating CAL materials. Some mention was made of a requirement for CAL hardware familiarization.

4. CAL Units. In the general comments section of the CAL Unit questionnaire, one unit observed that there was a need to instruct teachers how to prepare CAL courseware for students.

When asked for comments on courses used to train personnel, university courses were the most common courses listed. Other training was obtained from seminars, conferences, and CFTDC courses.

Comments on types of future courseware that personnel should be prepared to design included the need for personnel trained in analysis, design and evaluation rather than production of courseware.

Comments on topics to be included in the preparation of courseware designers included identification of a need for the skills to develop documentation (technical support materials, user manuals, handouts, help screens and off-line materials).

The section of the questionnaire concerned with authoring languages/systems currently in use revealed that there is no standard language or system. Current languages in use included the following: NATAL; BASIC; CAN 6; PILOT; CAN 8; EAASY; OASYS; COURSE OF ACTION; PCD 3; CBT 3; and Ada.

Most comments on how the course should be modified concerned an increased focus on CAL. It was also observed that a course was required to give instructors the skills required to teach in the CAL medium.

<u>Unformulated Needs.</u> The CFITS requires "personnel competent in CFITS concepts, management and procedures", and who are also responsive to pressures for change (CFAO 9-47, paras 11 b and 13).

Increasing complexity of technical equipment and training technology with accompanying high costs have resulted in a search for more cost effective methods of training (Kincaid and Saunders, 1986, p.164). Current and previous CAL projects have been directed at determining how computer technology will fit into the system. Three potential options for courseware development have been identified as having application, depending on the site (ibid, p.166):

1. off-the-shelf;

2. contractor developed; and
3. in-house developed.

The Defence White Paper (1987) emphasizes that advances in technology are key considerations in training of military personnel (p.77). It also plans for an increase in training and equipment for the reserves (p.65). Expansion of training options and instructor roles is inevitable if these plans are carried to their logical conclusion.

A potential problem with self-paced instruction was identified by Captain Holland in his Training Development Quarterly article "All Ahead Slow - There May be Hidden Obstacles" (Summer 1987): possible detrimental effects on group cohesion and organizational identity, especially during recruit and basic occupation training. This indicates a need for careful evaluation of CAL implementation strategies.

<u>Unperceived Needs</u>. Advances in both military and training technology are so rapid that many personnel are unaware of recent developments and the potential for training applications that they offer. Hypermedia, expert systems and networks are but a few examples. New CAL authoring systems which are more user friendly and flexible with regard to instructional design options are

proliferating rapidly and may dramatically change standard training paradigms.

Educational and training methods are also undergoing modifications as more research is carried out on how people learn. Imagery, memory organization, learning styles, and left and right brain functioning have had an impact on CF training design. These and other discoveries may result in application of training strategies with or without computers that bear little resemblance to those in existing courses.

Relevant External System Factors

Military acquisition of training hardware and software for both CAL and training aids is dependent to a large degree on the fiscal priorities of the federal government. A change in the envelope of expenditures allotted to DND which either increases or decreases funding for training will directly affect the implementation of all training, particularly that which requires introduction of new technology.

Training considerations in capital acquisition projects, although sometimes influenced by a Training Development Officer, are driven by the needs of the equipment being acquired and the contractor(s) supplying the equipment and/or training.

Many civilian training firms offer courses in computer programming and CAL design to meet a need in the private sector for personnel to design and produce courses. These courses tend to be expensive and tailored to one specific system.

Resources

Human Resources. The most common reason given for the lack of personnel designing self-paced packages at CF Schools was that no resources were allotted to that task. School Standards section (responsible for course quality control) and course design personnel were fully committed to formal course design and revision.

Posting cycles within CF Schools require that new personnel be trained in self-paced package design as those who are trained are posted out. Schools have difficulty freeing people for the course due to its length (4 weeks), and seldom employ them as self-paced package designers once they are trained due to higher priority commitments.

Personnel trained in evaluation and design of CAL courseware are rare, even in CAL units. Rarer still are personnel with programming or authoring skills in CAL courseware. No specific training other than graduate level university courses is available as designated military training for CAL trainers.

Military personnel trained by CAL courseware contractors for maintenance of the courseware (programming and/or authoring language ability) are not replaced by equally trained personnel when they are posted from the unit. Over time, in-house ability to maintain existing courseware is lost.

CAL expertise at the advisory level is also rare. Training Development Officers are the major CF resource for expertise in training. They have advisory functions in all parts of the CFITS, including training innovations such as CAL. All TDOs require a working knowledge of computer applications to training to be credible advisors.

Physical Resources. Most computer hardware and software at the schools was acquired as a result of research activities or capital acquisition contracts. No standardized hardware type, operating system or dedicated educational/training software currently exists.

Maintenance of older hardware (more than five years) is difficult to obtain. Contractors are also reluctant to support outdated software such as earlier versions of authoring languages or systems (early versions of Ada/CAMIL, CAN 6, and CLASS for example). Courseware created using these systems becomes almost impossible to revise.

Conclusions

The current TDC 3 course with its emphasis on paper-based linear PIP writing no longer fully meets CF needs for interactive (self-paced) materials design.

Information learned from the course is found useful in almost all areas of training, but is rarely specifically applied to designing self-paced learning material due to lack of resources at the schools. Standards/course design personnel are fully tasked with formal course design and revision priorities.

Should resources be reallocated so that self-paced instructional design becomes a priority, personnel would require training in the design and evaluation of the following types of interactive material using a multimedia approach:

1. pre-course packages;
2. academic upgrading;
3. study workbooks;
4. games/exercises;
5. tutorials;
6. job aids;
7. OJT packages; and

8. PIPs.

To meet the need, the TDC 3 course should be restructured as a multimedia interactive instructional materials design course to prepare its graduates to perform the following tasks:

1. design interactive instructional materials;
2. select media for interactive instruction;
3. prepare interactive instructional materials;
4. evaluate interactive materials; and
5. test interactive materials.

Further, specialized instructional technique training for instructors using CAL is required. The only instructional technique training for most military instructors is the TDC 1 course which does not prepare instructors for the course manager/tutor role required in CAL training. A course for CAL instructional technique should be created, either alone, in conjunction with other advanced instructional methods (discussion groups, role-playing, etc.), or as part of a revised TDC 1 course.

Training for personnel to evaluate off-the-shelf or contractor-produced courseware is also required. A course for evaluation of CAL courseware should prepare personnel to perform the following tasks:

1. evaluate courseware content;

2. evaluate courseware instructional presentation;
3. evaluate courseware documentation; and
4. evaluate courseware technical design.

As computers assume a higher profile in CF Schools, training for personnel to design and produce in-house CAL courseware will be required. Design possibilities, authoring and programming vary considerably among the hardware and software systems. Therefore, out-service training could give an initial capability until some standardization of CAL systems is achieved within the CF, or until a generic design course could be designed. The CF standardization will be partially dependent on standardization attempts within the computer industry.

Training for personnel to maintain existing CAL courseware is and will continue to be an on-going requirement. Hardware systems, operating systems, and authoring/programming systems/languages vary considerably, and may require continued use of out-service training in the short term.

Specialist Personnel Qualification Requirements (SPQRs) would then be necessary to justify out-service seminars and workshops offering training in CAL design, authoring and programming for specific hardware, software and authoring systems as required to train personnel in courseware creation and maintenance for individual CAL units.

Following reviews of civilian courses and some standardization (at least within each Command) on educational hardware, operating, and authoring systems, an in-house course should be created for generic CAL design.

To enhance the effectiveness of Training Development Officers as advisors, basic skills in interactive courseware design and evaluation, most notably in the CAL areas, are required. To achieve this, an 'Introduction to Educational Computing' segment is required in the TDO Basic Qualifying Course.

Lessons Learned from the Study

In addition to pointing out modifications required for the TDC 3 course, data for the needs analysis gave an indication of how little expertise in computer assisted learning currently exists within the Canadian Forces. CAL maintains an 'experimental' status in most units, with small pockets of 'CAL experts', often self-trained, providing advice and initiating projects. Until the CAL Implementation Project began to develop its Statement of Work which detailed the requirements for a CF CAL system, much of the CAL expertise lay with contractors who had an essentially free hand in the design of courseware to meet CF requirements. Courseware thus produced by contractors may or may not be a cost effective solution to CF training problems; it may be only a marketable solution looking for a problem to which it may partially apply. One result of the CAL Implementation Project is a set of CF specific requirements which will alleviate this problem.

If CAL is to be a serious contender in future training design for efficient and effective training for both Regular and Reserve forces, expertise in CAL design, evaluation and delivery must exist within the military in all phases of the CFITS.

CHAPTER 5

COMPUTERIZING THE TRAINING SYSTEM: A PROPOSAL

The present Canadian Forces Individual Training System (CFITS) is oriented mainly towards formal course training for the Regular force. As the total force concept gains momentum, Reserve force training will become more closely allied with that of the Regular force.

The part time nature of the Reserve force demands more emphasis on individualized, self-paced training and on-job training. The Regular force is constantly seeking more efficient and effective methods of training personnel to operational capability for progressively more sophisticated equipment and roles. In both cases, CAL could provide some or most of the individualized training.

For any courses or parts of courses based on CAL to be effective, both basic knowledge and expertise in the CAL field must be available in all phases of the training system. This knowledge may range from a simple awareness of what computers can and cannot do for training, to advanced CAL design, evaluation and programming abilities.

A proposal has been developed by the author to provide a framework for the inclusion of CAL in the present CFITS. It has three components: changes to the system (CFITS) itself, changes to the trainer training courses, and the expansion of the role of the Canadian Forces Training Development Centre (CFTDC) to include research.

The System

As the Canadian Forces Individual Training System (CFITS) expands to include aspects of Reserve force training, a window of opportunity opens for CAL concepts to be introduced. In some cases, CAL will be introduced for the Regular force and will be moved into Reserve training. In others, it will be the opposite, Reserve to Regular. In this way, the technology can be introduced in the normal life-cycle of a course and evolve in response to the training needs.

For such an evolution to occur, CAL knowledge and expertise must be available in all phases of the existing training system.

Analysis Phase

Specifications. Occupation analyses conducted by the Directorate of Military Occupational Structures (DMOS) are already computerized to the extent of statistical analysis of data returned from questionnaires. For the design of the questionnaires, expertise based on a solid background of computer ability and experience is required to ensure that questions on what, if any, aspects of computer knowledge are required for a given occupation. Questions on computer use are not generally asked at present unless the need is obvious. For example, a questionnaire for an administration clerk speciality in automated data processing would have several questions on computer knowledge included, while a questionnaire for a medical assistant would not.

Recent redesign of Reserve force occupational structures has resulted in a closer alliance with Regular force occupations. Although Regular force occupations may encompass several Reserve force occupations and some occupations exist which are exclusive to either the Regular or Reserve forces, many jobs and tasks are identical between the two forces. This simplifies training design in that both may take advantage of a course or CAL program designed for one.

<u>Course/On-Job Training Standards</u>. A new category is required for the task analyses in addition to 'training not required', 'course training required' and 'on-job training required'. It is 'individualized training required': training that can be conducted using flexible learning systems. Many tasks are learned by the individual alone,

whether from an instructor, book, study package or CAL program. Some tasks however, definitely require a team approach: drill, assault teams, and shipboard damage control all require teamwork in addition to the theoretical knowledge of what should be done. The former, 'individualized' training, could be learned by the individual during time set aside at his/her own unit, and is ideal for the Reserve force. The latter, 'group' training, would require attendance at a formal course.

Course Training Standards writing boards are already aware of group training needs. Knowledge of what can and cannot be taught using the 'individualized' methods, probably relying heavily on computer based material, would be required for all members of the CTS writing board. The TDC 8 (Standards Writing) course is available for CTS board members and should be made a prerequisite for board selection. It should also include instruction in CAL capabilities.

Design Phase

CAL expertise is a critical requirement in the design phase. If courses are divided into 'individualized' and 'group' portions, current cost and labor intensive instructor presentations to a classroom full of students will be minimized. The Course Training Plan design team must design courses that take advantage of the media available. All members must be able to determine which parts of the course should use CAL for pre-course study, which parts of the in-house portion could use CAL for individualized or team training, and which should be presented by an instructor.

The course for CTP writers (TDC 9) would require expansion on CAL topics to ensure a comprehensive knowledge of CAL capabilities and flexible learning concepts. An additional course, one to prepare CAL designers, would provide resource personnel to serve on the CTP writing team and design CAL software or prepare Statements of Work (SOWs) for contractor-produced courseware.

On-job training design is currently under review. Preliminary data indicate that many objectives are not achieved due to lack of equipment or availability of resources at the trainee's unit (Thain, 1988). The assignment of training to 'individualized', 'group', and 'on-job' may result in increased capability of the training resources to encompass some of the aspects of on-job-training formerly left to the units.

Conduct Phase

Courses. The proposed system of 'individualized' and 'group' training would require a different focus for trainers. The flexible learning component, even if conducted at a trainee's home unit, would require instructors to serve as tutors. These instructors would have a group of students for whom they would be responsible, as telephone tutors, on-line helpers, and/or distance administrators.

The in-house portion of the course would still require lectures and demonstrations for which the instructors must be trained as they are now. Any CAL conducted in-house would require specialized course managers who could tutor students having difficulty with the material and help those who were having problems with the hardware or software.

With formal theoretical knowledge lectures largely replaced by CAL either in the school or in units, other teaching methods would become more prominent. Instructors must then be prepared to use role playing, exercises, and guided discussion for subjects suitable for those methods. The TDC 1 (Instructional Techniques) course could be complemented by an additional course, Advanced Instructional Techniques, to prepare instructors to become CAL tutors or course managers and to conduct training using alternative methods.

Scheduling. Scheduling courses where the trainees are at different points in different modules, at different locations, and in self-paced or group-paced activities, could be an administrative nightmare. Automated course loading at NDHQ and Commands would be required, as would automated course scheduling at the Schools.

NDHQ and Commands would course load personnel in much the same manner as is now done, but with the requirement for a longer lead-in time to allow for self-paced pre-course study. The course loading must be coordinated with posting schedules to ensure the prospective student will have the necessary time and resources to complete pre-course work.

Once the schools have been informed about the number and types of courses they will be running, schedules will be prepared for specific students and pre-course materials sent out. The course schedules have minimum and maximum loading numbers which, with the assistance of a computer, can be adjusted to accommodate students who finish their pre-course material earlier or later than anticipated. Course start and completion times would be flexible, using average pre-course material completion times as a tentative starting point but also include the facility to be advanced or delayed to ensure optimum attendance on course.

Resource scheduling for school and off-site materials must be flexible enough to ensure optimum use of materials, without extensive stockpiles of unused equipment, cancellation of courses due to lack of equipment, or students waiting for availability of pre-course study materials. Computerized course scheduling and resource management would be the most cost effective method of solving these complex problems. An outline for a course scheduling system using interactive expert systems and databases has been designed and will be developed and field tested by the Canadian Forces Staff School.

Security. Schools sending computer courseware to students' units must have a method of ensuring that the carefully designed program is not altered or pirated. Licensed software used as part of the study materials must likewise be protected from copyright violation. Mainframe computers often have programs which have individual sign-ons and password protection, but these are still rare in microcomputers. Anyone with knowledge of how computers work can access any file on a microcomputer system with a hard disk. While this can be minimized by using only floppy disks for courseware, most sophisticated programs have memory requirements far in excess of a single disk capacity.

Courses encompassing sensitive material must also be protected. Single performance objectives may not be sensitive, but when they are put together, the course package may acquire a security classification. If these courses are networked, or even used by a single individual at a unit, they must be protected from accidental or deliberate copying or transmission.

Microcomputer based courses must have a security system that can control access to directories, sub-directories and individual files (Gerbrandt, P., 1988). Users can have read-only, read and write, copy, and/or delete access to files or any combination of the above. A boot-protect system (the PC can only be booted from the hard disk) is essential, with access to peripherals such as printers, internal or external disk drives, and modems restricted or allowed for each user. Password protection, and even encryption of files or whole directories can be used. If desired, a guest user category can be implemented where a user is totally unaware of the existence of the security system and any files other than those selected for guest viewing (PC DACS, 1987).

Equipment problems are responsible for the most complaints about CAL systems. Limited access to files and forbidden access to control files may solve some 'finger problems' frequently made by students experimenting with the system and causing a crash. The security program should not allow a format of the hard disk, intentional or unintentional.

Equipment problems will still occur of course, and will require a disaster recovery plan for both schools and units using the CAL courseware. This plan must include a worst case scenario plan of action. Determination must be made of how long the system can be down, and a procedure devised to ensure repairs are expedited. Regular backups of courses in progress will be required, with these and courseware backups stored off-site (Gerbrandt, P., 1988).

Evaluation Phase

Much more course evaluation data would be available if the current 'handraulic' process was less labor and time intensive. For example, an analysis of a multiple choice examination for one class requires that two people spend approximately six hours analyzing the data. This whole process could be performed by one person using a computer program in less than 15 minutes, including data input. Instructor and student course critiques would have more information were they not hand written at the end of the course (from 4 weeks to 6 months after the start) when earlier information has been forgotten.

The author is currently involved in a project to design a computerized evaluation system using a PC and an optical mark reader with database, spreadsheet, examination analysis, and questionnaire analysis software. Examinations will be simultaneously graded and analyzed to provide individual student results as well as descriptive statistics, degree of difficulty, and reliability information on the test as a whole. This information will be stored with results from practical performance checks and student interviews to give the instructor a synopsis for the student's final grade and course report. Instructor and trainee critiques will be collected weekly, analyzed, actioned immediately if appropriate and stored for historical reference. Instructor monitoring reports will be collected on each instructor at least once during each course. Part of these reports will be used for course evaluation, and part will be used by the instructor supervisors for the instructor's personnel evaluation reports. Standards section personnel will then have comprehensive data available to make recommendations for course changes if required, or data to support maintenance of the status quo.

To effectively evaluate CAL courseware, a standardized courseware evaluation tool must be adopted and Standards Section personnel trained in its use. The tool must take into consideration courseware content, instructional presentation, documentation, and technical quality (Owston, 1987), in addition to whether or not specific military training objectives are met. A course in CAL software evaluation and/or addition of this information in the Training Evaluation (TDC 10) course would permit Standards Section personnel to objectively assess the quality of CAL components of the courses they are evaluating.

A course of this type would also be useful for personnel involved in the training aspects of Capital Acquisition Projects for the evaluation of contractor-produced CAL courseware. Personnel must be capable of separating the educational merits of a CAL program from the 'bells and whistles' possible with the computer medium which may be irrelevant to or even obstruct the educational message.

Validation Phase

The validation phase of the CFITS has historically not been carried out as frequently as the Commands would wish due to the prohibitive personnel and time requirements for a non-computerized validation analysis. Several computerized systems are currently undergoing trials at the Commands to determine their suitability as a standardized validation tool. One such system, EXVAL, a British Army/Canadian Forces joint project with which the author is involved, could be described as an initial screening system, and would serve to point out problem areas in courses. It would be most useful as an initial tool to validate courses with serious problems. Another system provides an in-depth analysis of the course, but requires much more time to complete, even with the use of an automated program for statistical manipulation.

When a validation system is adopted, training will be required in its use. This training could be easily added to the Validation Course (TDC 11).

Synopsis

The major changes required to integrate CAL aspects into the training system are in the training of the trainers and in allowing the implementation of flexible learning systems. The latter implementation could be done slowly, with short courses and/or portions of longer in-house Regular force courses redesigned to take advantage of CAL and some Reserve training courses designed as flexible learning systems using CAL. However, CAL aspects of trainer training must be implemented before major CAL courseware implementation can begin.

Trainer Training

The Canadian Forces Training Development Center conducts or controls the majority of trainer training for the Regular force. In the proposal, this training role would expand to include Reserve force trainer training and be more focused on the control of trainer training than on the conduct of many courses. Each course would require alterations in content and/or delivery to include CAL information.

TDC 1 - Instructional Techniques Course

The TDC 1 course is usually the first point of contact that subject matter experts have with the training system. It is the flagship of the Training Development branch and should be a shining example of state-of-the-art training. It is not. It no longer reflects current training excellence. The principles and procedures behind the course remain sound, but updating is required.

Further, despite course loads of 48 students per course and 28 courses per year at CFTDC, and the conduct of several on-site courses at various Commands, instructors at many schools are scheduled for the TDC 1 course months or even years after they have commenced instructional duties. Some never receive instruction due to higher priority commitments on their time, or no vacancies on courses for which they are available (Skinner, 1988). An obvious solution is to conduct more courses, but this would place more strain on an already overloaded instructional staff.

As this course is partially self-paced using a series of paper-based PIPs (Programmed Instructional Packages), attempts were made to allow export of the course to the Commands and Schools that required them. Designated personnel from the concerned Commands and Schools were certified by CFTDC to conduct the course. Unfortunately, these personnel were seldom instructors themselves (generally they were instructor supervisors) and this fact combined with the self-paced nature of the course gave the students few role models and therefore less than optimum results. The time required to ensure that all students had at least two practice lessons to teach and a class of fellow trainees to instruct placed severe limitations on the self-paced nature of the course. Control of the course was further eroded by some institutions creating and teaching their own versions of the course to meet their needs, often with less theory and practice and occasionally giving incorrect information (ibid).

This course lends itself to redesign as an interactive 'guided discovery' CAL learning system using hypermedia, an expert tutor and interactive video. This system would be exportable to both Regular and Reserve force units. It would allow the aspiring instructor to plan lessons using his/her own subject matter and conduct the lessons for his/her own students under the guidance of his/her own supervisor. The interactive video component would provide several good to excellent instructors on whom the student could model his/her classroom behaviour. It would have the added benefit of introducing instructors to computer assisted learning concepts.

TDC 2 - Instructor Supervision

This course currently prepares supervisors to manage, guide, and evaluate the performance of instructors in classroom instruction settings. The proposed redesign of the TDC 1 course would require minor changes in this course and in the role of the instructor supervisor. The proposed expansion of instructor roles to include CAL tutoring/management and alternate instructional methods would also require additions to the course.

TDC 3 - Instructional Materials Design

As observed in the needs analysis from the previous chapter, this course should be restructured as a multimedia interactive instructional materials design course.

TDC 4 - (New Course) Advanced Instructional Technique

This course would take the place of the defunct TDC 4 standards writing course which was replaced by the TDC 8, 9, and 10 courses. It would prepare instructors to act as tutors and/or managers for CAL materials as well as providing the required skills to use guided discussion, role playing, simulations, exercises and other alternative training methodologies.

TDC 5 - Training Manager

The segment of this course concerned with CAL should be expanded to include an overview of CAL training potential and courseware evaluation. Portions of the course should also include capabilities and management information on computer managed training and computerized management tools such as scheduling and resource management systems.

<u>TDC 6 - Audio-Visual Aids Production</u>

In addition to current training aids, information should be added on computerized training aids such as computer driven video show systems. Information on screen design would allow the graduate of this course to serve as a team member on a CAL courseware design team.

<u>TDC 7 - Video Production</u>

Additions to this course should include information on designing interactive video for CAL courseware.

<u>TDC 8 - Course Training Standards Writing</u>

Instruction in flexible learning systems would be required for this course if the proposal for 'individualized' and 'group' training is adopted. Graduates of the course must be familiar with types of flexible learning systems and what can and cannot be taught using these systems.

<u>TDC 9 - Course Training Plan Writing</u>

Graduates of this course design training courses. If CAL is to be considered for all or part of a course, the portion of the CTP Writing course devoted to CAL must be expanded from a small amount of information on CAL as a possible training method or aid, to an entire section on CAL capabilities and design considerations. If the 'individualized' and 'group' training proposal is accepted, the course must also include more information on designing alternative methodologies such as role playing.

TDC 10 - Training Evaluation

If the evaluation system project is successful, training in its use will be required on this course. A CAL courseware evaluation methodology must also be taught.

TDC 11 - Training Validation

Training in the use of whichever computerized validation system is adopted for the Canadian Forces will have to be added to the present course.

Training Development Officer Basic Qualification Course

Training Development Officers are the CFITS training resource persons. They will be consulted on matters pertaining to CAL and must therefore be prepared with at least basic familiarization in computer applications to training. They must know CAL capabilities and major design requirements. Many consultation requests will concern evaluation of CAL courseware, from School Commandants if the

TDO is employed in a school, and from Project Managers if s/he is employed on a Capital Acquisition Project. CAL must assume more importance on the course than as one of several training methodologies. It is suggested that a performance objective concerned with introductory material on computers in education be incorporated into the course.

As training advisors in the information age, TDOs must also be conversant with computer applications in computer managed instruction and computer management tools. They will require a functional level of computer literacy which should be provided, or confirmed, on their basic course.

TDO CAL Specialist

This speciality already exists and is obtained by attendance at a university for a Masters degree. It is the opinion of this author that programming skills at a functional level are required for this speciality at this time, and will continue to be required until educational computing has developed to the point where user interfaces are totally reliable and flexible enough to allow a variety of instructional design options using an authoring system. This will not occur until the rate of change in computer technology slows or stabilizes. The TDO CAL specialist must keep current with developing systems, and this means s/he will require an understanding of how computer systems work. At the present, one of the best methods of obtaining this understanding is by programming.

New Courses

In addition to the new course proposed to replace the old TDC 4 course two other new courses are required to train CAL trainers:

1. Evaluation of CAL courseware - although parts of this topic are covered in the Evaluation course, a separate speciality course is required to serve the needs of personnel who will be evaluating courseware but not courses in general for example, School Chief Instructors, Unit Training Officers, and Capital Acquisition Project team members.
2. CAL design and authoring - this area is presently very diversified. Each authoring language and/or system varies in its appropriateness for specific types of courseware design. A short term measure for older existing systems would be to take advantage of civilian training courses in design and authoring for those systems, combined with the generic principles to be offered by the redesigned TDC 3 course. If and when a standard authoring language or system is established

for the Canadian Forces a course or courses must be developed to teach CAL design and authoring using that system.

Synopsis

With the exception of the TDC 3 course and the requirement for three new courses, updating the existing training courses for trainers to reflect an increased emphasis on CAL requires fairly minor additions. As these courses are modified over the years, consideration can be given to including more CAL portions.

Research and Development Center

The educational computer field is still in its infancy. Altering training courses to prepare trainers to cope with increased computer use in courses addresses only current and forseeable future needs. In educational computing the forseeable future is not a very long time. If plans are not made to keep up with current developments, the Canadian Forces will find itself out of the mainstream of training technology, rather than in its traditional place at the front.

The Canadian Forces Training Development Center has two roles: to train trainers and to provide training development expertise and assistance to the Canadian Forces as a whole through the Training Development Services Plan (TDSP). CFTDC is therefore divided into two functional sections, the Training Company, responsible for trainer training courses, and the Development Company, responsible for completing projects as assigned by National Defence Headquarters (NDHQ) in conjunction with Training Systems Headquarters (TSHQ).

The members of the Development Company, all TDOs, most of whom hold Masters Degrees in the educational field, respond to research or assistance requests concerning training matters. While this is a required function and offers training expertise on a short term basis to the entire Canadian Forces, much more could be done.

With the expertise in training research available in the company, and the need to continually monitor the training technology field for innovations applicable to the military, research projects should be initiated by this unit rather than merely responded to. Although this is true for all aspects of training; administration, testing, and curriculum design, to name but three, the need is perhaps the greatest in the CAL field as it develops the most rapidly.

An increase in resources, both human and physical, will be required if the Development Company is to include a credible research and design cell. One or two CAL specialist TDOs are not sufficient to conduct a comprehensive program to test and trial all the CAL innovations that could be applicable to military training. The TDO could however, act as consultant to and/or manage a team devoted to this function.

The core team, as envisioned, would consist of one or more of each of the following:

1. CAL specialist TDO;
2. Instructional Designer with computer specialization;
3. Systems analyst;
4. Computer technician;
5. Computer programmer; and
6. Graphic artist with computer specialization.

Additional team members could be added as required for specific projects on a short term basis. The team would have a continuing mandate to test and trial computer innovations to determine their suitability for Canadian Forces training. In addition, team members would act as consultants to units engaged in in-house CAL courseware design and be available as resource persons for units using CAL courseware.

If this is to be accomplished, funds would be required to rent, lease, or acquire new hardware and software for testing. Attendance at conferences and seminars would also be mandatory for all team members to ensure currency in their respective fields.

With such a team in place, it remains only to ensure that the information gathered is disseminated to Canadian Forces training establishments. A networked bulletin board system serving all CF Schools, Reserve Units and/or TDOs would be an ideal medium for publication of new findings in the CAL field.

Conclusions

Incorporation of CAL training information in all phases of the Canadian Forces Individual Training System will help to prepare it for increased reliance on CAL training. The resulting expansion of trainer training courses will ensure that trainers are prepared to use the technology. Creation of a CAL Research and Development cell in the Development Company of the Canadian Forces Training Development Centre will monitor technological change and ensure currency. These changes will enhance the effectiveness of the existing system without compromising any of its current effectiveness or efficiency.

CHAPTER 6

AN EXAMPLE: A CAL SYSTEM FOR TRAINERS

The Instructional Technique (TDC 1) Course was chosen by the author to begin the computerization of trainer training courses for several reasons. First, as the center of training expertise for the Canadian Forces, instructor training courses provided at the Canadian Forces Training Development Center should serve as models for state-of-the-art training. The TDC 1 Course is the initial contact with the Canadian Forces Training System for large numbers of subject matter expert instructors every year. The technology would have the best chance of reaching the most instructors quickly if CAL principles were taught at this level.

Second, the rapid changes in hardware, software, and therefore instructional design for computerized self-paced training almost preclude an immediate implementation of the redesigned Instructional Materials Design (TDC 3) Course. As indicated by the needs analysis, the requirement for this course is urgent, but cannot be met until more stabilization of the technology has been achieved. The TDC 1 course could incorporate some of the TDC 3 general principles during the stabilization period.

Thirdly, training the large numbers of instructors, Regular and Reserve, requiring the TDC 1 course would be greatly facilitated if the course was transportable to other Schools or Reserve units. This would be an excellent application for CAL, and serve to set the stage for similar implementations of the other trainer training courses.

If the course is to be used by other schools, it must stand alone; that is, it must require a minimum of instructor input except in a tutorial role. Instructional technique cannot be learned from books alone. It must be practiced, preferably with role models for the aspiring trainers to follow. As the target audience for the instructional technique course covers all military occupations and ranges in rank from Corporal to Major, a CAL program that would be effective for all would be challenging to create, but not impossible. Using newer CAL capabilities such as hypermedia, expert systems, extensive graphics, and interactive video, a program could be created to address these requirements.

A Trial Program

With a general concept outline in mind, a search was begun for tools with which to create the program. Tools that could combine hypermedia, an expert system, graphics and interactive video in a single program with any degree of ease proved difficult to find. An initial review of a user friendly hypermedia system, Macintosh HyperCard, indicated that it might be able to fulfill the role. A program was therefore created to test this possibility.

Auto mechanics was selected for the trial program for two reasons: to make the creation of an expert system as simple as possible, and to have a small identified training problem for the test. Transmission bearing problem diagnosis was chosen in consultation with an expert in automotives instruction, Mr. John Gerbrandt. This problem, like other mechanical problems, tends to follow very predictable rules: if A and B and C are present then D will always occur. An expert tutor could then be created using 'if...then', 'ask', and 'answer' statements in HyperCard's authoring language HyperTalk.

HyperCard has a strong graphics base and can incorporate laser videodisc information using a separate video driver program. Several videodiscs were reviewed for sections applicable to the program but none were found to have suitable information. As the technology existed to incorporate the video segments at a later date if a suitable videodisc was found or created, the program was completed using only graphics.

Acme Auto. The trial program, Acme Auto, was designed as a tutorial aid for students studying Auto Mechanics at the Southern Alberta Institute of Technology (SAIT). It is a combination of information retrieval, drill and practice, simulation, and expert tutor for transmission bearing problems. A guided discovery learning environment was created wherein the student is given a problem to solve (diagnosis of a transmission fault), access to the tools required to solve the problem (the practice room), and assistance if required (the expert tutor). A drill exercise was included for one concept that was identified as difficult to master (gear ratio calculation). A full program description is included in Appendix B.

Lessons Learned

HyperCard is a powerful and creative courseware authoring tool. Previous attempts to combine graphics and an expert system with a CAL program, once in BASICA and once in TurboPROLOG, met with very limited success. The BASICA program produced a reasonable transmission graphic with difficulty, but attempts to animate the graphic met with failure due to the amount and type of action required: each of the gears in the graphic must rotate at a different speed and in different directions. The program could not be combined with the expert system created in TurboPROLOG without extensive DOS routines.

The TurboPROLOG program by itself gave a limited user interface and no graphics. It would be difficult to produce an instructional program using only this language.

Following the HyperCard experience, it was recognized that such a program could have been created using almost any programming language, but with much more difficulty. The multiple branching possible in hypermedia would also require enormous amounts of memory if attempted in a general purpose language.

Even if a program such as Acme Auto could have been developed in another language, it is doubtful that it would have been. It was HyperCard that inspired the guided discovery learning environment used in Acme Auto, because it was easy to accomplish. Each computer language has strengths and weaknesses that tend to channel the courseware designer into various paths. It is only by working with the languages that the full possibilities within these paths become apparent. Creativity in courseware design may then be partially a function of the language used.

New or expanded languages and/or systems must be examined and used at a more than superficial level to exploit their creative potential. This must be done by people with experience and abilities in both computer operation and instructional design.

The Acme Auto program served to test some of the concepts that would be required in a Classroom Instruction Course. Using it as a model, the present course could be redesigned partially as a CAL package, the 'individualized' portion, and partially as an on-site course, the 'group' portion.

Instructional Techniques Course - TDC 1

The redesigned TDC 1 course would follow essentially the same format as the present course. Although very structured, it provides a working model for classroom instruction that will allow a subject matter expert instructor to present an effective lesson. There are two performance objectives to be achieved on the course: prepare a lesson and present a lesson.

The Course

The student would assigned to a course with an allotted time to complete the course, ideally during his/her orientation period when first posted to instructional duties. The first part of the course, prepare a lesson, would be designed as a self-paced interactive CAL course conducted at the student's own school and under the direction of an accredited instructor supervisor. This supervisor would be a graduate of the TDC 2 (Instructor Supervision) course who had been certified by the Canadian Forces Training Development Centre (CFTDC) to conduct on-site TDC 1 courses. The supervisor would have continuous contact with the TDC 1 Senior Instructor at CFTDC either on-line or by telephone.

The second part of the course, present a lesson, would also be completed at the unit under the direction of the same instructor supervisor. The practice skill and theory lessons would be taught to personnel awaiting training (PATs) at the school. The lesson prepared and presented for the student's performance check (final exam) would be taught to the instructor's own students using a lesson made from actual course information that the student would be teaching following graduation. Both practice and performance check lesson plans and lessons would be evaluated by the instructor supervisor. Following the performance check, a copy of the lesson plan, a videotape of the lesson and supervisor comments would be sent to the TDC 1 Senior Instructor at CFTDC for standards control.

The CAL Program

The guided discovery learning environment presents the learner with a problem to be solved, the tools required to solve the problem, and tutorial assistance if required. The student is free to 'discover' the material in his/her own way, but is kept on task by the expert tutor part of the program and by the fact that there is a definite problem to be solved.

The program will use a combination of hypermedia, an expert system and/or expert tutor, interactive video in the affective domain and detailed graphics. It will be designed to take advantage of techniques to encourage retention of concepts in long term memory: for example specificity, organization, dual encoding (text and graphics), focusing of attention to underlying principles, and establishing context. Each concept in the exercises will be designed to address all learning styles: 'what if', 'why', 'how', and 'what'.

The initial screen of the program will show an exterior view of a Canadian Forces School. The name of the student's own school could be displayed. A click on the door enters the building and puts the student into the School Orderly Room. In this area the student's 'tombstone' data will be collected (social insurance number, rank, name, occupation, and the date the course is commenced) for student records and to ensure that the program can store student work for a later session. The Orderly Room clerk will act as access to the Help stack and several icons will be displayed for the student to select his/her route through the program: the instructor's office (with his/her own name on the door), the library, and the Chief Instructor's Office.

<u>Instructor's Office (The Problem)</u>. Entering the office begins the simulation. There are two problems to be solved in the simulation: prepare a lesson plan for a knowledge lesson and prepare a lesson plan for a skill lesson. The preparation of a knowledge lesson plan will be the first problem. A random selection from five possible Enabling Objectives (EOs) will be made and the student, in his/her role as instructor, will be directed to prepare a lesson plan for the selected objective.

The EO will have two possible lesson objectives which the student must create. It will be supported by a Course Training Plan (CTP), Course Training Standard (CTS), and Occupation Training Specifications.

Material from the general occupation specifications that does not normally require training will be used to design a fictional course (including a CTS and CTP) for

Personnel Awaiting Training (PATs) to provide the enabling objectives for the program. PATs are usually recent graduates from recruit training who are employed by a School until their occupation training course begins. Short courses in material not covered by their basic training are often given to these people during their time at the school to assist in their socialization to the military and prevent erosion of 'student skills' during the wait for a course.

Following successful completion of the knowledge lesson objective by delivery of the lesson to a class, the student, in his/her role as instructor, will be presented with the second problem, preparation of the skill lesson. Selection of the EO for this lesson will be randomly made from five possibilities having the same source as the knowledge EOs.

A word processor with spelling checker, grammar checker, and lesson plan template will be available to the student in this area. A graphics editor for the creation of overhead projector slides, chalkboard plans, diagrams and other training aids will also be provided. S/he may enter a classroom (graphic) at any time to prepare it for the lesson, enter the library for information and/or consult with the Chief Instructor.

<u>Library (The Tools)</u>. This area allows the student to select from a variety of information retrieval activities and exercises. These tools include:

1. Course Training Plan (CTP), Course Training Standard (CTS), and occupation specifications for the Enabling Objectives.
2. A lesson planning process description.
3. An exercise on principles of instruction where the trainee selects a principle from a list and is given a written and/or video description randomly selected from several samples on the same principle. This will be followed by a drill in which the student must select which of several videos illustrates a specific principle. Answers will be reviewed by the Chief Instructor (expert tutor) with reinforcement messages given for correct answers and tutorial assistance for incorrect answers.
4. A description of the CFITS, its process and documents, including information on where lesson objectives fit in the system. Several examples from recruit training will be provided along with the PAT training course material so that a student may create a course from specification to CTP by selecting from a series of possibilities or

take apart a course to see how it was derived. The expert tutor will review the student designed course for a match with the actual course and give reinforcement or remedial instruction messages accordingly.

5. Information and an exercise on objective writing. This will include examples of the three part objective format, and emphasis on the use of action verbs. It is planned to illustrate action verbs by the use of animation (Daddy/Mommy watch me while I ...). The drill on objective writing will require the student to create an objective from randomly selected task statements. The objectives will be reviewed for a match to several possibilities by the expert tutor and the appropriate reinforcement given.
6. Types of lessons will be defined using text and illustrated by short video demonstrations. Most of the emphasis will be on knowledge and skill lessons but introductory material on advanced types such as guided discussion, role playing, case studies, CAL, and field trips will also be included.
7. An exercise on teaching points will include

text descriptions and short video demonstrations. The drill on extraction of teaching points from EOs will randomly select an EO and compare the student created teaching points with several possibilities. Appropriate expert tutor confirmation and/or tutoring will then be provided.

8. The verbal aids section will provide video demonstrations and text descriptions before the exercise begins. The student will have an opportunity to select from a number of possible verbal aids for a video instructor to use during a lesson, and view the effect of these aids on the video class. Reinforcement for correct choices will be obvious from the video class reaction. The video instructor, controlled by the expert tutor, will provide reasons why the incorrect choices did not work.

9. Visual aids will be illustrated by several examples in each category. Clicking on a particular aid will display the appropriate techniques for creating the aids on video. Although the emphasis will be on design and content of the visual aids instead of their preparation, there will be two exercises: the

first to plan and produce overhead projector slides using a graphics program, printer and photocopier; and the other a chalk board/flip chart design. Both exercises will be marked by the human instructor supervisor.

10. To assist with question techniques, video demonstrations and text descriptions of question techniques will be displayed, followed by a drill on questions. The student selects question components (question, time delay, which student, etc.) and sees the logical results from the instructor on the video display. The correct sequence should be obvious from the reaction of the videotaped class. The video instructor, controlled by the expert tutor will explain the problems arising from poor choices.

11. Text descriptions and video demonstrations of confirmation techniques will be presented, followed by a exercise on developing an end of lesson confirmation for a randomly selected objective. The expert tutor reviews the student answer for correlation with the performance statement, conditions and standard and gives appropriate feedback. An emphasis in this section will be on

the difference between the end-of-lesson confirmation and the test of the performance objective.

12. Graphic, text and video descriptions of possible classroom set ups will be combined with a practice wherein the trainee places objects appropriately on a graphic representing a classroom and the expert system chooses from graphic templates and/or video sequences to show the logical results of this setup: lines of vision, and instructor/student movement.

Chief Instructor (The Tutor). The expert tutor guides the student through the lesson planning process, and reviews drills and practices, pinpointing common problems and offering advice for improvement. The student may go to the Chief Instructor's office at any time to receive assistance in the process. After asking questions on progress made, the tutor will direct the student to the next step in the process or to areas requiring review. When the student's lesson plan is complete, the expert tutor will review it for "mechanical" problems - spelling (using a spellchecker), grammar (using a grammar checker), format and timing (comparing the lesson with templates). The student is then directed to see his/her instructor supervisor to make arrangements to conduct the lesson.

Resource Requirements

Additional physical resources will be required to conduct the course in this fashion. Two or more Macintosh computers with a minimum 1 megabyte of RAM and either two floppy or one floppy and one hard disk drives will be required for each school conducting the course. Additional necessary hardware for each machine includes: laser videodisc player, video monitor, and printer. In addition to the TDC 1 program, the following software will be required for each computer: HyperCard, video driver, word processor, and graphics editor. Dedicated classroom space will be required at each school for the conduct of the practice lessons.

A critical component of the program is the design and production of the videodisc. Several examples of good to excellent instructional technique will be required. Video segments featuring an instructor in a classroom with appropriate responses from a class of students are necessary to illustrate concepts, provide role models, and provide information for exercises. Design, scripting, casting, filming and production of this disk must be planned and executed by experts, either a Canadian Forces Instructional

Television Unit or a civilian contractor in consultation with a Canadian Forces Instructional Television specialist.

Conclusions

Development of the TDC 1 course using interactive CAL would serve three purposes: it would solve current problems with the course; serve as a vehicle for testing current CAL technology in a Canadian Forces application, and introduce subject matter instructors to Computer Assisted Learning. The experience with the Acme Auto program indicated great potential for a graphics based hypermedia system combined with an expert system or tutor to be used in CAL courseware design. The addition of interactive video to this system addresses the critical requirement of an instructor training program to have role models on whom students can pattern their classroom behaviour.

CHAPTER 7

COST BENEFIT ANALYSIS

The present Instructional Techniques Course (TDC 1) produces effective classroom instructors. As with any course that has been running for several years, it would benefit from some updating, but it is primarily deficient only in the numbers of students trained. Restricting export of the course and including more classroom lectures by course directors has alleviated some of the existing problems with degradation of standards and lack of role models, but has resulted in further limitation of the number of personnel.

Economic realities dictate that an expensive redesign of a course which is presently functional, would not even be contemplated without an option analysis that shows redesign as the most effective option to train increased numbers. A comparison of existing and proposed costs showing cost or personnel savings from a course redesign would also be required in these times of fiscal restraint.

Option Analysis

Regular Force Schools have difficulty meeting their instructor training needs with the current system (Skinner, 1988). An increased number of Reserve force instructors will also require training to meet total force commitments. Increasing the number of classroom instructor course graduates could be accomplished in several ways.

<u>Option A - Increase numbers of serials of TDC 1 Course at CFTDC, Borden</u>

An increase in the number of graduates to 1500 from the current 1344 would serve the training needs of most Regular Force training schools. Course standards would continue to be strictly controlled and maintained by CFTDC. Some role models would be provided by lectures given by the course directors.

Students would still need to travel to take the course, and problems with conflicting commitments preventing course loading would still apply. Reserve Force students would have to compete with Regular Force students for course positions during the summer months. An increase in instructional personnel (bilingual) would be required as well as expansion of facilities. Training in shifts (0800-1600, 1600-2400 hours) would ease the demand on the facilities, but would require even more instructors.

This option would solve some short term problems and would result in higher numbers of graduates. It does not address longer term problems, such as the requirement for student travel and increased Reserve Force students. The course would eventually require redesign to encompass changes brought about by increased use of CAL.

<u>Option B - Export TDC 1 Course to Command Training Schools</u>

Student travel would be minimized with this option if the course was held in all schools. Students would receive the course on, or shortly after, posting to the school, eliminating the wait for a CFTDC course. As for the CFTDC course, role models would be available from lectures given by course directors.

Many of the Command training schools are small and geographically dispersed. Maritime Command has schools on both east and west coasts. Mobile Command has schools from Gagetown, New Brunswick to Wainwright, Alberta and points between. Air Command schools cover the country from Shearwater, Nova Scotia to Comox, British Columbia. Training System schools may likewise be found all over Canada from Cornwallis, Nova Scotia to Chilliwack, British Columbia. Navy, Army and Air Force Reserve units are also scattered all over the country.

To ensure that standards are maintained, TDC 1 course directors (instructors) must be certified to conduct the course. The personnel resources bill to provide and the training bill to certify these instructors for each school would be unacceptable. Centralizing the course at major centers for each command would alleviate this problem, but would allow the student travel problem to resurface.

This option would be prohibitively expensive but would allow instructors to be trained as and where required. It could lead to problems with course standardization, and eventual redesign of the course would still be necessary to accommodate changes required by increased CAL use.

Option C - Redesign the TDC 1 as a CAL Course

This option would allow delivery of a standardized TDC 1 course as and where required without student travel or an increase in instructional staff. Many role models would be provided by interactive videodisc. Existing TDC 1 instructional staff could be utilized as telephone or on-line tutors. Existing instructor supervisors would expand their roles to include supervision of the trainee instructor's practice lessons as well as normal lesson evaluations. The redesigned course would incorporate aspects of CAL training as well as information on options other than standard classroom presentation.

Hardware, software and courseware costs would be high for the initial implementation. Implementation could begin with major Command schools and progress with the same software and courseware to include all schools as hardware is acquired.

Analysis

Option A would increase the number of TDC 1 course graduates, but also increase student travel, instructor and facility costs. Standardization is maintained, but future instructor training needs are not addressed.

Option B would increase the number of TDC 1 course graduates and eliminate student travel but would dramatically increase instructor costs. Future instructor training needs are not addressed and existing course standardization could be compromised.

Option C would increase the number of TDC 1 course graduates and eliminate student travel without increasing instructor costs. Standardization and future instructor training needs are fully addressed. Initial implementation of this course would be costly.

The Instructional Techniques Course (TDC 1) is nearing the end of its life-cycle and will soon require revision. This is a logical time to design this course as an interactive CAL course if costs for implementation can be amortized to show an eventual lower cost per student for training.

Cost Comparison

All three options are a combination of theory and practical training, and all three use self-pacing. Options A and B deliver the theory in a classroom setting using a combination of self-paced programmed instructional packages and instructor-presented lectures. Option C delivers all theory by computer assisted learning. All options require the student to present practice lessons. Cost comparisons were made between classroom and CAL training. Option B is not included in the comparisons as the increase in personnel required to have TDC 1 instructors at every school would not be contemplated. Several costing models (Andrews and Thomson, undated; Brandt, 1987; Kemner-Richardson, Lamos and West, 1985; and Spencer, 1984) were reviewed to design the costing model used in tables 1 through 3. The first section of the resulting model is concerned with the course requirements (table 1), the second section costs courseware requirements (table 2), and the third compares personnel costs (table 3).

Classroom training costs include normal revisions and updating of the courseware. CAL costs include courseware

Table 1 Course Requirements for Classroom Instructor Course

	CLASSROOM	CAL
Numbers of students trained:		
Regular Force Schools	60	60
Average number of instructors/School	50	50
Average turnover rate per year (%)	30	30
Number requiring instruction	900	900
Reserve Force Instructors	500	500
Total numbers requiring training	1,500	1,500
Number of students per site:		
Option A	1,500	
Option C (1500 students/60 sites)		25
Courseware Required:		
Prepare Knowledge Lesson -theory (hours)	25	25
practical	7	7
Prepare Skill Lesson - theory	15	15
practical	7	7
Present Knowledge Lesson - practical	3	3
Present Skill Lesson - practical	3	3
Total (hours) - theory	40	40
practical	20	20

Table 2 <u>Courseware Costs</u>

	CLASSROOM	CAL
Courseware Production Costs:		
Length of program (hours theory)	40	40
Hours development/hour training (theory)	25	200
Development cost/hour (theory)	25	100
Length of program (hours practical)	20	20
Hours development/hour training (pract.)	25	25
Development cost/hour (practical)	25	25
Total cost for development	37,500	812,500
Course Support Costs:		
Computer hardware (60 sites x $12,000)		720,000
Computer software (60 sites x $ 1,000)		60,000
Maintenance/year		25,000
Supplies/year	50,000	
Total Courseware Costs:	87,500	1,617,000

Table 3 Personnel Costs

	CLASSROOM	CAL
Personnel Costs:		
Instructor/student ratio (x:1)	8	60
Instructor time (hours/year)	1,312	1,312
Number of instructors/year	9	1
Instructor salaries/year	225,000	25,000
Student salary (for course)	750	750
Student salaries/year	1,125,000	1,125,000
Students who travel (80%)	1,200	
Travel costs (average $500/student)	600,000	
Temporary duty costs (avg $100/student)	120,000	
Total personnel costs/year	2,070,000	1,150,000
Total Training Costs		
Total cost	2,157,000	2,767,000
One-time costs	37,500	1,592,000
One-time costs/year over 5 years	7,500	318,400
Yearly costs	2,120,000	1,175,000
Cost/year over 5 years	2,127,500	1,493,400
Cost per student	1,418	996

development and hardware acquisition. Both calculations include student and instructor salaries and maintenance costs. Option A costs are calculated on the assumption that all training would be conducted at CFTDC. Option C assumes that training would be conducted at major schools (those currently employing over 20 instructors). The average turnover rate is somewhat optimistic for some schools which have a rate of 50% or higher. The travel costs may also be optimistic in that they assume a large percentage of students will travel by Service Air or personal motor vehicle. Civilian airline travel would be more expensive. Costs for rations and quarters for students are also not included.

Conclusions

Although the startup costs for computer assisted learning are higher than those associated with continued centralized classroom instruction, the individual cost per student over five years is less, $996 per student for CAL and $1,418 per student for classroom training (table 3). These costs are calculated using average student and instructor salaries and travel costs. No time saving for the CAL course is included in the calculations, but may be realized when the course is run, as students will be proceeding at their own pace through the course and do not have to depend on travel schedules to return to their own units if finished early.

Option B would require many more instructors than are included in the calculations, at least one for each of the 60 schools, and would not be cost effective to implement. To increase graduate numbers past 1500, the instructor costs for option A would also increase. To increase graduate numbers for option C, shift training could be implemented without additional cost (calculations are for 6 hours a day usage). Export of the course created for option C would require only hardware and software, facilitating use by small schools and Reserve units.

Redesign of the Instructional Techniques course as an interactive CAL course would be a cost effective method to increase the numbers of trained instructors and provide the training when it is required in an instructor's job. It would have the additional advantage of introducing instructors to CAL concepts early in their experience with the training system.

CHAPTER 8

CONCLUSIONS

The information age is here and will not go away even if it is ignored. It must be understood and put to use, and that without the luxury of protracted deliberation about how best to implement the necessary changes such as was enjoyed during the early years of the agricultural and industrial ages. Bureaucracies, like the military, have an especially difficult time because they have large numbers of personnel and quantities of material devoted to maintaining the status quo; therefore change is a very slow process.

Technology proliferation in society as a whole has resulted in a need for people skilled in managing the machines that turn data into information. These people are also required in the military, simply to handle the information produced by and for thousands of people. Even more dramatic however, is the effect of technology on the tools of war. The sailor, soldier, or airman is now responsible for the operation and/or maintenance of several million dollars worth of incredibly complex equipment and must be adequately trained. The demand here is even greater than in the civilian education system. A Captain of a ship will not be satisfied with a technician who 'knows about' machinery systems; s/he demands that any technician on board the ship be able to repair the machinery, preferably quickly. The soldier must be able to solve a weapon problem, not in a repair shop with all tools and manuals immediately to hand, but in a muddy field, in the dark, while under fire. An aircraft pilot cannot merely know the theory of flight, s/he must be able to fly the aircraft at or beyond its limits while under great stress, both emotional and physical.

The amount of training required by these scenarios is expensive, especially if conducted in a standard classroom environment which must go at the pace of the slow average student. Computer Assisted Learning projects within the Canadian Forces have indicated that self-paced CAL can reduce training costs by allowing students to proceed at their own pace. The projects have also shown that the use of CAL must have a coordinated implementation plan to prevent chaos. A logical way to ensure coordination is to have CAL expertise available in all phases of the Canadian Forces Individual Training System.

The use of computers in education and training is relatively new. Designing a state-of-the-art CAL package, and having it and all necessary computer hardware and software 'fall out of the sky' into the hands of a classroom instructor will not result in more efficient and effective training, as it will not be used. If however, it fell into the hands of an instructor who knew what it was and how to use it, training could well become more efficient and effective.

If instructors require training in how to use CAL, so too, do those who support the instructors. The Canadian Forces Individual Training System (CFITS) does an excellent job of supporting instructors for classroom instruction. To effectively support CAL, minor changes must be made at all levels of the system to include more information on this learning medium. Instructor training courses, from Instructional Technique to the Training Development Officer Basic Qualification Course, must also either expand or include sections of CAL so that all personnel are prepared to use this emerging technology.

The needs analysis study demonstrated that both Commands and Canadian Forces Schools are becoming more concerned with self-pacing and computerizing their courses. As the awareness builds, course modifications to include more computer use will become more and more accepted. As personnel become more familiar with computer use in the classroom either by teaching or taking a course in which they are used, they will begin to see more applications for computer technology in their own fields, and further progress can be made.

Introduction of computer assisted learning within the existing Training System will give a framework for the new technology and allow controlled, systematic implementation. This can only happen with CAL knowledge existing at all levels of the system and trainers who are comfortable with the special requirements of the technology.

Awareness can be built by exposing personnel to computer assisted learning early in their involvement with the training system. Classroom instructors will continue to be required for a long time, even as CAL implementation gains momentum. The use of a CAL course to introduce potential instructors to the training system, the Instructional Techniques course, will expose trainers to the medium and ease the transition to CAL tutors at a later stage.

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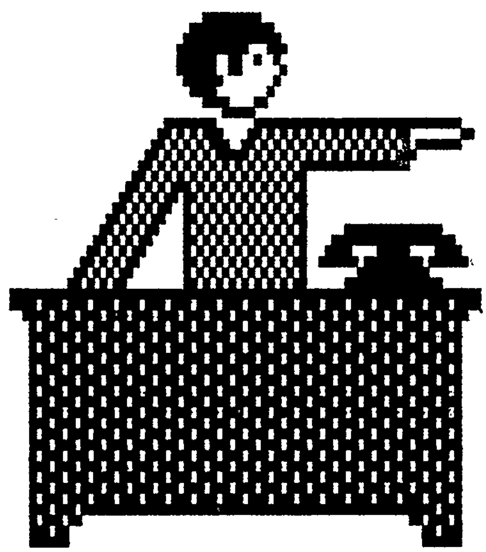
APPENDIX A

COMMAND



QUESTIONNAIRE

COMMAND QUESTIONNAIRE

INTRODUCTION

The TDC 3 course is being reviewed to determine if it meets current organizational needs for instructional materials design and whether any part of the course should be changed to better meet these needs.

As a Command training representative, you are asked to comment on the need for self-paced training materials in your Command, and whether or not changes are required to the TDC 3 course.

The course is to be reviewed in the context of instructional materials design for all forms of self-paced learning. When answering the questionnaire, self-paced learning should be understood to have the following definition:

> Self-paced learning is any planned learning experience in which the individual proceeds at his/her own pace. This includes programmed instruction, computer assisted learning (CAL), study assignments and simulations. It also includes situations where the learner is working alone and sessions where an instructor, tutor or guide is present, but the pace of learning is dictated by the trainee/learner.

The information from the questionnaire will be used ONLY for the needs analysis report. The report will show trends and WILL NOT mention any individual by name or implication.

The questions require either that a response box be ticked or a response be written. For example:

Have you attended the TDC 3 course?

YES ☑ NO ☐

What was your opinion of the course?

Write your comments here

If your answers do not fit in the spaces alotted, feel free to write on the back of the page or on the extra pages at the end of the questionnaire. If you have any questions, contact either Capt. M.J. Mayo at (403) 239-9792 or Capt. D. Hansen, CFTDC Borden, 423-2711.

COMMAND QUESTIONNAIRE

1. What, in your opinion, should be the future of the TDC 3 course?

   a. keep the course in it's present format ☐

   b. scrap the course ☐

   c. modify the course ☐

2. If you answered b or c to question 1, WHY should the course be scrapped or HOW should the course be modified?

   ____

   ____

   ____

   ____

   ____

4. Is there a need for self-paced packages for CURRENT training in your command: total courses, portions of courses, job-aids, pre-course packages, on-site training, etc.?

   YES ☐ NO ☐

5. Is there a need for self-paced packages for FUTURE training in your command, resulting from course redesign projects or course changes?

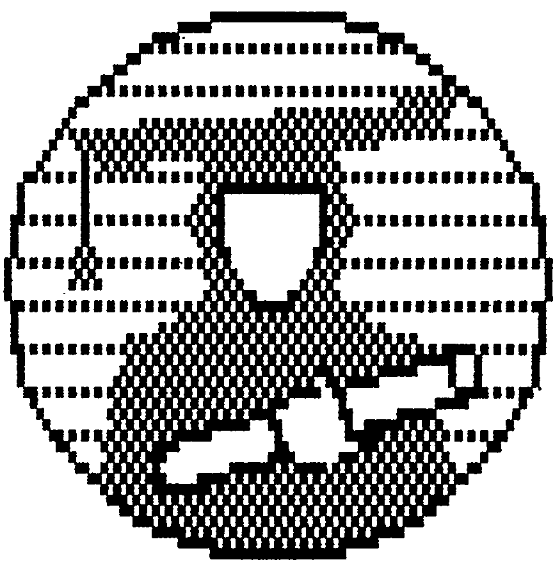
   YES ☐ NO ☐

6. If YES to question 4 or 5, please predict the approximate number of packages that would be required.

TYPE	NONE	1-5	5-10	10-20	20-50	50+
a) pre-course packages	☐	☐	☐	☐	☐	☐
b) academic upgrading	☐	☐	☐	☐	☐	☐
c) simulations	☐	☐	☐	☐	☐	☐
d) study workbooks	☐	☐	☐	☐	☐	☐
e) games/exercises	☐	☐	☐	☐	☐	☐
f) tutorials	☐	☐	☐	☐	☐	☐
g) CAL programs	☐	☐	☐	☐	☐	☐
h) PIPs	☐	☐	☐	☐	☐	☐
j) job-aids	☐	☐	☐	☐	☐	☐
k) OJT packages	☐	☐	☐	☐	☐	☐
l) other						
____________________	☐	☐	☐	☐	☐	☐
____________________	☐	☐	☐	☐	☐	☐
____________________	☐	☐	☐	☐	☐	☐

Additional comments:

TDC 3 GRADUATE



QUESTIONNAIRE

TDC 3 GRADUATE QUESTIONNAIRE

INTRODUCTION

The TDC 3 course is being reviewed to determine if it meets current organizational needs for instructional materials design and whether any part of the course should be changed to better meet these needs.

As a graduate of the course, you are asked to comment on it and judge how well it prepared you for designing instructional materials in your job.

The course is being reviewed in the context of instructional materials design for all forms of self-paced learning. When answering the questionnaire, self-paced learning should be understood to have the following definition:

> Self-paced learning is any planned learning experience in which the individual proceeds at his/her own pace. This includes programmed instruction, computer assisted learning (CAL), study assignments and simulations. It also includes situations when the learner is working alone and sessions where an instructor, tutor or guide is present, but the pace of learning is dictated by the trainee/learner.

The information from the questionnaire will be used ONLY for the needs analysis report. The report will show trends and WILL NOT mention any individual by name or implication.

The questions require either that a response box be ticked or a response be written. For example:

Have you attended the TDC 3 course?

YES [✓] NO [ ]

What was your opinion of the course?

Write your comments here

____

If your answers do not fit in the spaces alotted, feel free to write on the back of the page or on the extra pages at the end of the questionnaire. If you have any questions, contact either Capt. M.J. Mayo at (403) 239-9792 or Capt. D. Hansen, CFTDC Borden, 423-2711.

TDC 3 GRADUATE QUESTIONNAIRE

1. What was the serial number of the course you attended? (if unknown, write year and month of course)

   ____

2. Did you complete your project?

   YES ☐ NO ☐

   If NO go to question 5.

3. How long (in months) after the course was your project completed?

   ____

4. Which type of program was your project?

   LINEAR ☐

   BRANCHING ☐

   ADJUNCT ☐

5. Are you currently employed in training?

   YES ☐ NO ☐

6. Are you currently writing self-paced packages?

   YES ☐ NO ☐

7. If NO to question 6, do you anticipate using the knowledge from the course in the future and if so, how?

   ____

   ____

   ____

   ____

8. Did you write any self-paced packages before the course?

YES ☐ NO ☐

9. How many self-paced packages have you written, not including your project?

	0	1	2	3	more
before the course	☐	☐	☐	☐	☐
after the course	☐	☐	☐	☐	☐

10. Self-paced packages (including project) were designed:

a. as paper based packages ☐

b. as computer based packages ☐

c. some paper and some computer based packages ☐

11. What was(were) the most useful part(s) of the course for you?

PO	ESSENTIAL	USEFUL	USELESS
Select topic for programming	☐	☐	☐
Analyze performance objectives	☐	☐	☐
Construct programmed modules	☐	☐	☐
Edit programmed modules	☐	☐	☐
Evaluate programmed modules	☐	☐	☐

12. What would you like to see changed in the course?

____

____

____

____

13. Please rate the types of self-paced learning packages with which you have been involved, as a student, as an instructor or as a reviewer. If you have been involved with more than one package of the type listed, state the number of packages that received the rating ticked.

	EXCELLENT #	rating	GOOD #	rating	USABLE #	rating	BAD #	rating
example	2	☑	___	☐	3	☑	1	☑
a) pre-course packages	___	☐	___	☐	___	☐	___	☐
b) academic upgrading packages	___	☐	___	☐	___	☐	___	☐
c) simulations	___	☐	___	☐	___	☐	___	☐
d) study workbooks	___	☐	___	☐	___	☐	___	☐
e) games/exercises	___	☐	___	☐	___	☐	___	☐
f) tutorials	___	☐	___	☐	___	☐	___	☐
g) CAL programs	___	☐	___	☐	___	☐	___	☐
h) PIPs	___	☐	___	☐	___	☐	___	☐
j) job-aids	___	☐	___	☐	___	☐	___	☐
k) OJT packages	___	☐	___	☐	___	☐	___	☐

14. Which, if any of the above types of self-paced learning have you designed?

____

____

____

____

15. If you have used or designed self-paced packages for CAL, did the TDC 3 course prepare you to design for this type of self-pacing?

YES ☐ NO ☐

16. If NO to question 15, what other topics are required?

____

____

____

____

____

17. What, in your opinion, should be the future of the TDC 3 course?

a. keep the course in it's present format ☐

b. scrap the course ☐

c. modify the course ☐

18. If you answered b or c to question 17, WHY should the course be scrapped or HOW should the course be modified?

____

____

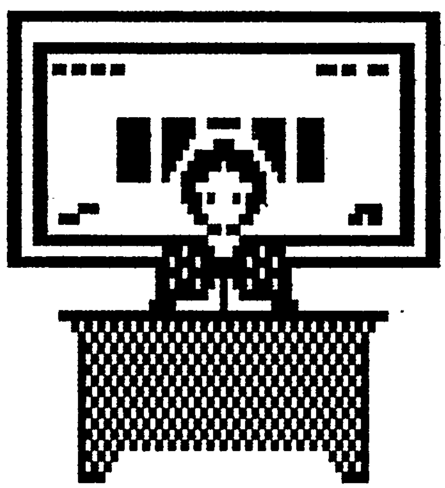
____

____

____

Additional comments:

CF SCHOOL



QUESTIONNAIRE

CF SCHOOL QUESTIONNAIRE

INTRODUCTION

The TDC 3 course is being reviewed to determine if it meets current organizational needs for instructional materials design and whether any part of the course needs to be changed to better meet these needs.

As a School training representative, you are asked to comment on the need for self-paced training materials in your school, and whether or not TDC 3 graduates are sufficiently prepared to meet the self-paced package design needs of your school.

The course is to be reviewed in the context of instructional materials design for all forms of self-paced learning. When answering the questionnaire, self-paced learning should be understood to have the following definition:

> Self-paced learning is any planned learning experience in which the individual proceeds at his/her own pace. This includes programmed instruction, computer assisted learning (CAL), study assignments and simulations. It also includes situations where the learner is working alone and sessions where an instructor, tutor or guide is present, but the pace of learning is dictated by the trainee/learner.

The information from the questionnaire will be used ONLY for the needs analysis report. The report will show trends and WILL NOT mention any individual by name or implication.

The questions require either that a response box be ticked or a response be written. For example:

Have you attended the TDC 3 course?

YES ☑ NO ☐

What was your opinion of the course?

Write your comments here

____

____

If your answers do not fit in the spaces alotted, feel free to write on the back of the page or on the extra pages at the end of the questionnaire. If you have any questions, contact either Capt. M.J. Mayo at (403) 239-9792 or Capt. D. Hansen, CFTDC Borden, 423-2711.

SCHOOL QUESTIONNAIRE

1. Are any of your staff currently employed in writing self-paced packages?

   YES ☐ NO ☐

   (if NO, go to question 5)

2. Approximately what percentage of the self-paced package writers have completed the TDC 3 course? ____________%

3. Are the self-paced package writers who completed the TDC 3 course sufficiently trained to prepare packages to meet the needs of your school?

   YES ☐ NO ☐

4. If NO to question 3, in which areas do they require more training?

   ____

   ____

   ____

5. Approximately how many of your personnel require TDC 3 training per year? ______________________________

6. What in your opinion should be the future of the TDC 3 course?

   a. keep the course in it's present format ☐

   b. scrap the course ☐

   c. modify the course ☐

7. If you answered b or c to question 6, WHY should the course be scrapped or HOW should the course be modified?

   ____

   ____

   ____

   ____

8. Is there a need for self-paced packages for CURRENT training in your school: total courses, portions of courses, job-aids, pre-course packages, on-site training, etc.?

YES ☐ NO ☐

9. Is there a need for self-paced packages for FUTURE training in your in your school, based on future projects or course changes?

YES ☐ NO ☐

10. If YES to question 8 or 9, please predict the approximate number of packages that would be required.

TYPE	NONE	1-5	5-10	10-20	20-50	50+
a) pre-course packages	☐	☐	☐	☐	☐	☐
b) academic upgrading	☐	☐	☐	☐	☐	☐
c) simulations	☐	☐	☐	☐	☐	☐
d) study workbooks	☐	☐	☐	☐	☐	☐
e) games/exercises	☐	☐	☐	☐	☐	☐
f) tutorials	☐	☐	☐	☐	☐	☐
g) CAL programs	☐	☐	☐	☐	☐	☐
h) PIPs	☐	☐	☐	☐	☐	☐
j) job-aids	☐	☐	☐	☐	☐	☐
k) OJT packages	☐	☐	☐	☐	☐	☐
l) other						
______________________	☐	☐	☐	☐	☐	☐
______________________	☐	☐	☐	☐	☐	☐

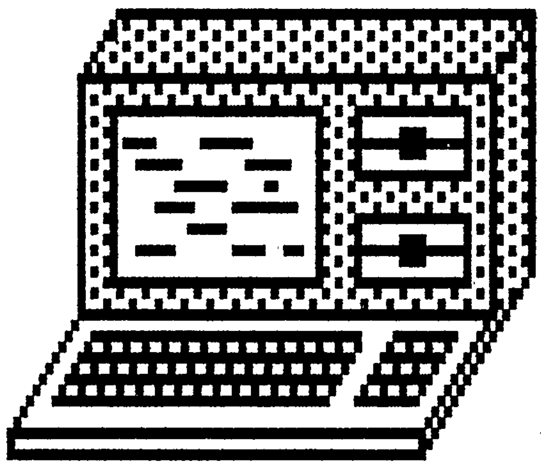
11. Do you anticipate an increase in CAL for courses or parts of courses within your school?

YES ☐ NO ☐

12. If you answered yes to question 11, what additional training is required for those of your staff who will be designing or ammending these CAL packages?

Additional comments:

CAL UNIT



QUESTIONNAIRE

CAL UNIT QUESTIONNAIRE

INTRODUCTION

The TDC 3 course is being reviewed to determine if it meets current organizational needs for instructional materials design and whether any part of the course should be changed to better meet these needs.

As a CAL unit training representative, you are asked to comment on how well the TDC 3 course prepares its graduates to meet design needs for CAL coursewear at your unit. In addition, you are asked to determine required knowledge and skills for this specialized field.

The course is being reviewed in the context of instructional materials design for all forms of self-paced learning. When answering the questionnaire, self-paced learning should be understood to have the following definition:

> Self-paced learning is any planned learning experience in which the individual proceeds at his/her own pace. This includes programmed instruction, computer assisted learning (CAL), study assignments and simulations. It also includes situations where the learner is working alone and sessions where an instructor, tutor or guide is present, but the pace of learning is dictated by the learner/trainee.

The information from the questionnaire will be used ONLY for the needs analysis report. The report will show trends and WILL NOT mention any individual by name or implication.

The questions require either that a response box be ticked or a response be written. For example:

Have you attended the TDC 3 course?

YES ☑ NO ☐

What was your opinion of the course?

Write your comments here
____
____
____

If your answers do not fit in the spaces alotted, feel free to write on the back of the page or on the extra pages at the end of the questionnaire. If you have any questions, contact either Capt. M.J. Mayo at (403) 239-9792 or Capt. D. Hansen, CFTDC Borden, 423-2711.

CAL UNIT QUESTIONNAIRE

1. How many of the courseware writers or designers at your unit have completed the TDC 3 course, and:

    a) completed the project ____________________

    b) did not complete the project ____________________

2. Are the courseware writers or designers who completed the TDC 3 course sufficiently trained to prepare packages to meet the needs of your unit?

    YES ☐ NO ☐

3. How do you ensure that courseware writers or designers are trained to meet the design needs of your unit in addition to or instead of attendance at the TDC 3 course? (tick as many as apply)

    a) informal on-job training ☐

    b) formal on-job training ☐

    c) in-service courses ☐

    d) out-service courses ☐

4. If you answered either c or d to question 3, please list the courses below:

____

____

____

____

____

5. Which of the following types of CURRENT courseware should your package writers be prepared to design?

a) drill and practice ☐

b) tutorials ☐

c) simulations ☐

d) instructional games ☐

6. Which of the following types of FUTURE courseware should your package writers be prepared to design?

a) CAL multimedia (graphics, sound, video, etc.) ☐

b) hyper media/hyper text
(learner chooses from a variety of related information packages at differing levels and designed for different learning styles - for example, Macintosh Hypercard) ☐

c) CAL with on-line learning style diagnosis
(program assesses learners style of learning and presents material IAW diagnosed style) ☐

d) tutorial expert systems
(designer utilizes existing expert system to act as tutor in program - checks learner responses, steps learner through problem-solving process, etc.) ☐

e) other as listed below ☐

____

____

____

____

____

____

7. Which of the following topics should be included in the preparation for courseware designers?

a) frame creation ☐

b) screen design ☐

c) interactive video systems ☐

d) windowing systems ☐

e) audio systems (speech, music, sounds, etc.) ☐

f) graphics design and creation ☐

g) digitized sound and/or images ☐

h) record keeping ☐

i) other as listed below ☐

____

____

____

8. Which of the following subject areas are or should be required knowledge for CAL package writers at your unit:

a) programming language(s) ☐

b) authoring language(s) ☐

c) authoring systems ☐

d) operating systems ☐

e) network communications ☐

f) knowledge engineering ☐

g) computer systems design ☐

h) technical trouble shooting ☐

i) other as listed below ☐

____

____

____

9. If you answered a,b, or c to question 8, please list the languages/systems below:

___

___

___

10. In your opinion, how should a course for CAL writers be taught?

a) formal course at centralized school ☐

b) formal course on-site ☐

c) on-line course at centralized school with tutors available ☐

d) on-line course on-site with tutors available on-site ☐

e) on-line course on-site with tutors available on-line or by telephone ☐

f) OJT ☐

g) other as listed below ☐

___

___

___

11. Please state reasons for your choice in question 10

___

___

___

12. Please rate the following EOs from the current TDC 3 course for applicibility to your specialized design needs.

EO	REQUIRED	USEFUL	USELESS
SELECT COURSE TOPIC FOR PROGRAMMING			
a) apply feasibility factors	☐	☐	☐
b) apply selection criteria	☐	☐	☐
c) determine media type	☐	☐	☐
ANALYSE PERFORMANCE OBJECTIVES			
a) write enabling objectives	☐	☐	☐
b) determine teaching points	☐	☐	☐
CONSTRUCT PROGRAMMED MODULES			
a) write baboon frames	☐	☐	☐
b) write branching frames	☐	☐	☐
c) write adjustive devices	☐	☐	☐
d) write terminal frames	☐	☐	☐
e) write constructed response frames	☐	☐	☐
f) write selected response	☐	☐	☐
g) write adjunct programs	☐	☐	☐
h) evaluate audio-visual materials	☐	☐	☐
i) produce multi-media programs	☐	☐	☐
EDIT PROGRAMMED MODULES			
a) identify technical accuracy errors	☐	☐	☐
b) identify programming errors	☐	☐	☐
c) identify composition errors	☐	☐	☐
EVALUATE PROGRAMMED MODULES			
a) draft a master validation exam	☐	☐	☐
b) draft a threshold knowledge test	☐	☐	☐
c) administer tests	☐	☐	☐
d) conduct one-to-one testing	☐	☐	☐
e) conduct small group testing	☐	☐	☐
f) conduct field testing	☐	☐	☐
g) analyse data	☐	☐	☐
h) restructure modules	☐	☐	☐

13. What, in your opinion is the future of the TDC 3 course?

    a. keep the course in it's present format ☐

    b. scrap the course ☐

    c. modify the course ☐

14. If you answered c to question 4, HOW should the course be modified?

____

____

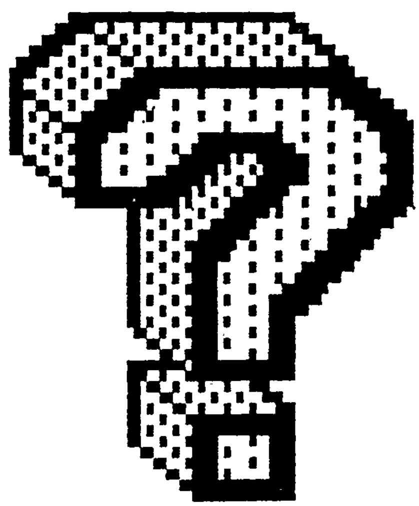
____

____

____

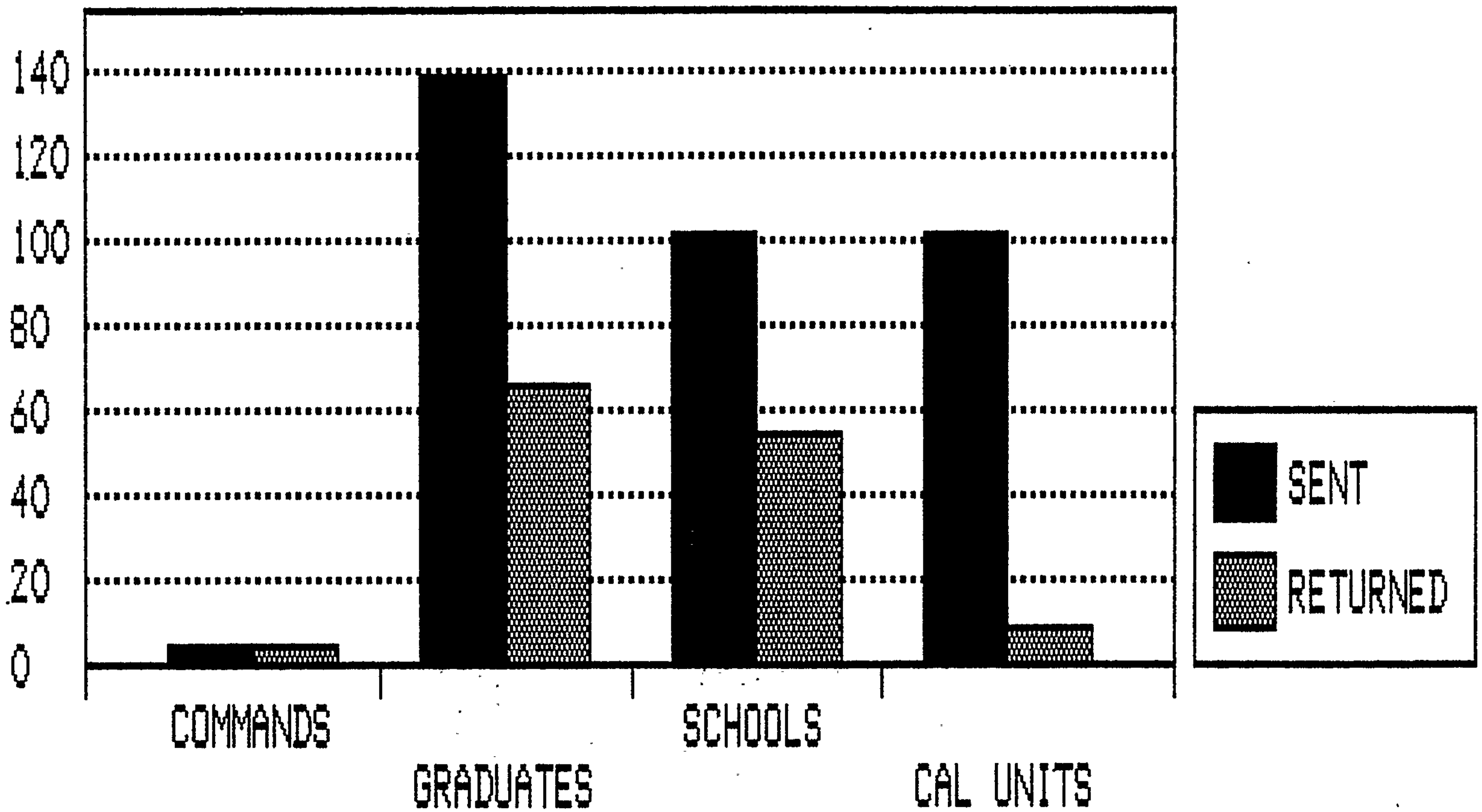
Additional comments:

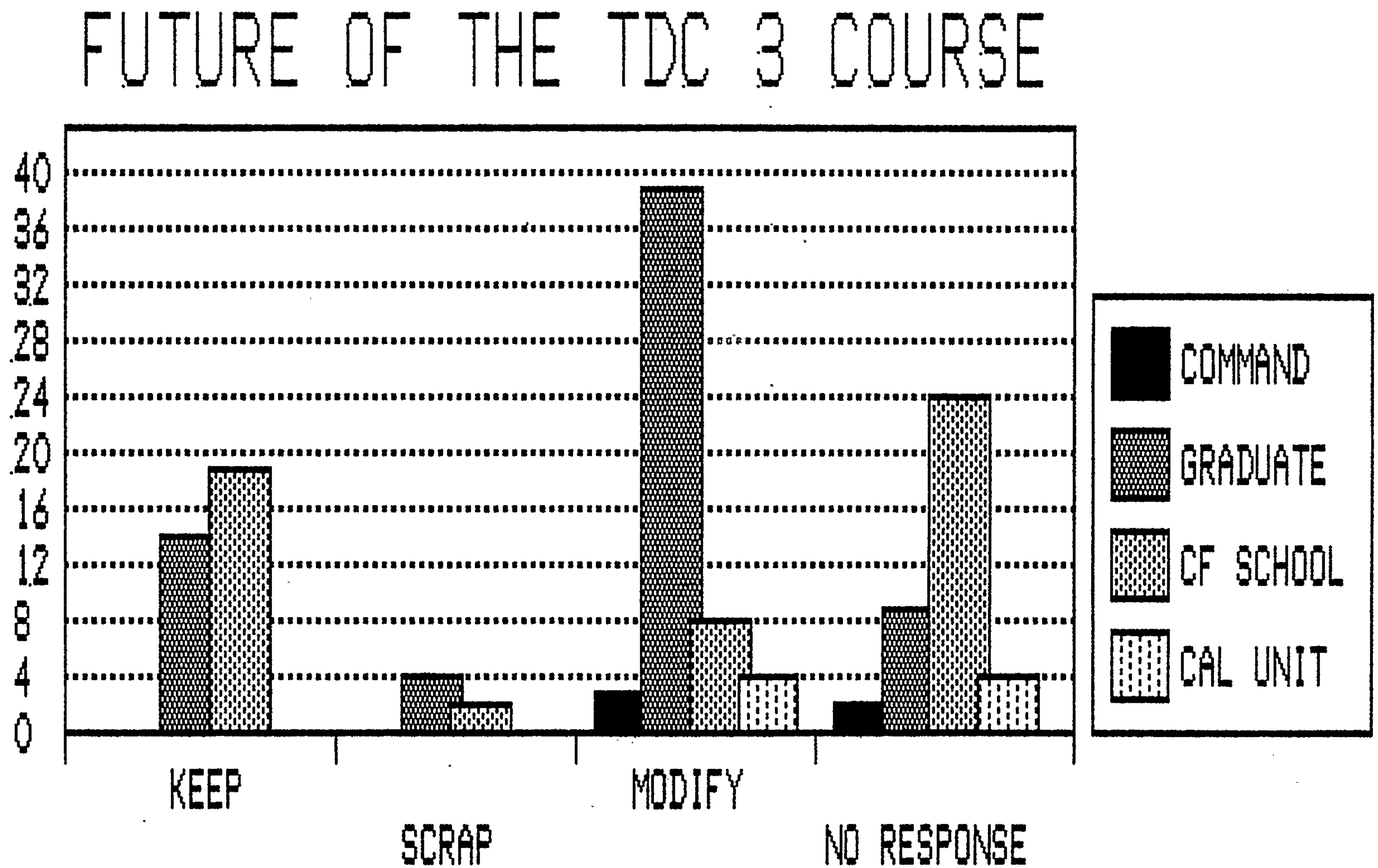
GENERAL



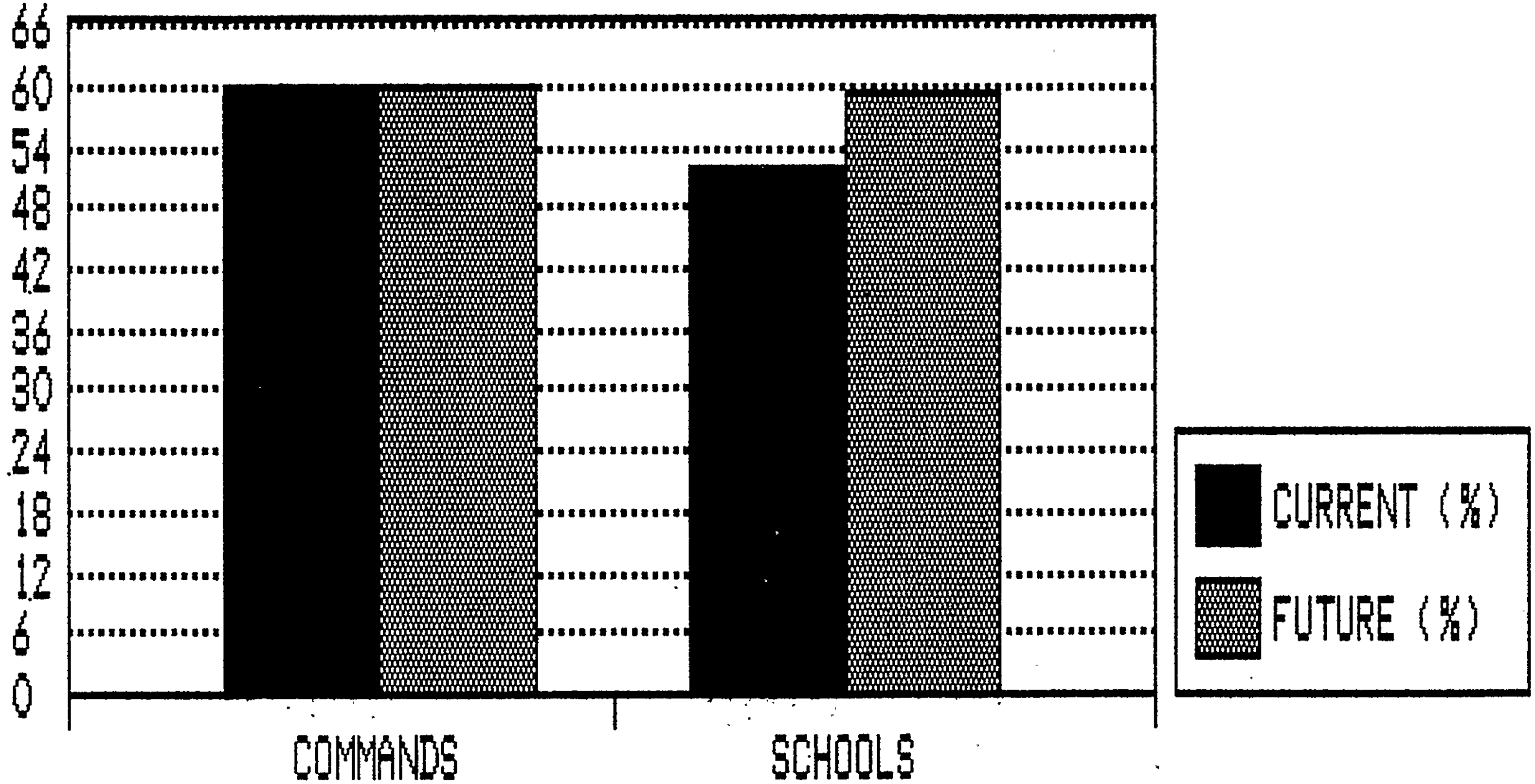
STATISTICS

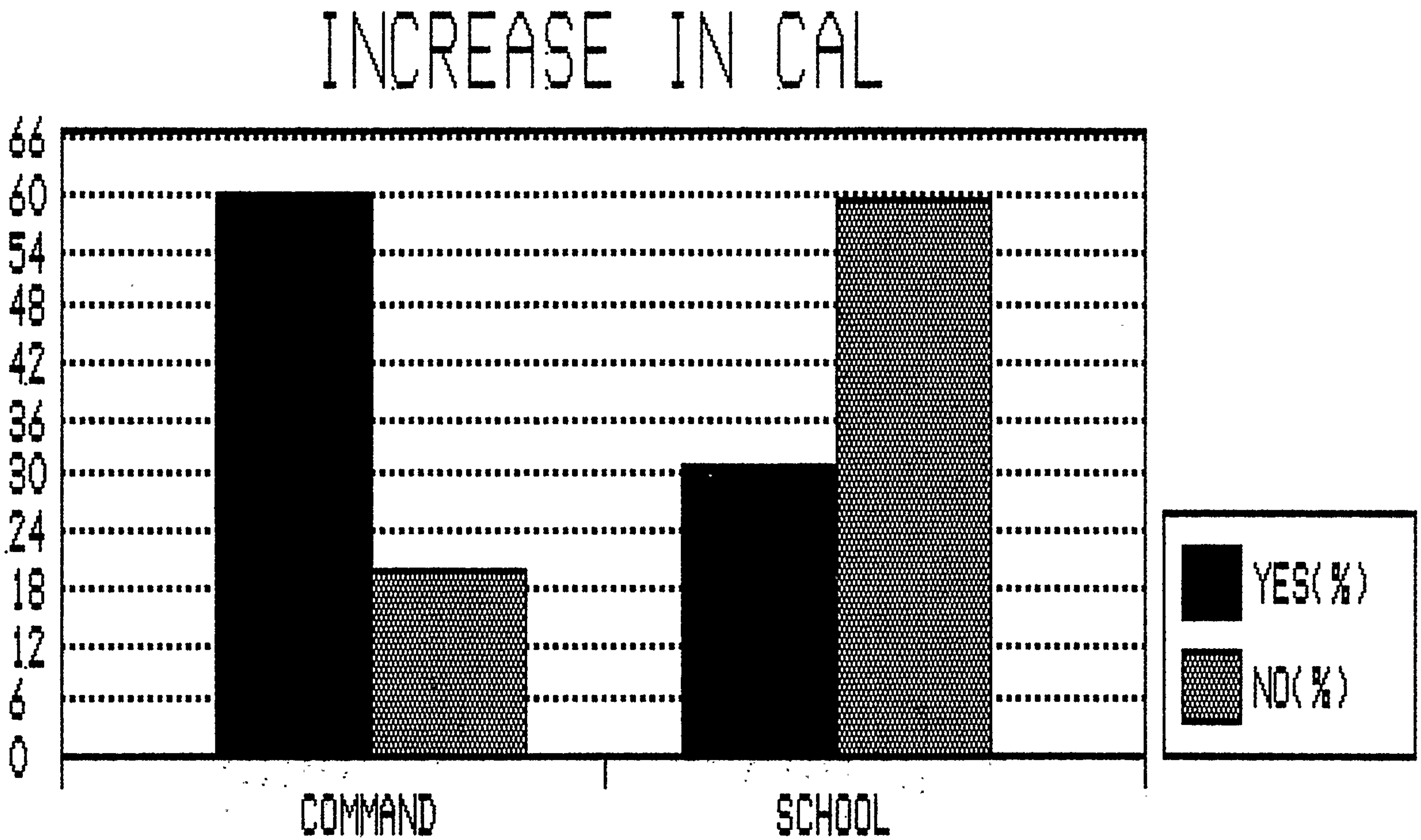
QUESTIONNAIRE RETURN RATES

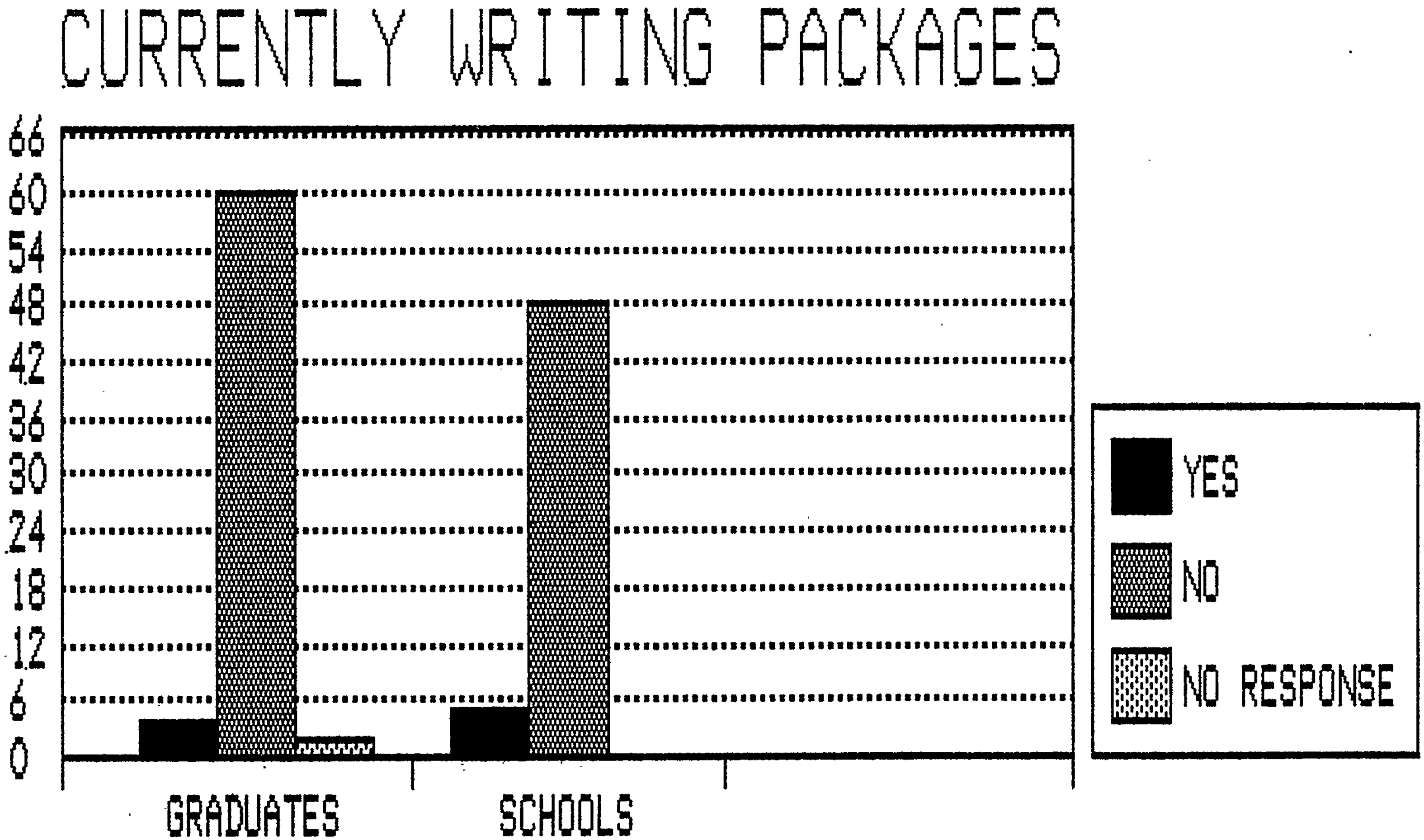



FUTURE OF THE TDC 3 COURSE
40
36
32
28
24
20
16
12
8
4
0
KEEP
SCRAP
MODIFY
NO RESPONSE
COMMAND
GRADUATE
CF SCHOOL
CAL UNIT

NEED FOR SELF-PACED MATERIAL




INCREASE IN CAL
66
60
54
48
42
36
30
24
18
12
6
0
COMMAND
SCHOOL
YES(%)
NO(%)


CURRENTLY WRITING PACKAGES
66
60
54
48
42
36
30
24
18
12
6
0
GRADUATES
SCHOOLS
YES
NO
NO RESPONSE

APPENDIX B

Acme Auto

The trial program, Acme Auto, was designed as a tutorial aid for students studying Auto Mechanics at the Southern Alberta Institute of Technology (SAIT). It is a combination of information retrieval, drill and practice, simulation and expert tutor for transmission bearing problems. A guided discovery learning environment was created wherein the student is given a problem to solve (diagnosis of a transmission fault), access to the tools required to solve the problem (the practice room), and assistance if required (the expert tutor). A drill exercise was included for one concept that was identified as difficult to master (gear ratio calculation).

Program Description

Acme Auto requires a Macintosh computer with a minimum 1 megabyte of RAM and either dual 720K floppy disks or a single floppy and one hard disk. HyperCard is required to run the program.

Designed as an adjunct to training for use in a library or computer laboratory, the program is entered from the HyperCard Home card. The student clicks on the Acme Auto button on the Home card to go to the first card of the Acme Auto stack: an exterior view of the building (Figure 1). A click on the door enters the building and shows the reception area (Figure 2) where a route through the program may be chosen by clicking on the appropriate icon. The student may enter the practice room, the transmission shop or the senior technician's office in any order. A click on the receptionist displays a help stack containing information about all parts of the program.

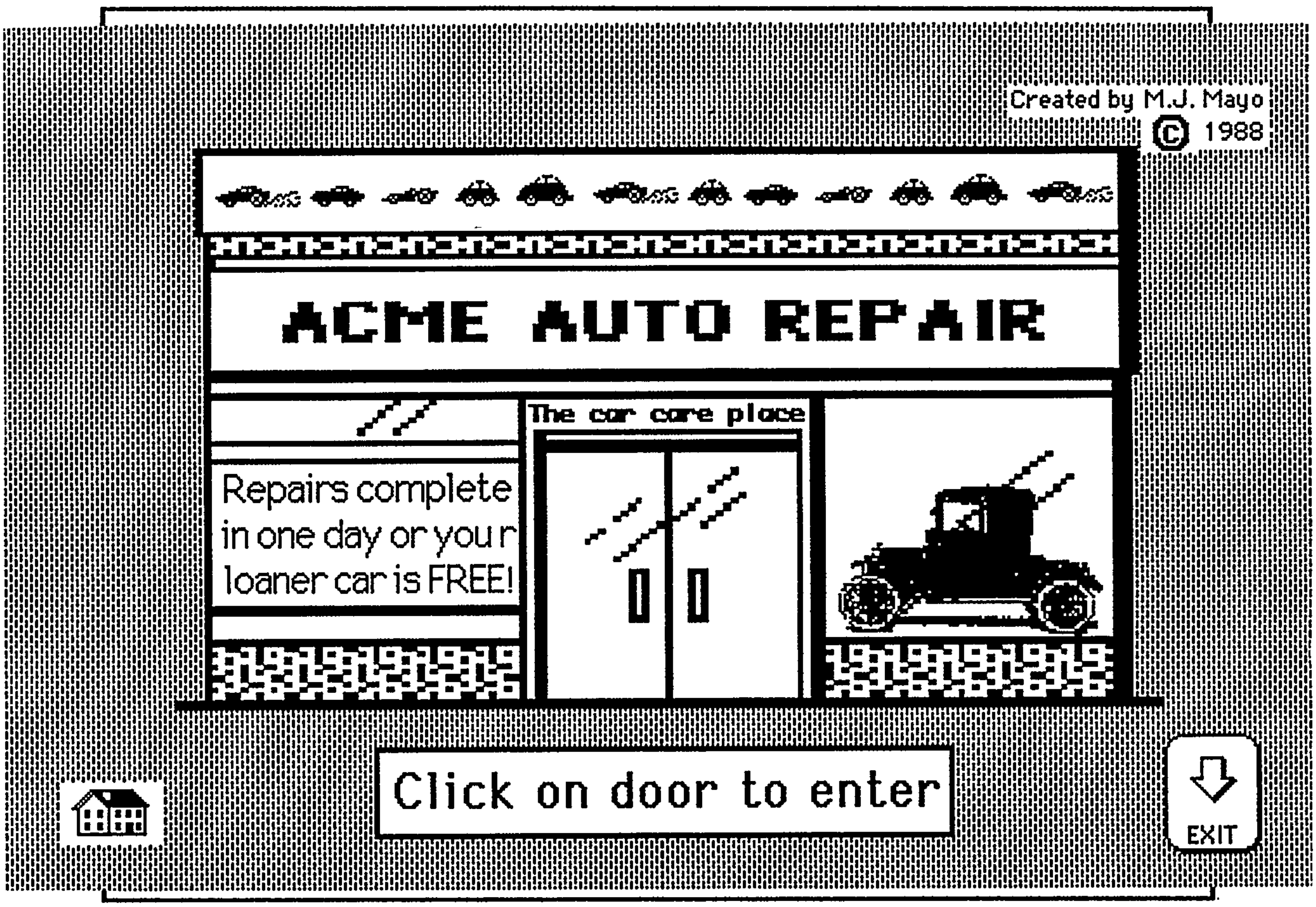


Figure 1. Acme Auto building exterior screen.

Transmission Shop (The Problem). After the student has entered the transmission shop (Figure 3), a click on a ringing phone begins the simulation. A random selection is then made by the computer of: one of five possible transmission problems (drive pinion bearing, mainshaft pilot

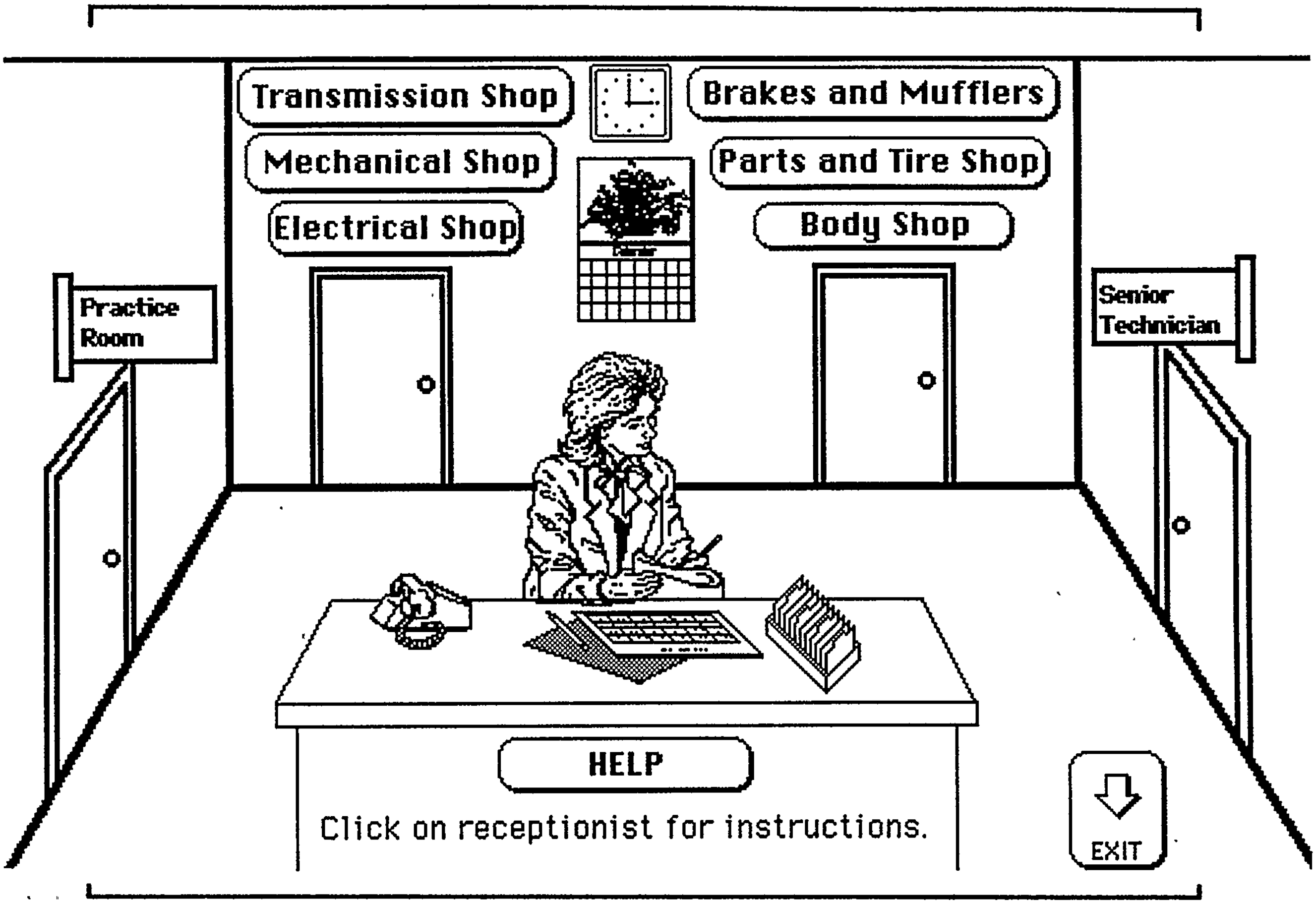


Figure 2. Reception area screen.

bearing, mainshaft rear bearing, counter gear bearings, and a non-bearing problem); one of three possible customer graphics (two male and one female); and one of three possible customer types (one mechanically inclined, one 'difficult' customer, and one mechanically ignorant). The problem, customer type and customer graphic are then constant until the student either solves the problem or quits the program, no matter what other paths through the program are taken; the student may return to the practice room for information without losing his/her place.

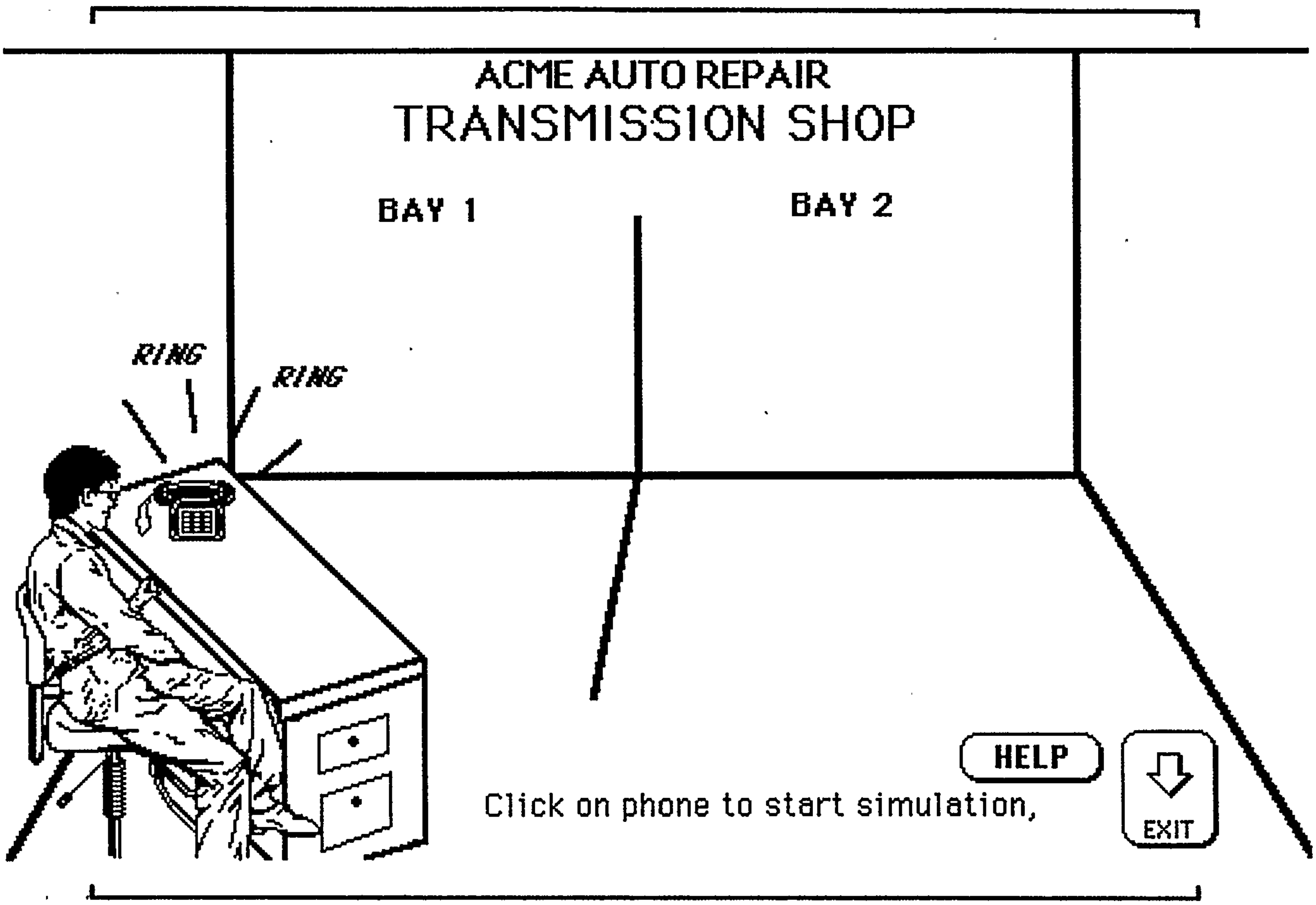


Figure 3. Transmission Shop screen before the start of the simulation.

When the simulation begins, a split screen showing the selected customer graphic and the shop technician is displayed (Figure 4). The student, in the role of shop technician, conducts an initial dialog with the customer, following which s/he is presented with a series of choices (Figure 5):

1. Talk to the customer. This option takes the student back to the customer for questions. At

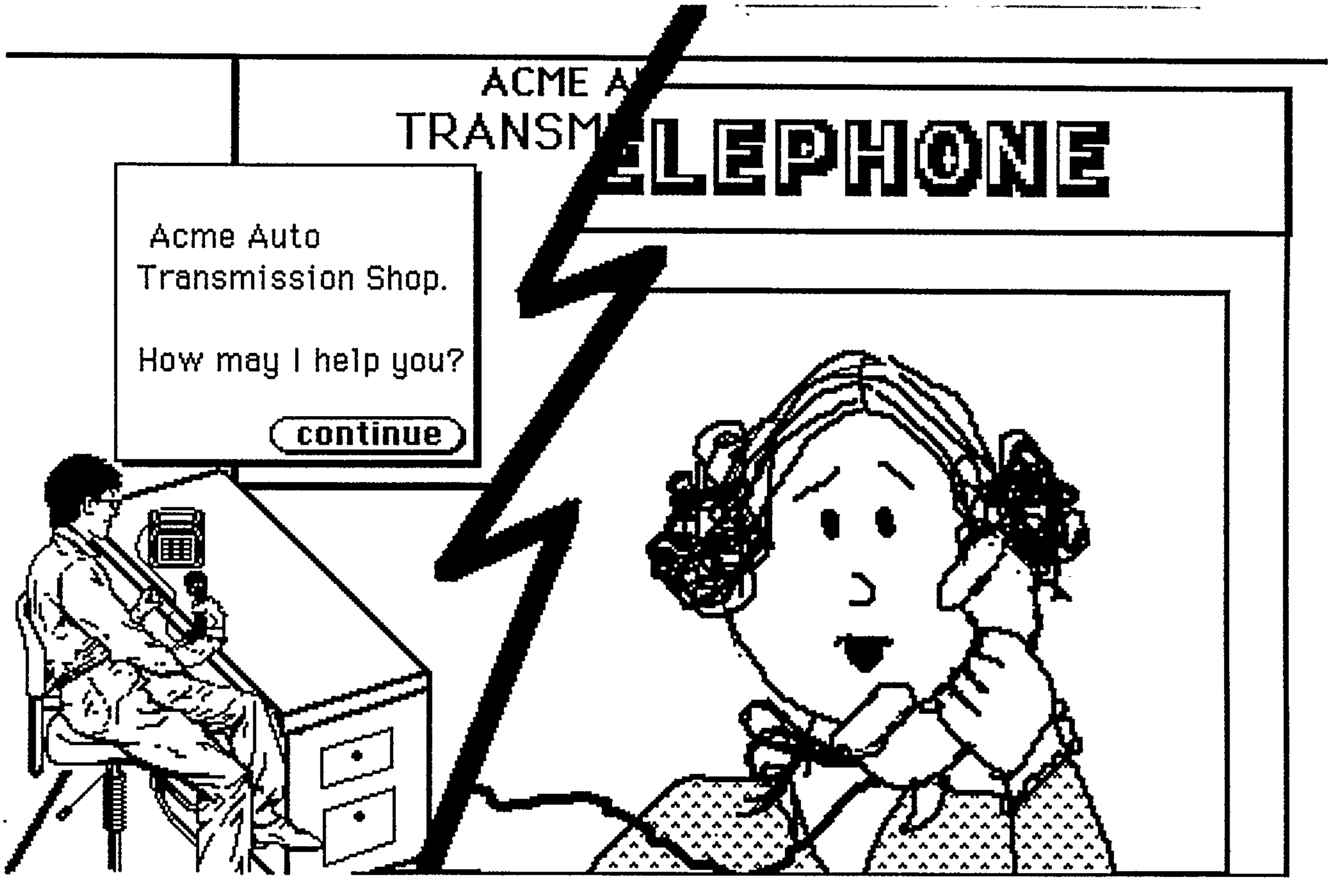


Figure 4. Transmission Shop screen showing customer/technician dialog.

least two questions may be asked: what kind of sound is heard? and in what gears is it heard? Customers will answer depending on their type. Type 1, the mechanically inclined, will offer all information required and answer further questions unless the problem is not in a bearing. Type 2, the 'difficult' customer, will give no useful information and will not answer further questions. Type 3, the mechanically ignorant, will give no useful information but will give accurate answers to further questions unless the problem is not in a bearing.

2. Take the car for a test drive. This option takes the student to a graphic of the inside of a car (Figure 6). The car will respond with the appropriate noise for the problem and gear as they are selected.

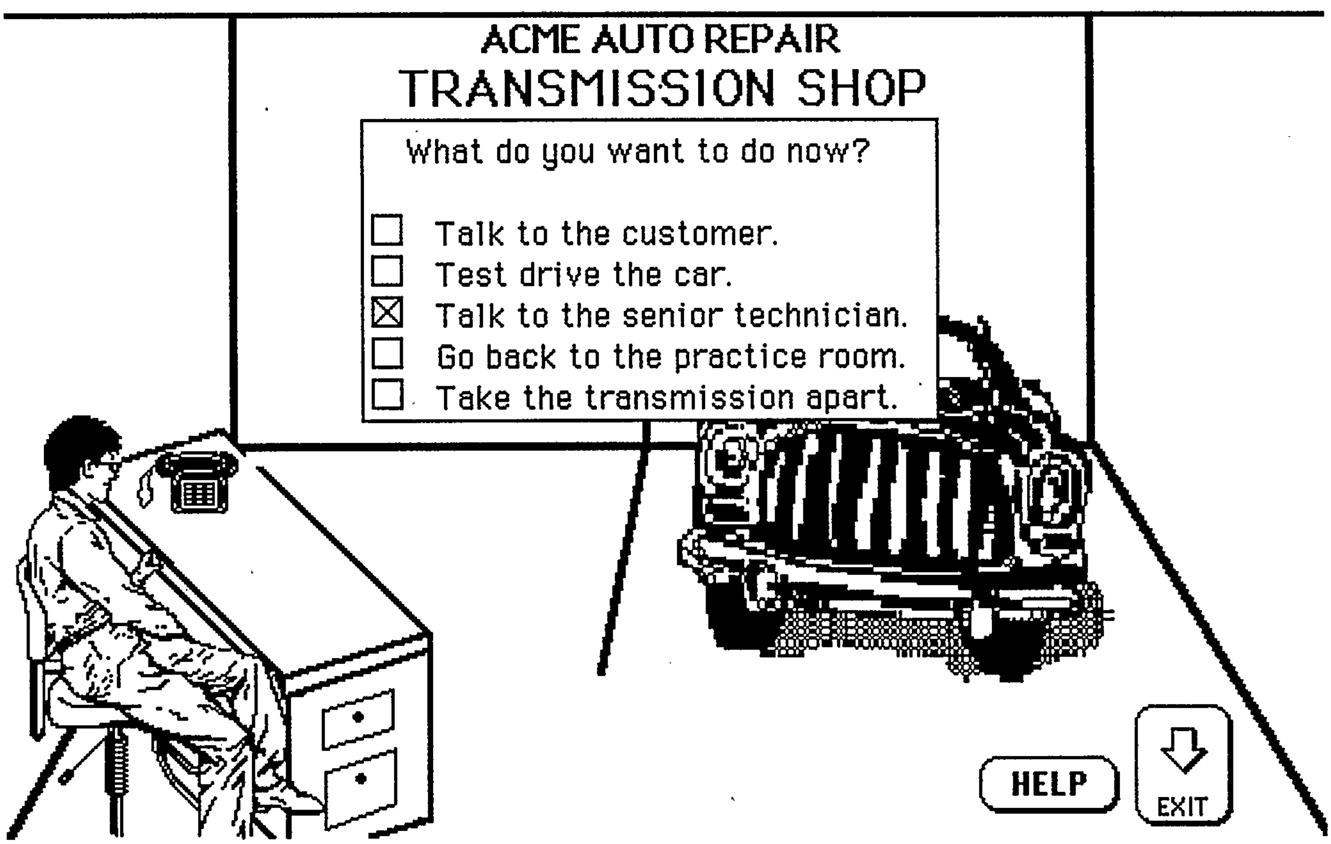


Figure 5. Transmission shop screen after the start of the simulation.

3. Return to the practice room. This option may be selected at any time without changing the progress through the simulation.

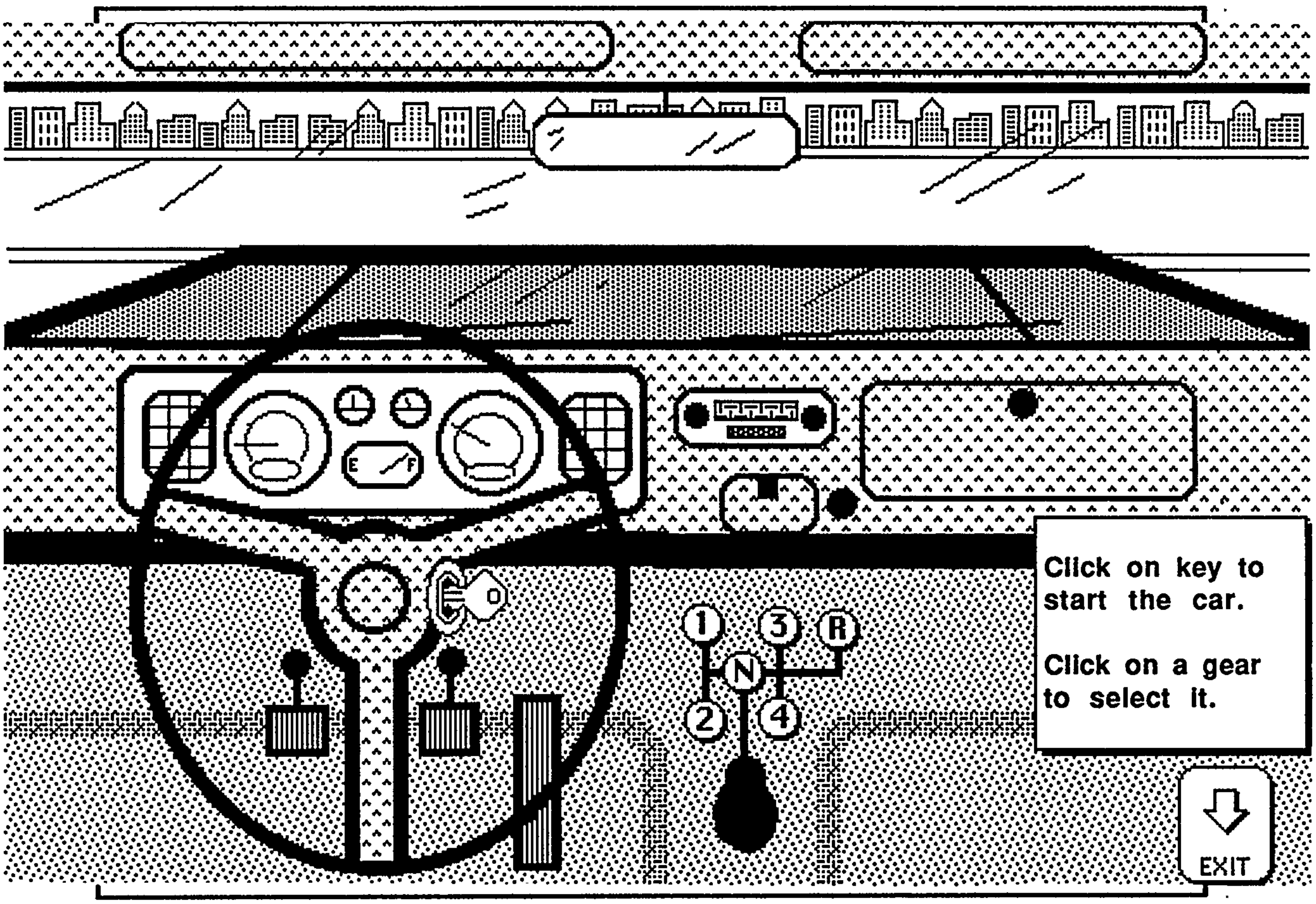


Figure 6. Car screen.

4. Talk to the Senior Technician. This option takes the student to the Senior Technician's office where assistance may be obtained for any part of the problem diagnosis process.
5. Take the transmission apart. This option will respond with a prompt to see the senior technician who will determine if the student's

diagnosis is correct.

6. Exit returns the student to the reception area but does not stop the simulation.
7. Help takes the student to the help stack.

Practice Room (The Tools). This area (Figure 7) allows the student to select from a variety of information retrieval activities and/or a drill and practice in calculating gear ratios. The student may choose any or all of the following in any order:

1. View a description of the problem diagnosis process.

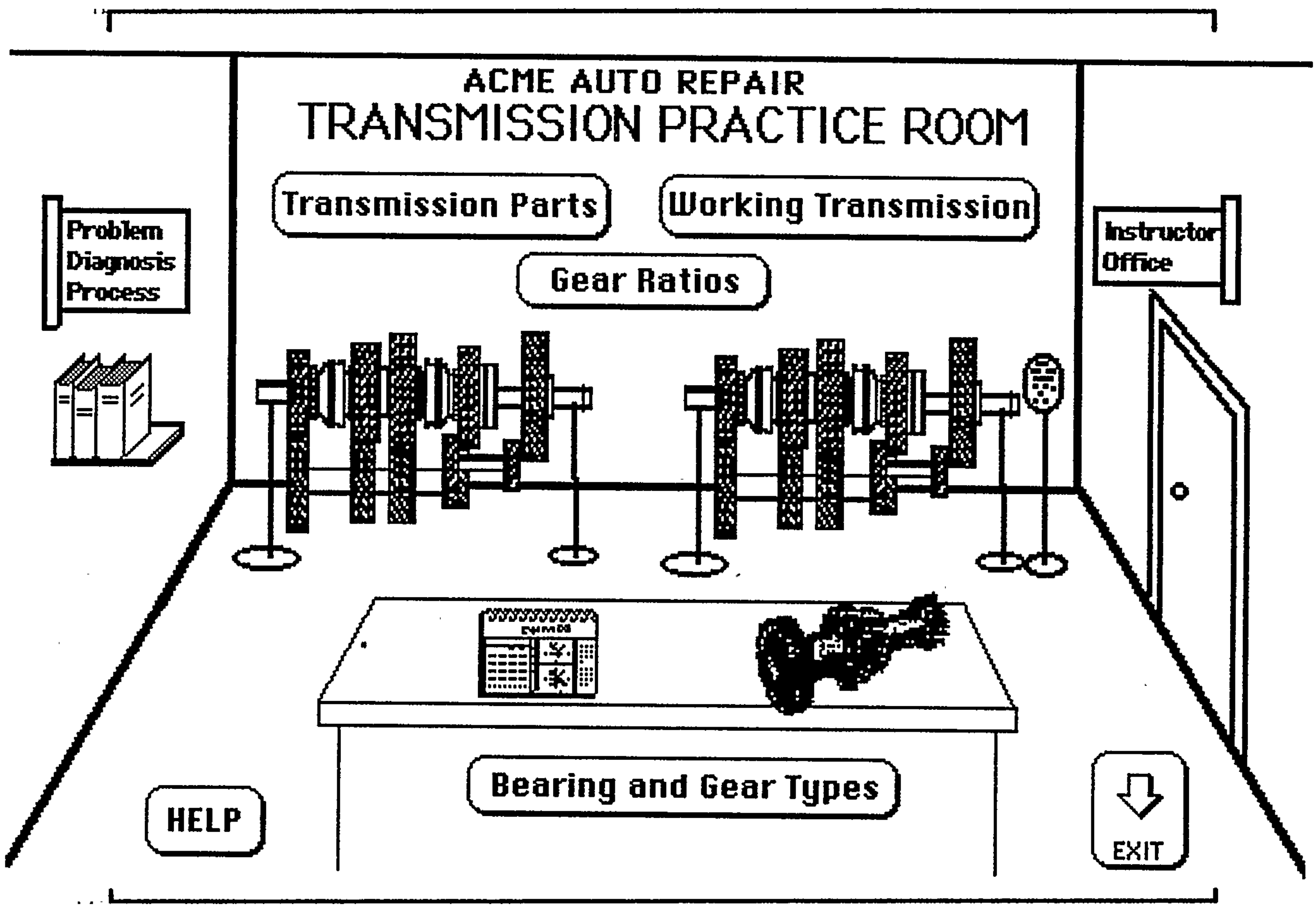


Figure 7. Practice Room screen.

2. Selectively examine a transmission part by part to see the various bearing types and locations (Figure 8).
3. Examine a working transmission to determine which gears are turning, in which direction they and the driveshaft are turning, and what the power flow is in each selected gear.
4. Enter the instructor's office (Figure 9) to receive instructions and a welcome message.
5. View theoretical information on gears and bearings.

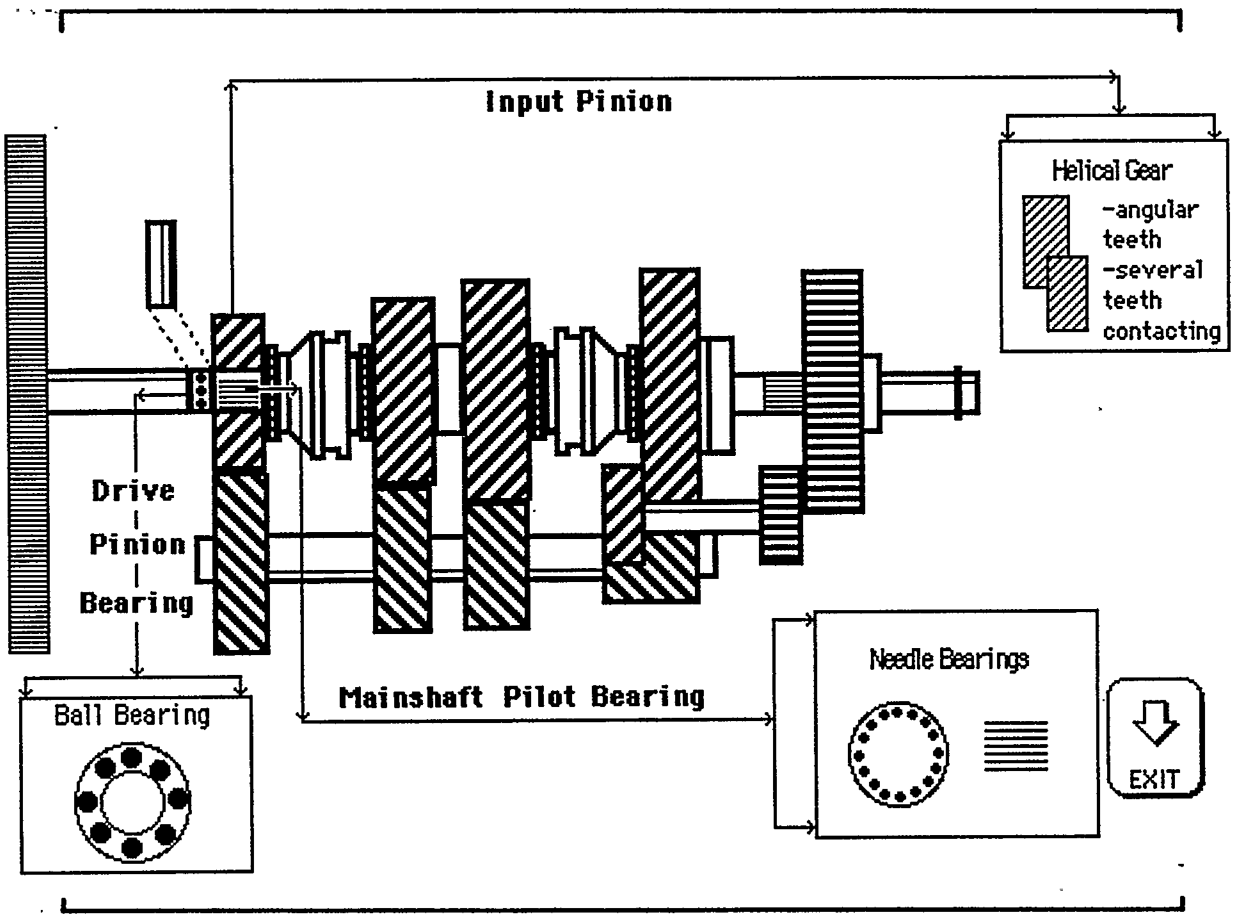


Figure 8. Transmission screen.

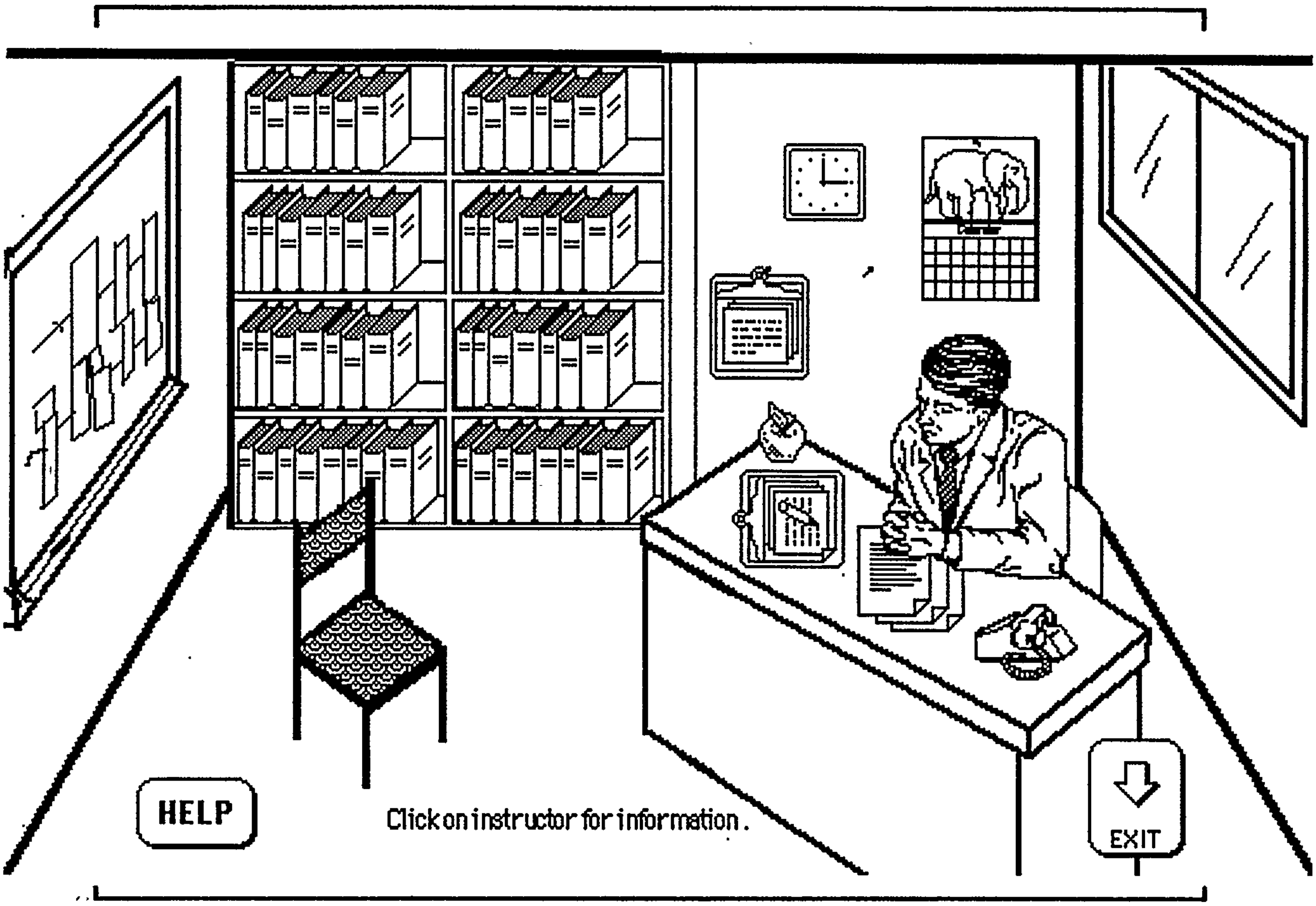


Figure 9. Instructor's office screen.

6. Go to the help stack (Figure 10) to get information on the entire program.
7. Exit back to the reception area.
8. Practice calculating gear ratios (Figure 11).

The gear ratio drill randomly selects from one of three gear sets (Saginaw, Ford, or Chrysler), and from one of five possible gears (first, second, third, fourth, and reverse). The student has available the formula for calculating the gear ratio and access to the power flow diagrams. When ready to answer, s/he clicks on the ready to

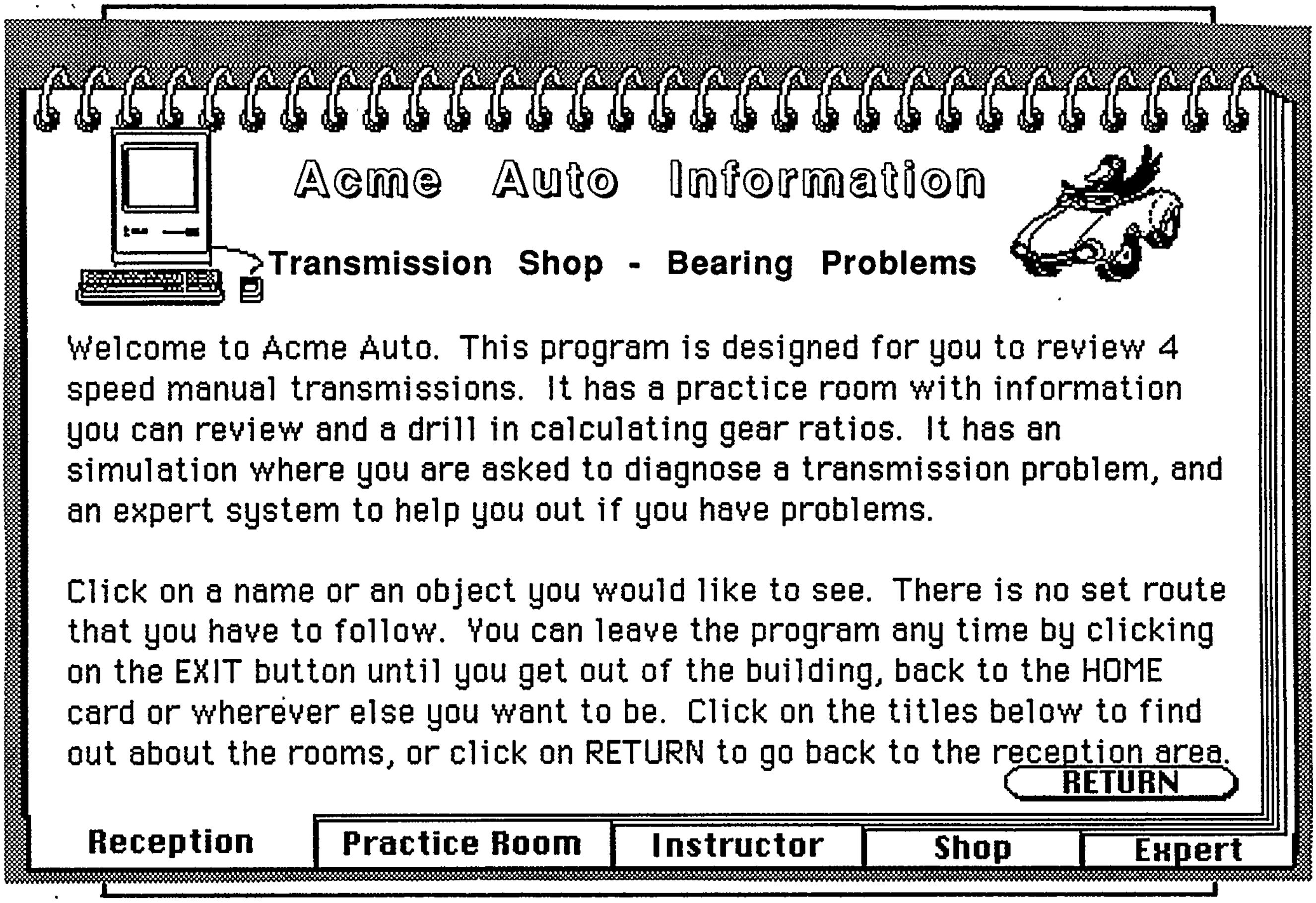


Figure 10. Help stack screen.

answer button and a field is shown into which the answer is typed. On a computer with a hard disk, it would be possible to provide a calculator as well.

If the answer is correct, a reinforcement message is shown. If incorrect, the student is directed to review the formula and power flow diagram. If still incorrect, the expert tutor (instructor) shows the step by step calculation of the ratio for the specific gear set and selected gear by appropriate showing and flashing of information fields (Figure 12).

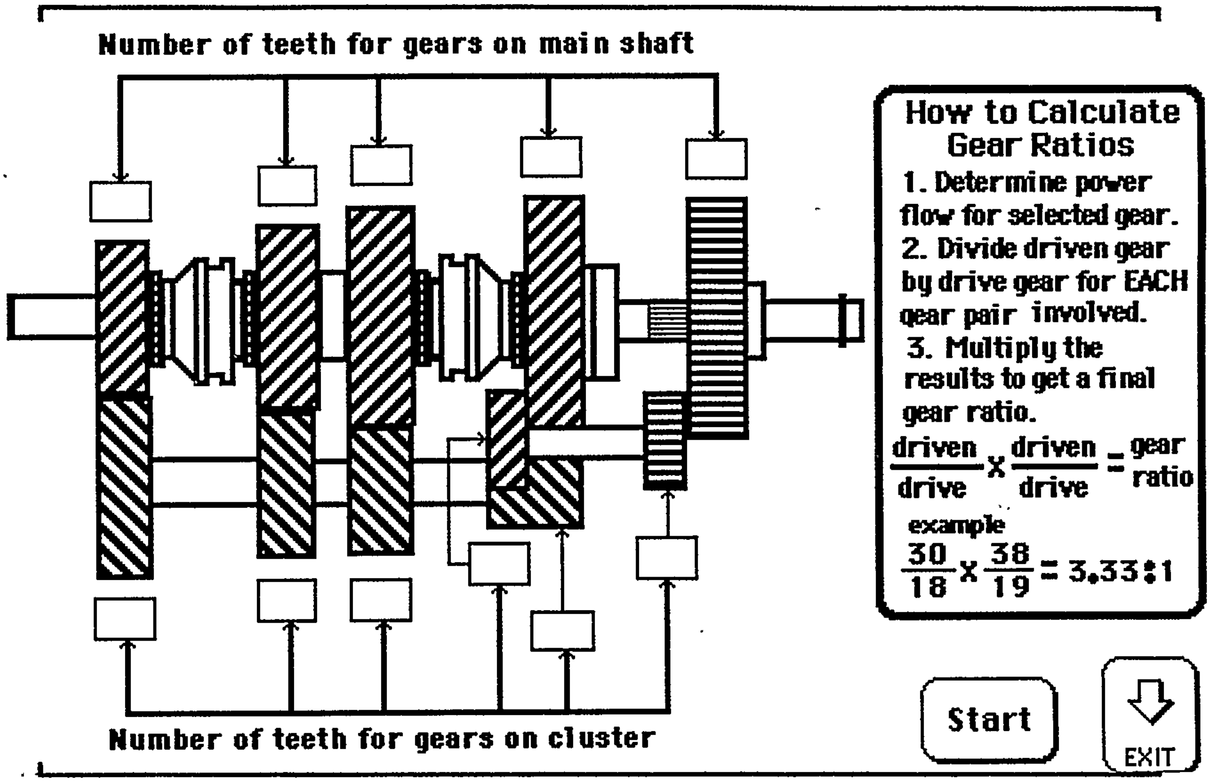


Figure 11. Gear ratio drill screen.

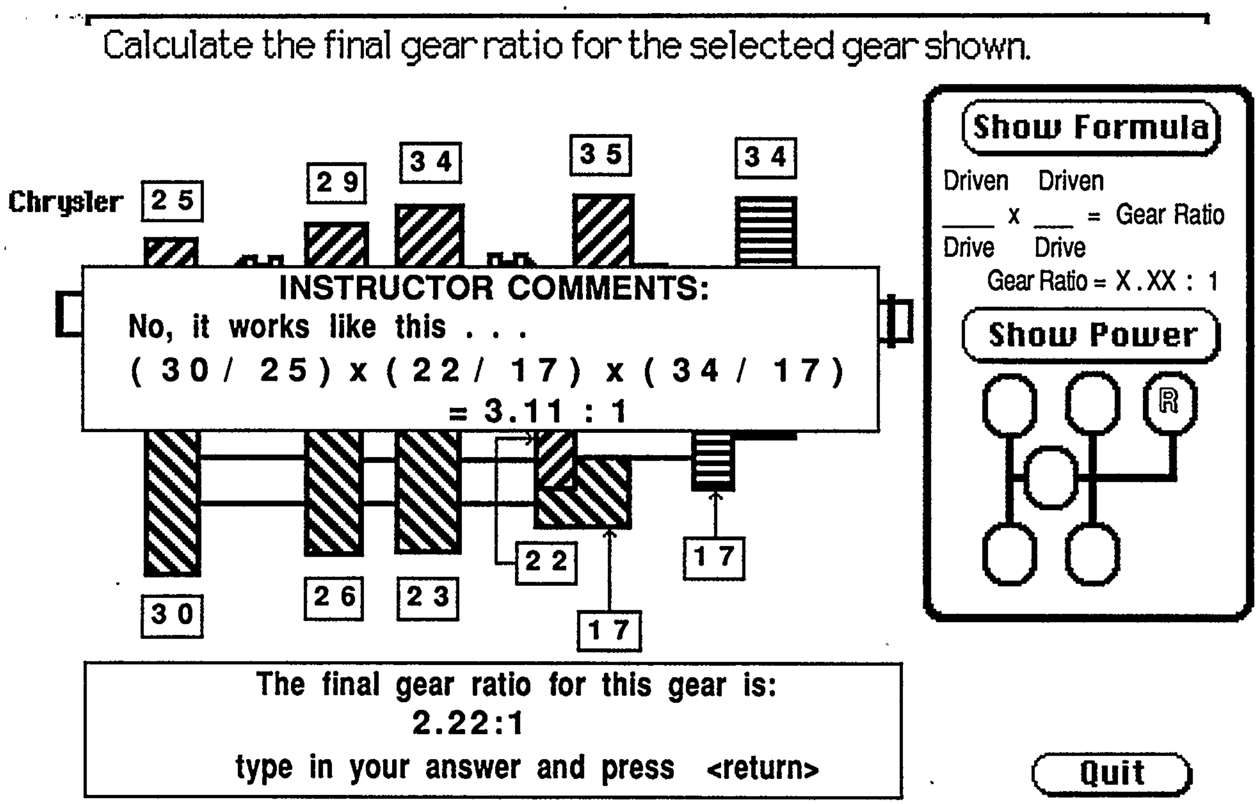


Figure 12. Gear ratio drill after instructor calculation

Senior Technician Office. Until the simulation has started, the senior technician will only display a welcome message and information on the program (Figure 13). After simulation has started, he acts as an expert tutor to guide the the student through the problem diagnosis process and check his/her answers (Figure 14).

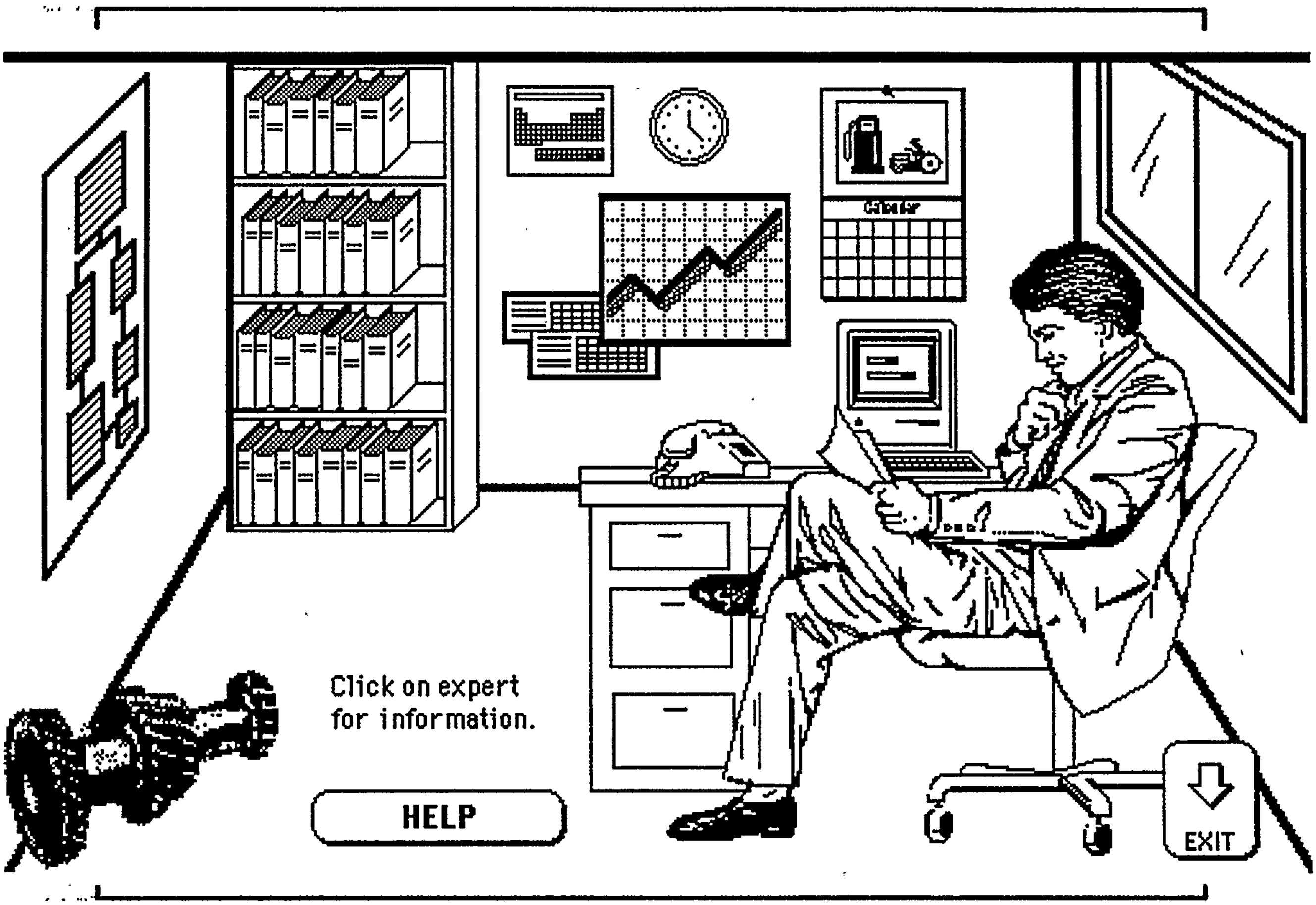


Figure 13. Senior technician office screen before simulation has started.

During a consultation with the Senior Technician, the student may request instructions on what to do next. After some questions on what s/he has done so far, s/he is directed to the next step in the process. If the student has determined what the problem is, the senior technician will question to see if the process has been followed, and will determine if the answer is correct. If it is not, the student will be directed to whatever part of the process requires review. If the answer is correct, s/he will be taken to a transmission (Figure 15) and required to click on the faulty part to repair it.

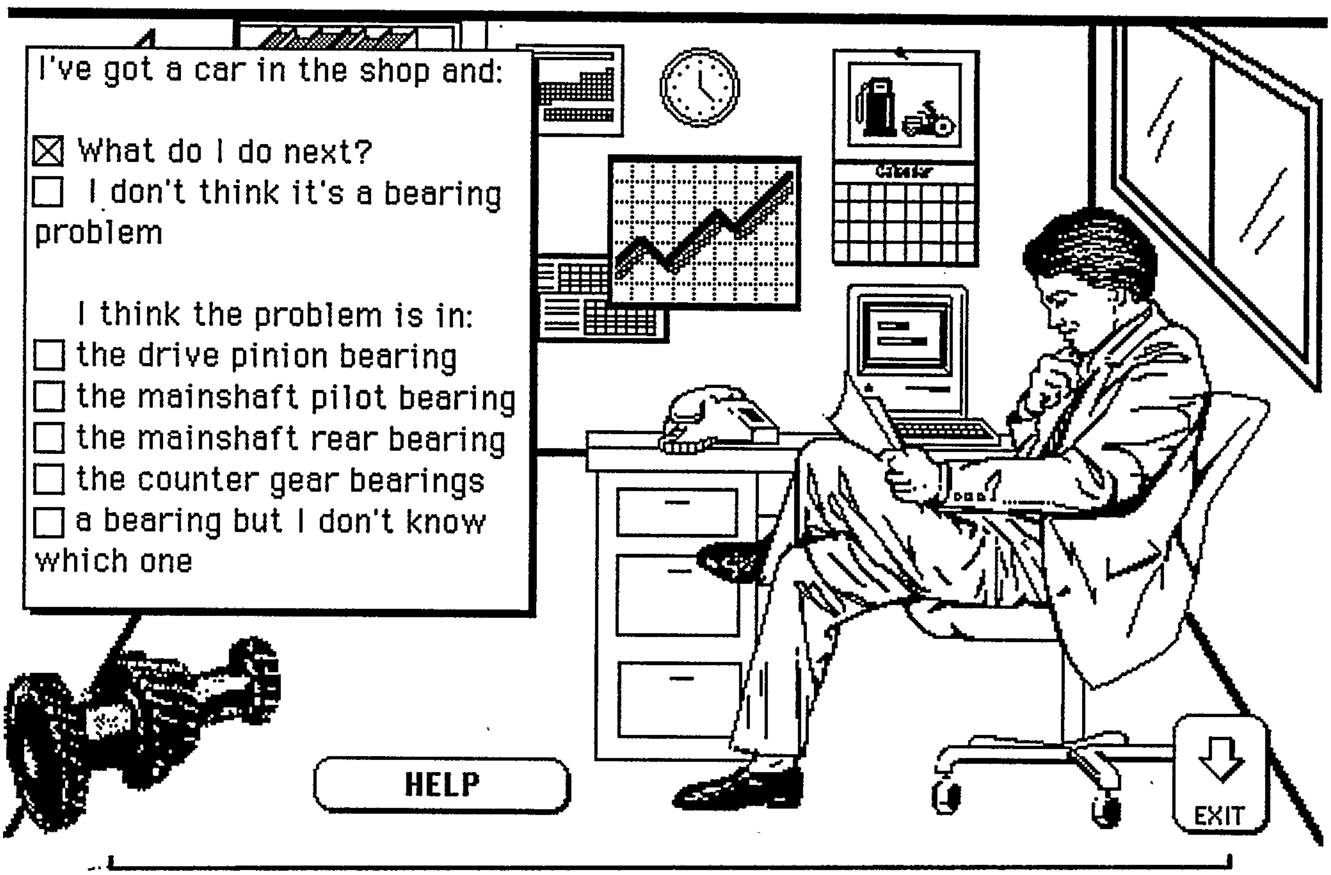


Figure 14. Senior technician office screen during consultation.

If the problem is not in a bearing, the senior technician will direct the student to try the simulation again if s/he has correctly determined that fact. If the student determines that the problem is in a bearing but cannot decide which one, the senior technician will direct him/her to the practice room for review. If s/he still cannot solve the problem, the senior technician will give the answer along with an explanation of how it was derived.

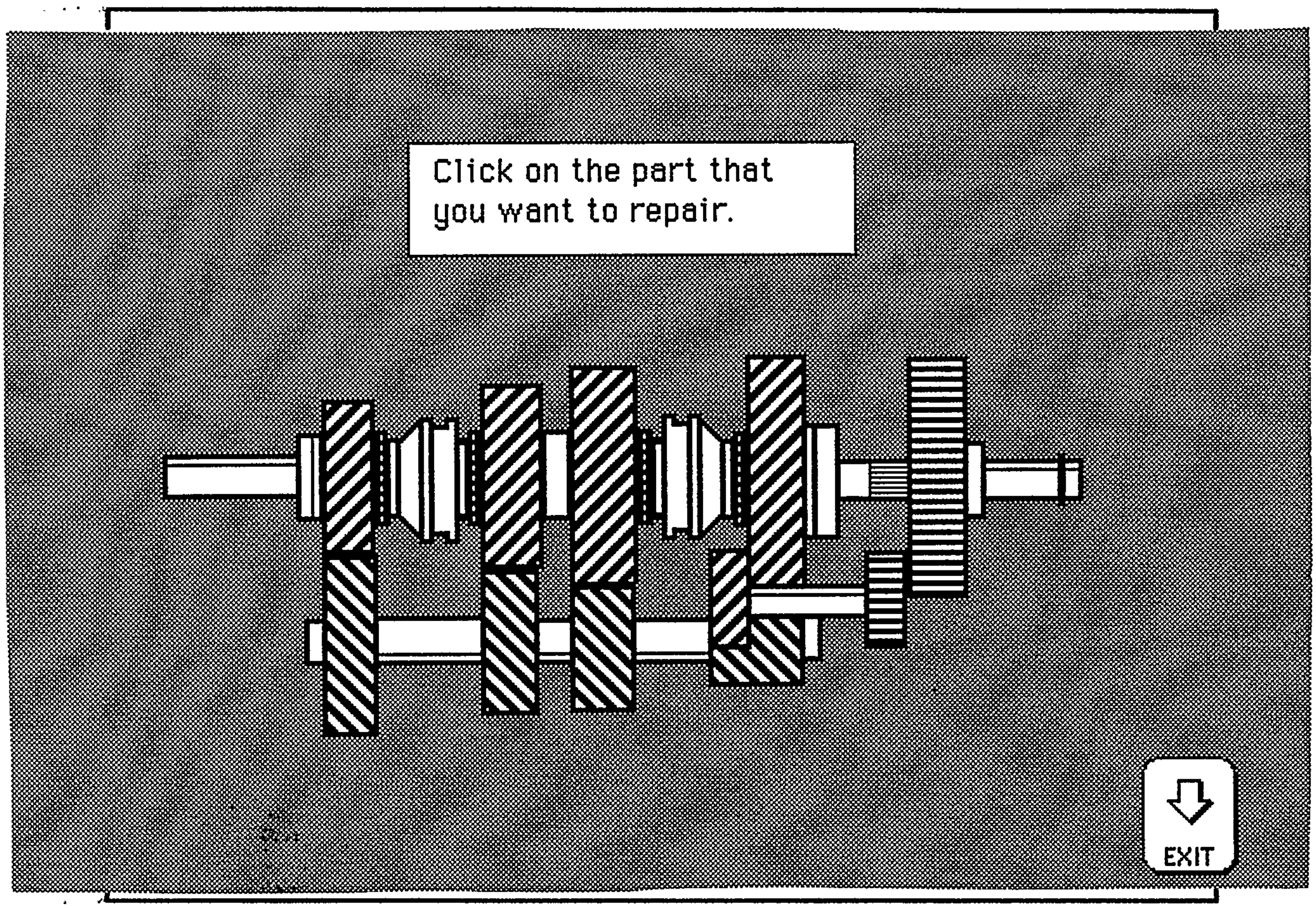


Figure 15. Transmission repair screen.

Program Testing

Review of the program by training and automotive subject matter experts in the Automotives Section of the Southern Alberta Institute of Technology found the program to be technically correct and in accordance with SAIT training principles and philosophy.

Individual students in the SAIT program were selected for trials and ammendments were made to the program. A full class trial of the program occurred in May 1988. Students were introduced to the program and instructed to complete the gear ratio drill, as that was the class topic. One hour was spent with the program in class time. Students were then advised that the program was available to them for use in their own time, and all but one student took advantage of its availability. Test results on gear ratios and transmission bearing problems showed a class average two points above the historical class average for a twenty question test on the subject.

The program was demonstrated to other first year automotives instructors at SAIT in June 1988. Six of the seven instructors attending the demonstration indicated interest in further development of the program