

Evaluating a Computer-Based
On-Job Training System

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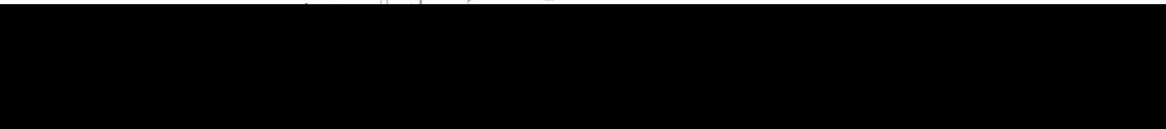
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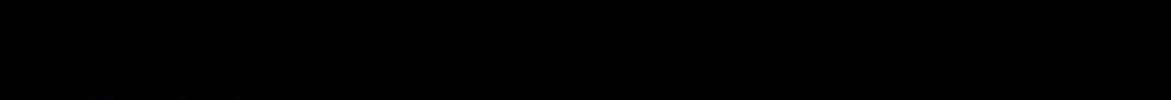
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ABSTRACT

Computer-based training (CBT) often is reported as providing better instruction, less expensively and faster than the traditional, lecture-demonstration methodology. The use of CBT at the job site to provide "on demand", "where required" training has rarely been examined.

This study was designed to determine if a self-paced computer-based on-job training (OJT) system would be as effective and as cost efficient as traditional instruction. The training occurred in a workshop beside the vehicle the student was being taught to maintain.

The study sample consisted of 59 corporals and privates drawn from a number of Regular and Reserve infantry units of the Canadian Forces. Twenty-seven of these soldiers were assigned to the treatment group, with the remaining 30 forming the control group. Quantitative data were collected from Personal Information Sheets, written and practical pre and post-tests of achievement, and Student Evaluation of the Course questionnaires.

The CBT system was significantly better in the areas of knowledge acquisition, per student costs and the time required for the training. The traditional methodology,

however, was significantly better in the area of skill acquisition. The results of the student course evaluations revealed there was no significant differences between the two methodologies.

Based on the results of this study, a computer-based OJT system could provide a viable and cost effective option to the current method of training soldiers to maintain vehicles.

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Chapter 1: Introduction

Background to the Problem

For several years, the Canadian Forces (CF) have been interested in alternative methods of conducting training. To this end, a number of studies investigating various options have been conducted at both the command and National Defence Headquarters (NDHQ) levels - e.g., Maritime Other Ranks Production Study (CF, 1978a), Voice Interactive Maintenance Aiding Device Study [VIMAD] (Hawrylak, 1987), Definition of Requirement for Computer Aided Learning in the Canadian Forces Training System, (CF, 1987e) and A Study of Interactive Training Resource Requirements in the Canadian Forces Training System (CF, 1989e). Since the introduction of the 1987 White Paper On Defence (Government of Canada, 1987), however, both the pace and formal aspect of such investigations have increased. NDHQ has contracted out a survey of civilian institutions to determine which would be interested in conducting trades courses for the CF. The LaRose Report (LaRose, 1989) subsequently formed the basis for a project to create a costing model for conducting training, contracting out training or initiating new or different training methodologies (Donofrio, Hansen, & Syvertsen, 1989). Moreover, a general survey of the status

of the On-Job Training (OJT) program within the CF was completed at about the same time (CF, 1989a). Finally, a number of other projects are presently being conducted to determine how to train the increased number of Reservists envisioned by the White Paper On Defence (Government of Canada 1987 & 1991) and to improve the quality of training of existing members.

The increasing complexity of the equipment currently being introduced into the CF, the mix of materials and equipment already in existence, the part-time nature of the Reserves, the present high attrition rate of trained personnel (both Regular and Reserve) and the high front end costs of training comprise the largest sources of difficulty being experienced by the CF training system (Government of Canada, 1987 & 1991; CF, 1989b; Donofrio et al., 1989). For example, Regular Land Electrical Mechanical Engineer privates receive 183 man days of training prior to reporting to their first unit (CF, 1988b). These graduates are then considered to be apprentices and must undergo an extended period of OJT before being permitted to work on their own. Unless new training approaches and methodologies are implemented, Electrical and Mechanical specialties are introduced, or old equipment is retired enmasse prior to the arrival of any new equipment, this training period is

likely to increase (Department of Defense, 1981). Further, members of the occupation already in units must be upgraded as modifications to existing equipment are promulgated or new equipment is introduced.

The problem is even greater if the Reserves are also examined. Training is conducted one night a week (i.e., three hours) for a specified period of time (such as five, six or seven weeks duration) or during the summer for one to two months. Restrictions in time, equipment, training materials, and qualified training personnel result in a less than adequate product (CF, 1989b & 1989c). Graduates lack detailed knowledge of the equipment they have studied and have little experience in problem solving, trouble shooting, and repairs. Unit OJT programs to rectify these weaknesses are non-existent (CF, 1989b).

The increasing complexity of new equipment is dictated by operational requirements and CF's budget constraints. New equipment must therefore be capable of performing numerous tasks under a variety of conditions, hence increasing its complexity. To compensate for the shortfall in new equipment, the equipment being replaced is often transferred to the Reserves for their use, thus, remaining in the system. Manpower limitations negate the option of specializing personnel. Regular maintainers must therefore

continue to be trained in the repair of this aging equipment so as to provide second and third line support to the Reserves. This results in longer courses so that the technicians can maintain both the new and the old equipment. This in turn imposes an increasingly heavy burden on an already over-strained training system and a force undergoing a reduction in both numbers and operating budget (DOD, 1981).

The overall problem was too large to be adequately dealt with in a study of this nature. It was therefore decided to examine the general category of training methodology.

Statement of the Problem

Presently, many of the Reserve and Regular combat arms units in Canada are experiencing a great deal of difficulty keeping their vehicles in a roadworthy condition (CF, 1984a, 1984b, 1985a, 1985b, 1989d, 1989e, & 1990a). Large numbers of vehicles are unfit to be operated safely and are declared Vehicle Off Road (VOR) - i.e. are not permitted to be driven until such time as the necessary maintenance required to bring them up to standard has been completed. Normally, only 10% of such vehicles are VOR due to a lack of spare parts - the remainder are largely the result of poor driver

maintenance. The reasons for this high VOR rate are many. For the purposes of this research project, however, the study will concentrate on those reasons which are associated with the training of the personnel who perform the actual maintenance (i.e., the drivers). Maritime Command experienced a similar situation with their Solar Saturn Gas Turbine Generators aboard the DDH 280 class of ships (Hawrylak, 1987). In an effort to rectify this situation and reduce the cost of maintenance training within the navy, it initiated a technology research project called Voice Interactive Maintenance Aiding Device (VIMAD). The subsequent evaluation of the project revealed some problems with the configuration of the system tested but the evaluators felt that the concept held merit and should be explored further. In fact, they recommended that the army and the air force should also explore similar systems (Hawrylak, 1987).

The Purpose of the Study

The purposes of this study were threefold:

1. to determine if a self-paced computer-based on job maintenance training system (SCOMTS) would be as effective as traditional, formal training.
2. to examine the impact of such a system on the attitudes and motivation of students.

3. to determine if such a computer-based training (CBT) system is a cost effective alternative to traditional, formal instruction (i.e., lecture-demonstration).

The feasibility of a self-paced CBT system is important to determine for two reasons. First, much of an army unit's mobility is dependent upon its vehicles. Any reduction of this mobility is reflected in a corresponding reduction in its operational capability. Therefore, it is imperative that the greatest proportion of a unit's vehicles remain in a roadworthy condition at all times.

The second reason is more basic. If successful, the study could result in significant savings in the areas of time, effort and money for the Department of National Defence. A viable self-paced CBT system could offer more flexible training programs to both Regular and Reserve unit commanders. Further, it would permit true course portability which, in turn, could facilitate the introduction of distributed training for Reservists. Finally, all such training would be standardized throughout the various commands of the CF.

Chapter 2: Review of the Literature

The purpose of this chapter is to review the findings of researchers and training practitioners who have examined the relationship between CBT and student learning.

Historical Perspective

Until the mid-1960s, the CF were more of a reluctant follower than a leader in the research, development and implementation of new training concepts, methodologies, and technology. A lack of funds and an apparent unwillingness to try anything that was not first incorporated into either the British or American training structures resulted in a situation whereby the Canadian military training procedures and technology lagged ten or more years behind both the civilian sector and our allies (CF, 1985c; CF, 1987d). For example, the Canadian Army Manual of Training 2-38, Principles and Methods of Instruction (CF, 1963), was updated in 1963 to reflect the 1955 edition of the British Army Manual of Training (MOD, 1955). In fact, Figures 19, 20, and 21 (CF, 1963, pp. 104/105) were direct copies of World War II training aids used by both the British and Canadian armies. Further, as late as 1963, widespread use of OJT was not an option for the various arms and

organizations of the Royal Canadian Navy, Royal Canadian Air Force, and Royal Canadian Army. Apprenticeship training in the maintainer trades was the only acceptable form of OJT. CBT did not merit consideration (Thain & Hansen, 1989).

Shortly after the publication of CAMT 2-38, the Canadian military broke with tradition and accepted programmed learning packages as a training option. This was a significant event as the US army had only implemented self-paced learning packages five years earlier and both the British army and the Canadian industrial sector were still examining this option (CF,1987b). Further, the concept of self-paced learning had until that time been considered an aberration to an organization which considered uniformity the foundation of good military discipline and training. The link between programmed learning packages and OJT was not, however, made. OJT was still organized much along the lines of a master craftsman modelling accepted behaviours and procedures to a partially trained understudy (CF,1987b; Thain & Hansen, 1989).

In the late 1960s, the CF took yet another bold step in redefining its training requirements and training system. With the introduction of the CF Individual Training System (CFITS), the Canadian military joined those of the United States and Britain in utilizing a Systems Approach to

Training (SAT) (CF, 1985c). Although 10 years late, the implementation of this more systematic approach established the foundations upon which new training methodologies and technologies were introduced. Formalized within the Analysis and Design phases of the CFITS was a requirement to identify the most efficient and effective method of conducting training (CF, 1985c; CF,1987d). OJT therefore became an institutionalized option within this framework and was applicable throughout all trades and branches of the CF (CF, 1978b). Moreover, it was broadened to include, not only the master craftsman/apprentice scenario, but also organized classes at the job or unit location, the use of Programmed Information Packages, and student participation in significant activities which could not be conducted in the school due to a lack of training time, facilities, opportunity or resources (CF, 1978b; Thain & Hansen, 1989). The utilization of one or more computers to present and/or manage training thus became an option for course designers.

The Canadian military's first foray into the field of computer assisted learning (CAL) occurred during the period 1973-77; 20 years after the US Navy sponsored and directed computer managed instruction (CMI) research by a number of universities and research organizations, and 10 years after the British military implemented general CAL research

studies (CF, 1979; Sapp, 1987; Ledebuer, 1988). A modest trial project was conducted at the CF School of Communications and Electronics in Kingston, Ontario, to determine the viability of and the problems associated with this form of instruction (CF, 1979; Sapp, 1987). Subsequently, several training methodology and technology research projects were initiated under the auspices of Project U-Train (CF, 1979).

In 1983 for example, Project U-Train sponsored an experimental program to examine the effectiveness of self-paced CBT for the teaching of Supply Technicians (Constable, 1986). Unfortunately, the program failed because the CF chose a computer system which ceased to be marketed and supported shortly after it was purchased. Further, both the school in question and the CF transportation and personnel administration organizations were not prepared to permit students to graduate upon completion of the course materials. True to their traditions, these organizations required all students to graduate together on a formal parade. Early finishing students shovelled snow, moved furniture, or were employed in a number of other general duties. This removed any incentive to complete the course early and subsequently affected the performance of the brighter students. Course critiques often contained

comments expressing student dissatisfaction with the boring nature of the materials and frustration with the lack of flexibility within the "system" (Constable, 1986).

At approximately the same time, the Canadian navy experimented with an even more radical form of CBT - a combination OJT system and computer-based job performance aid called VIMAD. VIMAD was borrowed from the US Defence Advanced Research Projects Agency and

... was conceived as a job performance aid that would present procedural instruction from an electronic database. The system would act as a surrogate teacher or a "sergeant on the shoulder," showing by example and controlling the sequence of operations to complete the task...The user would view instructions through an eyepiece on a headset and communicate with the system by voice, allowing the instruction to be delivered while the task was being executed and without requiring the user to take his hands away from the task. The instructional sequence...would step the user through the process in a linear fashion and provide various levels of detailed help depending on the user's level of experience (Riley, Baum, & Vestewig, 1983).

Although the Maritime Command VIMAD Project Final Report (Hawrylak, 1987) stated that the experiment was a success, it was in reality a project ahead of its time and the level of available technology. Users complained about the weight of the helmet, the poor discrimination of the black and white graphics projected on the 2 X 2 inch eye monitor, and the eye strain caused by the monitor being so close to their faces (Hawrylak, 1987). The bulk and difficulty in

assembling the eight foot high stack of electronic equipment required to support the helmet-mounted device also detracted from user enthusiasm (Hawrylak, 1987). Unfortunately, the details of the experiments conducted by both Riley et al. (1983) and Maritime Command (Hawrylak, 1987) were not recorded in either project report. It is therefore difficult to replicate their experiments or validate their findings. It is sufficient to say, however, that VIMAD is currently stored in a room on the third floor of the Naval Operations School (Halifax). Moreover, it was never implemented within the fleet, the navy's training program, nor the US military.

Although both the U-Train and VIMAD projects did not survive the experimental stages, they were successful in another area. They demonstrated to high ranking decision-makers the inherent potential of CBT systems and provided these officers with the justification they required to garner Treasury Board support for a CAL capability project. In July of 1985, Project G-1841 (The CAL Capability Program Development Project) was approved and received funding (CF, 1989k). Since that time, the CF have experimented with or implemented programs to introduce beginning tradespersons to the operational and maintenance concepts of a generic inertial navigation systems (Sapp, 1987), to support the

training of aircraft technicians on the first and second line maintenance tasks on the CF-18 aircraft (Sapp, 1987), to teach electronic warfare (Hansen & Thain, 1988), to support the development of virtual training environments (Kerr & Manning, 1991), to train navy operators and maintainers to perform their duties on equipment new to the CF (Hansen, 1992a, 1992b), and to perform a CMI function in support of training within the CF Fleet Schools (Sekaly, in progress). Further, efforts have been made, through allied country cooperation and technology exchange agreements, to acquire courseware to instruct Rules of the Road (DOD, 1989a), Relative Velocity (DOD, 1989b), and Navigation (DOD, 1989c); and software to support the course management functions of test item analysis (USAF, 1987), and validation (Data & Research Services, 1987).

None of the aforementioned projects, however, permitted the type of self-paced learning engendered in the Project U-Train sponsored Supply Technician Course or emulate the capability of VIMAD. They were, instead, reflections of the lock-step CBT and CMI inherent in the US and British military organizations of the early to middle 1980s. Further, they were all sponsored by either the air or sea elements of the CF. The army is only now examining the opportunities offered by CBT, particularly in the areas of distance learning and distributed training.

Rationale For CBT

In 1988, Ledebuer (1988, p. 13) argued that the rationale for CBT was straightforward. Citing Robert Lynch (1971), he wrote:

It has long been recognized and accepted that no two people learn at the same rate, i.e., learning abilities vary considerably. Each person can learn most effectively when the sequence of instructional material, the pace and mode of instruction and even the style of presentation are tailored to his individual capabilities and desires. CBT offers an opportunity for highly individualized and selective training.

Bruner's writings provided some support for this contention with the statement that "Since learning and problem solving depend upon the exploration of alternatives, instruction must facilitate and regulate the exploration of alternatives on the part of the learner. (Bruner, 1967, p. 43)." Again, well designed CBT permits such exploration.

Holding's work did not, however, support either of these contentions. He maintained that only two types of learning occur - information, and serial or procedural learning. In the first instance, information is presented, the student is tested on it, and then feedback is provided (stimulus-response). The feedback motivates and directs the student in the right direction. In serial learning, the skill is broken into sub-skills or sequences and these are taught individually and then integrate in a linear fashion. In both cases, however, differences in individual student

learning capabilities, desires, or capacities are not taken into consideration. Therefore, one type of instruction fits all needs (Holding, 1965). Early forms of drill and practice CBT fall within this view.

Gagné (1975, 1985, 1991) extended the ideas of Bruner and Holding and brought them closer to Lynch's assertion. He maintained that the sequence of instructional materials, the pace and mode of instruction, and the style of presentation must not only take into consideration the student's capabilities, but also the desired type of learning outcome. Intellectual skills, cognitive strategies, attitudes, and motor skills require different arrangements of the events of instruction. He was not, however, specific as to the methodology or technology which would best suit these requirements. He felt that it was the course designer or teacher's responsibility to arrange the external learning situation so as to accommodate all these factors. CBT may be but one option in this process.

The Advantages of CBT

In 1983, Kearsley argued that all military commissioned CBT applications are predicated on the need to improve the effectiveness and efficiency of the training, and to reduce its long term resource requirements. From these overall

goals, course designers derive a number of more specific objectives. He identified eleven definitive reasons for utilizing CBT. For the purposes of this discussion, however, some of these have been combined. The resulting seven reasons are amplified as follows:

Improved Control. Control over the various aspects of the training process is of great interest to most large organizations such as the military. CBT, more than any other methodology, provides these organizations with both the amount of flexibility and control they demand. At the macro level, training can be made uniform and can be established at a level of standardization which is optimal for organizational needs (Ledeboer, 1988). Unlike most traditional methodologies, this level is never compromised because of the personality, confidence, experience, or physical and psychological health of the instructor. The training is designed to identify the needs of the individual student and then adapt the instruction to address those needs (Semb, Ellis, Montague, & Wulfeck, 1991). The number of students per class and their varying backgrounds do not impact on the level and method by which the materials are presented. Finally, all students receive the same entry, progress, and final tests, and are required to perform at the same level in order to advance.

At the intermediate level, CBT provides the instructor with the means to monitor every aspect of the student's performance and then provide assistance where required (Ledeboer, 1988). In addition to test scores, the CMI function of CBT records student decision points, the paths taken through the materials, the areas not examined, the time spent on each portion of the lesson, and those areas, if any, where the student experienced difficulty or repeated instruction for one reason or another (Palmarozza, 1990). The instructor uses this data to evaluate the student's instructional prescription. He/she then determines both the validity and reliability of the criteria - this is very important with weaker students or in hypertext situations (Ledeboer, 1988; Thomas, 1991). Finally, the CMI function provides the instructor with more control over the report writing process (Ledeboer, 1988).

At the micro level, CBT provides the individual student with a measure of control over the type and the amount of information or skills he/she requires in order to do the job, and the learning path to be followed (Woods, 1988). The details of micro level control overlap with individualization of instruction and will be discussed in that section of this paper.

Improved Quality of Training. The quality and effectiveness of instruction are major concerns for most training establishments and educational institutions. New ideas and technological innovations are continually being examined and their impact on the learning process investigated. This has resulted in numerous research studies being conducted to both evaluate these ideas and methodologies and to determine their effectiveness in comparison with what is already being done within a particular organization. Few technologies have, however, received more attention and study than the area of CBT (Shlechter, 1986; Shlechter & Boldovici, 1987).

Research findings on the effectiveness of CBT are often mixed. The reports indicate that gains in student effectiveness range from little or no effect to substantial gains. Critics argue that researchers are displaying the outcomes of a technology vs a methodology, therefore, effectiveness studies are inappropriate (Shlechter, 1986; Shlechter & Boldovici, 1987; Ledebouer, 1988). Researchers, however, maintain that in suitable educational and training environments, CBT yields significant improvements in student achievement and transfer of training over conventional

instructional methods (Carter & Perkins, 1991). As Colonel Aldrich (1991) noted:

CBT is not simply a better, more efficient way of doing the same old job of training. It gives us a chance to go far beyond finite, parochial specialism. CBT gives us opportunities we never had before, opportunities for remediation, for flexible, objective testing, (Aldrich, 1991, p.79).

Since 1980, there has been a proliferation of research on the efficacy of this training medium (Clements, 1986; Dalgaard, 1984; Kulik, 1983; Kulik, Bangert, & Williams, 1983; Kulik & Bangert-Drowns, 1984; Kulik & Kulik, 1987). Dazed and Hulvershorn (1983), for example, found that achievement scores for CBT and conventional instruction were equivalent. Burns and Bozeman (1981) noted that 45% of their students had greater achievement, 40% experienced no change, and 15% had mixed results. A small experiment utilizing CBT for the teaching of the fuel management systems of the C-141 and C-5A aircraft ($N = 26$) revealed that the experimental group ($n = 13$) exceeded the specified proficiency standard. Moreover, the experimental group achieved a mean proficiency rating across the eight tasks examined which was significantly superior ($p < .001$) to that of the control group (Edwards, 1986). In Marrero and Chin's (1991) study, CBT taught students scored significantly higher ($p < .01$) on knowledge tests than did

the control group. There was, however, no significant difference between the groups for three of the four performance tests. On the last performance test, the treatment group again performed significantly better ($p < .05$) than the control group.

There are many reasons for the effectiveness of properly designed and implemented CBT. For example, CBT is a more controlled environment than traditional instruction (Stephenson, 1990). Most programs follow an algorithm which reduces the spontaneous variability in the learning environment. Since CBT often utilizes the latest in technology, it is also more state-of-the-art. Finally, procedural tools may be built into a CBT course to better manage the instruction (Stephenson, 1990). This management function permits the early identification of student problems and the implementation of appropriate remedial action.

Modern CBT also permits the combining of many different types of material into one application (Falk & Carlson, 1988; E.J. Hansen, 1989). Courseware designers have the opportunity of employing still pictures, graphics, overlays and animation in their lessons. This reduces the requirement for complicated written descriptions of

situations, procedures or equipment. The visual impact of the program is particularly important for those of lower-level reading skills (Woods, 1988).

The technology also permits the use of high fidelity simulation which can result in faster learning (Wenig & Wolansky, 1972; Wilson, Olmstead & Texler, 1972; Jones & Smith, 1988; Straker, 1988; Lewick-Wallace & Jask, 1988; Leonard, 1989; & Watts, 1989) and quicker transfer of newly acquired knowledge and skills to work environments (Podagrosi & Taylor, 1988; & Woods, 1988). The relevance of both the context and the content of the material has a significant impact on learning (Woods, 1988). CBT tutorials and simulations, more-so-than traditional instruction, permit the positioning of materials in realistic or near realistic settings (Thomas, 1991). The student is therefore not required to make the mental jump from presentation of material in class to actual application.

Others believe that the effectiveness of CBT rests in its ability to address the cognitive style of the learner (Cheney, 1980; Post, 1987; Whyte, 1991). At the macro level, CBT can be designed to be adaptive to the cognitive style of the individual learner rather than the learner being forced to adapt to the organization of the training (Semb et al., 1991; Thomas, 1991; Whyte, 1991). At the

micro level, each interaction can be carefully designed to "draw the student into" the training and encourage him/her to interact with the content rather than the training system. Interactive courseware is usually designed to respond in a user friendly, conversational way (Thomas, 1991). All feedback is appropriate and encouraging, thereby ensuring that students understand the materials being taught (Bruner, 1967; Gagné, 1975, 1985; Gagné & Briggs, 1979; Kearsley, 1983).

The practice provided by CBT is another factor which contributes to improving its training effectiveness (Kearsley, 1983). Practice provides students with an opportunity to increase their skill levels and retention rates. This in turn facilitates the transfer of these skill and knowledge elements to the job (Bruner, 1967; Gagné, 1975, 1985; Gagné & Briggs, 1979).

CBT also frees the instructor from the chalkboard and permits him/her to do other things (Straker, 1988). He/she is also released from many of his/her administrative and supervisory roles and is permitted to spend more time and energy assisting individual students, preparing lessons, or supervising the class (Azbell, 1988; Horton, Levitt, & Givens, 1988; Leonard, 1989). As immediate supervisors are often the on-job trainers in military organizations, this

freedom permits them to spend more time supervising both their workers and the students - in effect reducing their own workload (Carpenter-Hoffman, 1973, 1980).

Finally, a combination of the above factors, if properly integrated, can result in more interesting, challenging, and dynamic lessons than lecture-based instruction alone (Peters & Ranger, 1988; Reese, Eastmond & Sutherland, 1988; Leonard, 1989). Students, regardless of age, are forced to take an active part in the learning process. This increases time on task (Larsen, 1987; Podagrosi & Taylor, 1988; Underwood, 1988; Reese et al, 1988), intrinsic motivation (Wenig & Wolansky, 1972) and the expectancy for success (Goble, Cole, & Holland, 1988). Students advance at their own pace and can overlearn through additional practice if required (Wenig & Wolansky, 1972; Goble et al, 1988; Semb et al, 1991). Further, all learning activities are completed in a confidential manner, therefore, students are encouraged to overcome fear of failure and develop a willingness to seek alternate solutions to problems (Falk & Carlson, 1988; Lewick-Wallace & Jask, 1988). Finally, the nature of the media permits almost immediate access to all materials in the program, thus reducing distraction time for students and retaining their interest (Chambers, 1987).

Reduced Resource Requirements. One of the most pervasive findings in the CBT literature, both civilian and military alike, is that the use of CBT generally results in reduced resource requirements over extended periods of time (Manion, 1985; Palmarozza, 1990). The nature and level of these savings, however, is a source of some debate among training technologists, educators, and researchers. Many researchers determine "life cycle cost savings by estimating operating costs and personnel costs which would accompany implementation of new programs..." (Shlechter, 1986). Others examine only the life cycle costs associated with a program and exclude the initial out-lay costs when determining the nature and extent of these savings (Christiansen, 1985). The military, however, views life cycle cost and savings estimates as a function of outlay, operating, and personnel costs. Savings are accrued by reducing training time, maintenance to training support equipment and damage to said support equipment (Shlechter, 1986; Shlechter & Boldovici, 1987; CF, 1988b; Hansen, 1988; Podagrosi & Taylor, 1988). Lost opportunity costs (i.e., those costs or opportunities the organization must accept or forego in order to utilize its personnel, equipment, facilities and resources for this use (Head, 1985)) are also occasionally factored into military training cost estimates (CF, 1988b; D.G. Hansen, 1989).

Regardless of which costing model is chosen, the literature supports the contention that CBT results in cost savings for both training and educational establishments. For example, both self-paced and group-paced CBT permit organizations to make better use of their instructors by eliminating the need to repeatedly teach basic material (Azbell, 1988; Palmarozza, 1990). This not only helped to optimize instruction but also reduced lost opportunity costs (Head, 1985). Moreover, in those circumstances where incremental staff (i.e., instructors provided by units or organizations outside the control of the training establishment) were employed in support of training, self-paced CBT resulted in savings in the areas of reduced costs for rations, accommodations, separation and temporary duty allowances and, in some instances, travel. Student costs in these areas were similarly reduced (CF, 1988b; Hansen, 1988; Palmarozza, 1990; Marrero & Chin, 1991).

Ledeboer (1988) and Carter and Perkins (1991) found that properly designed and integrated CBT course management functions required fewer standards and administrative personnel, and fewer facilities to maintain records and administer the training. Further, the tracking capability inherent in this function permitted staff to determine the

rate of progress for each student in particular and the class in general. This facilitated the accurate forecasting of such resource requirements as training devices or real equipment, and the subsequent delivery of the minimum number necessary to support the training. For example, classes which normally required 15 sets of electronic testing equipment and computer boards for practice purposes, required only eight sets due to the differential rate of progress achieved by the students on the self-paced materials. Management staff were able to quickly determine this requirement and ensure that only eight sets (plus one spare) were delivered at the appropriate time. This reduced both the number of pieces of equipment required, and the cost of maintaining and storing these items (Podagrosi & Taylor, 1988; Leonard, 1989; Carter & Perkins, 1991).

Podagrosi & Taylor (1988), Buckley (1991), and Marrero & Chin (1991) found that various forms of CBT reduced the requirement to use real equipment or trainers for practice purposes. Brockett (1988) and Podagrosi & Taylor (1988) noted that it also permitted instruction to be provided on the internal operation of a piece of equipment without having to tear it apart, thereby reducing the risk to the students, the equipment, and the environment. These factors in turn reduced acquisition, operating, maintenance,

support, and replacement costs, as well as those costs which were incurred in the event of injury to one or more students (Hansen, 1991).

The final area where cost savings may be realized involves those situations where the cost of an instructor's time is difficult to justify - i.e., when only one or two people need to be trained (Marrero & Chin, 1991). Brockett (1988) and Marrero & Chin (1991) found that in such circumstances, an interactive training program with a good record keeping utility better met the need of providing more cost-effective instruction than traditional classroom training. Moreover, the flexibility of CBT systems permitted training to be scheduled when it was most convenient and cost-effective for the organization (Brockett, 1988).

Efficient Use of Training Time. The efficient use of training time has a major influence on resource utilization. The longer a course runs, the greater the resources dedicated to and eventually consumed by that course (CF, 1986a). Course length also impacts on the number of students which can be taught. The shorter the course, the more students that can be taught per year within a dedicated resource parameter (i.e., specified number of instructors,

facilities and resources). Therefore, the greater the number of students taught the more cost effective the course (CF, 1986a).

Although costs are important in their own right, the operational impact of the training requirement is often more critical to commanders. Specifically, the faster a qualified serviceperson can be produced by a training establishment, the greater the flexibility and operational capability that is afforded to the operational commander. A military organization which has a significant portion of its personnel away on training for extended periods of time is far less effective than a similar organization which has the same number of personnel undergoing training for far shorter periods of time. The time required to train a serviceperson also becomes critical in those situations where large numbers of personnel require training frequently, or during mobilization for war (Ledebøer, 1988).

It is often reported in the literature that CBT requires less training time than standup instruction. Shlechter (1986, p.5), for example, cited a 1985 Orlansky study that noted:

...the median savings time for 19 military studies when compared to conventional instruction was 30 percent with a time savings range of -31% to 89%. These studies have also failed to find any noticeable decrements in students' learning associated with spending less time in instruction.

Palmarozza (1990) reported that CBT required 25-35% less time than conventional instruction. Dazed and Hulvershorn (1983) found that CBT required 37% less time than the conventional instruction. In his review of the literature, Sivley (1989) noted that time savings may even reach as high as 40% of the teaching time. His own study produced a 60% time saving with CBT.

There are many reasons for the range in the time savings noted above. Some of the figures cited are for self-paced CBT, some are for lock-step CBT, and some are for peer tutored CBT. Regardless of which set of figures are chosen, however, the data and the literature support the contention that CBT will result in training time savings when compared with conventional instruction.

Timeliness and Availability. Kearsley (1983), CF (1986a), Goble et al (1988), Crawford (1989), and Shlechter (1990) all maintained that CBT is ideal for providing training "on demand" and "where demanded". The individualized, self-paced nature of most CBT provided this "on demand" capability (Ledebouer, 1988; Semb et al, 1991). Organizations were also afforded the flexibility to conduct the training when either they have the requirement or when the students were available.

CBT permits training to be broken into smaller, more directly applicable segments, thus reducing the amount of skill and knowledge which is lost during that period of time when the individual receives instruction and the time he/she actually employs his/her new skills and knowledge on the job (Goble et al., 1988; Martinez, 1990). It also minimizes the amount of time the individual is away from his/her primary duty (Goble et al., 1988). For military commanders, this translates into higher unit operational readiness and capability (Palmarozza; 1990). Moreover, it reduces the amount of attrition currently being experienced because service personnel are frustrated by the amount of time they spend on course and away from the job they enlisted to perform (Crawford, 1989; Palmarozza, 1990).

CBT can be provided "where demanded" due to the portable nature of the medium (Carter & Perkins, 1991; Semb et al., 1991). This is possible because the computer administers the lessons, practices and tests, and tracks scores, dates, times and other data (Brockett, 1988; Thomas, 1991). Operations, therefore, do not have to shut down while personnel are in training. Moreover, the type of OJT envisioned in the VIMAD, Hand Held Tutor, and CHIP programs can be implemented (Riley et al., 1983; Goble et al., 1988; Holland & Wisher, 1990; Shlechter, 1990). Students would

not be required to travel to off-site locations, thus reducing costs and lost productivity time, and maximizing the use of available equipment and facilities (Lubin, 1988; Thomas, 1991). Further, expert assistance from supervisors and more experienced co-workers would be readily available (Lubin, 1988).

The twin "on demand" and "where demanded" capabilities of CBT are currently receiving very close examination from the US and Canadian militaries for the purpose of training Reservists (Crawford, 1989; CF, 1989b; Quinones, 1990). The traditional part-time soldier has limited time available for training. Parades usually occur two nights per week and one saturday per month. Courses of varying durations are offered during this period, as well as during the summer months. Parade time must be divided among courses, normal administration, medical and dental examinations, drill, and physical fitness. Further, individuals may miss training due to illness or job conflicts. Finally, training conducted during holiday periods usually conflicts with family plans and commitments. Training, therefore, often resembles a catch-as-one-catch-can affair. The flexible nature of properly designed and implemented CBT can help to overcome these limitations (Crawford, 1989; Quinones, 1990).

Individualization. The individualization of instruction is closely associated with advantage number one (Improved Control) and impacts directly on all the others. As Butler (1985, p. 12) noted, "...students are not merely passive receptacles for information; they continuously interact with incoming data and alter them to suit their needs or a particular situation." Courseware designers should, therefore, prepare their materials to address not only the objectives of the course, but also the preferences of the individual and the manner in which he/she processes information (Gagné, 1975; Semb et al., 1991). This is particularly important when training adults (NAPCAE, 1975). Adults are more experienced with attending and perceiving, and have established their own patterns (Gagné, 1975; NAPCAE, 1975; Semb et al., 1991).

When properly designed and employed, the self directed aspect of individualized instruction permits students "to establish meaningfulness and organize their own structures to relate subordinate principles to larger context (Ausubel, 1968; Gagné, 1975, p. 13)." Further, they are able to link these principles to the immediate and long term goals of both the instruction and the reasons for the training. In essence, they create their own process of expectancy (i.e., what they expect to happen as a consequence of their

learning activity) and instills within themselves the anticipation of the reward he/she will obtain when they achieve these goals (Estes, 1972). This is an important factor in motivating students to learn. Gagné (1975) considered this motivation as the all important precursor or first phase of learning. If the student is not motivated, learning will be severely curtailed.

Taken as a whole, individualized instruction attempts to address those personal characteristics, capabilities, and interests which affect a student's ability to learn. Specifically, it takes into consideration an individual's:

... present attitudes, interests, motives, values and needs; general information-processing and learning skills and habits; perception of the present arrangement of the environment; previously acquired knowledge and skills related to that which is to be learned; general education level; past experience with various teaching/learning methods; specific aptitudes, as measured by aptitude tests; and general intelligence as measured by IQ tests. (Butler, 1985; p.12).

Butler (1985) felt that these factors affected learning outcomes more than aptitudes. "There is no single nor general aptitude for learning; the individual has many different aptitudes at different levels, depending on the kind of learning and the subject matter involved (Butler, 1985, p.14)." He also noted that:

...the amount of time allowed for learning has an equally significant impact on the effects of the individual situation and on the outcomes of the process. Theoretically at least, every student can master a particular learning task if each is given as much time and help as needed. In fact, the effects of individual differences tend to disappear when students proceed at their own best rates. Although additional time may be a very effective means of addressing individual situations, time alone does not determine the level of mastery. We should allow every student enough time to complete the learning process, and so to master the learning task, but the amount of time will be determined by their individual situations and by the quality of the learning situation as well (all of this is a strong argument for individualized instruction) (Butler, 1985, p.14).

Improved User Satisfaction. The literature usually reports that CBT fosters positive attitudes towards the instruction in general and the methodology in particular. For example, Marrero & Chin (1991) noted that their students ($N = 15$) felt that CBT was easy to operate (93%), easy to follow (86%), reduced the time required to learn the task (87%), adequately prepared them to perform the task (80%), and provided information in a more organized fashion (87%). Further, 80% of those interviewed felt more instruction should be presented via CBT. Packer (1988) found that adults, in particular, were enthusiastic about the way his CBT program permitted them to compete against an "expert" when completing assignments. Ledebor (1988) and Carter & Perkins (1991) observed that student participation was high

with CBT. Students liked the ability to tailor the system to their needs, the graphics were seen as providing more realism, and the feedback provided by most CBT programs enhanced motivation. Shlechter (1990) found that his students ($N = 85$) were favourably impressed with the US Army's Hand Held Tutor program. Twenty-five made only positive comments towards the program while two students made only negative comments - the remainder expressed generally positive observations. The provision of immediate feedback and the ability to recall screens and information were two highly cited positive attributes of this instruction. Azbell (1988) and Marrero & Chin (1991) also noted that their students were generally enthusiastic about and positive toward CBT. Analysis of post-course attitude surveys revealed that student interest remained at a consistently high level throughout programs, and both their understanding of concepts and their enjoyment increased from beginning to end. Finally, Eisenberg (1986) found that 96% of her students ($N = 311$) indicated that learning by computer was interesting or very interesting, 78% stated a preference for learning by a computer program over learning from a book, and 92% indicated that they would like to learn another subject by computer.

Many of these studies compared some form of CBT with traditional, lock-step classroom instruction in order to determine which of the two forms of instruction was most efficient and cost effective. Apart from Eisenberg's (1986) study, student attitudes were not a major criterion - they were usually solicited out of interest. In 1985, however, the US Navy Personnel Research and Development Center initiated a research project which was specifically designed to compare self-paced and group-paced instruction on training effectiveness, training efficiency, and student attitudes and motivation (McDonald, Hurlock, Ellis, & Whitehill, 1989). Students were randomly assigned to the group-paced ($n = 150$) and to the self-paced conditions ($n = 115$). Next, they were subjected to the Armed Services Vocational Aptitude Battery to identify differences between the members of each group - there were none. Finally, specially designed attitudinal surveys were completed at the end of the training.

McDonald et al (1989) confirmed much of what had been determined by the less formal examinations of student attitudes. Students in the self-paced condition, for example, expressed more confidence in their ability to perform well in the course and to apply themselves to study than did the group-paced students. Moreover, they felt

more pressure to complete the training and felt more satisfied with how much they were learning than did the group-paced students. Conversely, group-paced students felt more strongly than did self-paced students that they would keep working at dull material until finished. Group-paced students also complained more than their self-paced counterparts about the amount of time they had to spend studying.

Instructional Design Applied to CBT

The creation of a CBT course without the organizing structure and discipline of instructional design principles is a hit-or-miss proposition (Johnson, 1985). As explained by Gagné & Briggs (1979), Dick & Carey (1985) and Gagné (1991), designing instruction goes beyond merely outlining topics to be covered. Attention must be paid to the external conditions which "...activate and support the learning of the individual student... (Gagné & Briggs, 1979, p. 4)", as well as, the student's own internal conditions which facilitate learning (Gagné, 1975, 1985). "These conditions are in turn dependent upon what is being learned (Gagné & Briggs, 1979, p.13)." The systematic design of instruction (SAT) requires that both a rationale for the training and a focus be identified at the very beginning of

the design process. Without this clearly enunciated statement of intent, the planning and implementation phases will lack the necessary direction to ensure that the subsequent training meets the requirements of both the student and the end-user (Gagné & Briggs, 1979; Dick & Carey, 1985). The identification of the tasks, the skills, and the knowledge required to perform a job are all guided by the overall goal(s) and rationale for the training. Further, the organization of both the external and internal learning conditions are affected by the parameters set by the goals and the rationale.

The SAT has many iterations. Gagné & Briggs (1979), for example, described a methodology they called Instructional Systems Design (ISD).

Figure 1. Stages in Designing Instructional Systems (Gagné & Briggs, 1979, p.23)

System Level

1. Analysis of Needs, Goals and Priorities
2. Analysis of Resources, Constraints, and Alternate Delivery Systems
3. Determination of Scope and Sequence of Curriculum and Courses; Delivery System Design

Course Level

4. Determining Course Structure and Sequence
5. Analysis of Course Objectives

Lesson Level

6. Definition of Performance Objectives
7. Preparing Lesson Plans (for Modules)
8. Developing, Selecting Materials, Media
9. Assessing Student Performance

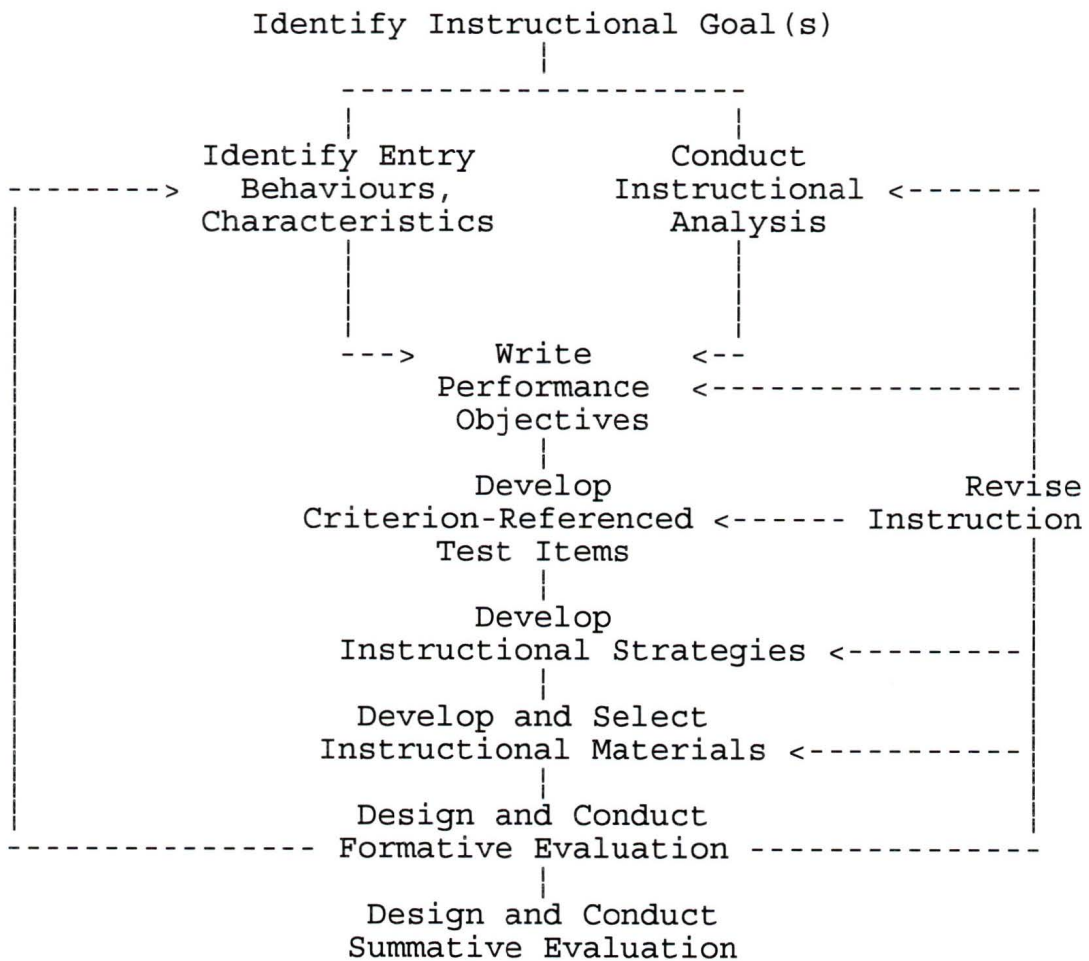
Systems Level

10. Teacher Preparation
11. Formative Evaluation
12. Field Testing, Revision
13. Summative Evaluation
14. Installation and Diffusion

As illustrated in Figure 1, the ISD model is a 14 stage methodology which encompasses three levels of responsibility. Each stage is not, however, a discrete entity, but, rather, is a constantly changing phase of the design process. "If properly employed, there is much working back and forth between the stages as the design work progresses (Gagné & Briggs, 1979, p.40)." It should be noted this is the current methodology used by all branches of the United States government and its armed forces.

The Systems Approach Model is another form of SAT (Dick & Carey, 1985). This model, however, appears to be aimed at a lower, more specific level of instructional design than the model proposed by Gagné & Briggs (1979).

Figure 2. The Dick and Carey Systems Approach Model for Designing Instruction (Dick & Carey, 1985, p.2)



As indicated in Figure 2, student entry behaviours and characteristics are identified very early in the design process. This model, therefore, appears to make a more concerted effort at designing the training to suit the needs of the individual rather than having the individual meet the requirements of the training.

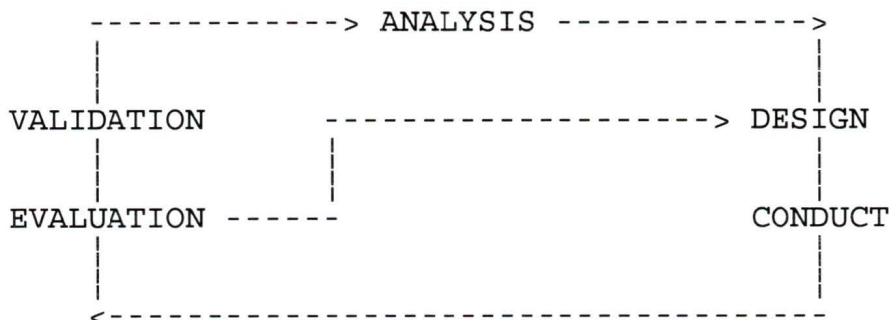
Conversely, the ISD model appears to take the latter approach. A training shortfall is identified, the course goals are set, the instruction is designed to address the various intellectual skills and learning strategies inherent in students, and a set of prerequisites are established for the course. The student comes to the course with these prerequisites and engages in training which has not identified his/her educational background, linguistic orientation (if applicable), attitudes towards the instruction, field dependency/independency and sex.

The two models also differ in the stage at which the instructional delivery system is identified. Gagné & Briggs (1979) made this determination during Stage 3 of their model - well before the conduct of the instructional analysis (Stage 5) and the writing of the performance objectives (Stage 6). Dick & Carey (1985), on the other hand, performed these functions prior to selecting a delivery system. This difference in approach has at least one

significant implication. Developers using Gagné & Briggs' model could easily select a delivery system which does not accommodate the instructional material. Specifically, the decision could be made to use CBT for materials which are not stable or are situation specific. This happened to the American Express Corporation in 1985 and resulted in significant monetary and human resource expenditures keeping the courseware current (Rampy, 1986).

The materials employed in this study were prepared utilizing a paradigm which combines the best facets of both these and other ISD models. The Canadian Forces Individual Training System (CFITS) is a combination SAT and management model which controls the quality and the quantity of training, as well as the various resources dedicated to all aspects of the training (CF,1987a). Moreover, like most SAT models, the procedures defined in this model are "...supported by instructional theories (i.e., theories which prescribe manipulations of instructional variables and conditions hypothesized to improve learning)... (Kintsch, Tennyson, Gagné, & Muraida, 1991, p.18)."

Figure 3. Phases of the Canadian Forces Individual Training System (CF, 1987c, p.2-2-2).



As depicted in Figure 3, each component or phase of the CFITS is essential and is linked with the other phases. Further, "each phase may consist of a series of processes conducted by individuals or organizations and has clear cut responsibilities (Carter, 1989, p.3)." The system continues to refine the training to respond to changing requirements based upon the interactions of one or more of the phases.

The Analysis Phase of the CFITS corresponds to all or parts of the functions and responsibilities associated with Stages 1 through 6 of the ISD model and Steps 1 and 4 of the Dick & Carey model. The first stage "...includes all the activities related to determining, defining and documenting a training requirement resulting from a newly-created CF job or changes to an existing one (CF,1987c, p.2-2-2)." A detailed and objective examination of the job is conducted to identify the skills, knowledge, and characteristics a

serviceperson must possess in order to successfully perform that job. This process is called an Occupational Analysis and results in a document called a Specification (CF, 1988a; CF, 1989g).

During the Task Analysis stage, both the task list in the Specification and the Occupational Analysis data are re-examined to determine whether training is or is not required for each specified task or task element(s) (CF, 1989g). The components are then organized into a structure which reflects both the overall view of the job as a whole and the interdependencies among tasks. Further, overlaps in skill, attitude and knowledge needs and sequences in operations are identified. Performance objectives are developed for those tasks requiring training and are written in the format advocated by Mager (CF, 1988c). Next, the designers determine whether the performance objectives can be achieved more effectively by formal course or on-job training (CF, 1987c). Finally, a Course Training Standard is produced (CF, 1989f).

The Course Training Standard provides the critical guidelines for student evaluation, and identifies the planning factors, resource requirements and constraints that must be considered during the development, design, and conduct of training. It also defines the general aim of the training relative to CF operational needs (CF, 1987a; CF,

1988a; Carter, 1989). Although the Course Training Standard may impose some resource limitations on the training agency, it does not specify how the training will be conducted. Unlike the ISD model, this decision is based upon the results of the Instructional Analysis step of the Design Phase - much like Dick & Carey's model.

The Design Phase corresponds to all or parts of Stages 5 through 12 of the ISD model and Steps 2 through 8 and part of Step 10 of the Systems Approach Model. The overall aim of this phase is to develop a training strategy and detail the learning activities and environment(s) which will ensure the performance objectives defined in the Course Training Standard are achieved efficiently and effectively. The major design activity is called the Instructional Analysis and usually follows the procedures detailed by Dick & Carey (1985). The performance objectives listed in the Course Training Standard are analyzed in order to identify the supporting (or enabling) knowledge, skills, and attitudes required to achieve each objective.

Gagné (1985) is commonly utilized at this point to identify specific strategies for teaching discriminations, facts, concepts, rules, principles, and problem solving. Questions of what to teach and how to teach it effectively are addressed "...by prescribing a system of classifying

learning outcomes with a corresponding set of instructional strategies or steps... (Okey, Santiago, & Peters, 1988, p.3)." Explicit direction is provided on the preparation of the introduction to a lesson to ensure the learner's attention is gained, purposes are communicated, and prerequisites are recalled (Okey et al., 1988). In essence, designers utilize Gagné's (1985) Cognitive Theory to incorporate the processes of learning and thinking into the design process (Kintsch et al., 1991). The resulting design decisions, teaching strategies, and directions to instructors are incorporated into a series of enabling objectives.

All objectives are then grouped into the order most likely to facilitate learning. Progress and enabling checks are designed and the training methods, media, and instructional environments for each performance objective are examined to determine which will provide the most cost-effective and instructionally efficient combination. The resource requirements for the selected instructional strategies are subsequently identified. All this material is then integrated into a training management plan called the Course Training Plan (CF,1987c; CF, 1989h.). Finally, a formative evaluation process consisting of one-on-one, small group and pilot courses are conducted to determine the effectiveness of the training design (CF,1987c; CF, 1989h).

The activities associated with the Conduct Phase of the CFITS closely resemble similar steps or stages of both the ISD and the Systems Approach models. The aim of this phase is to produce a serviceperson who successfully achieves all the performance objectives. To accomplish this, the courseware designer organizes the materials to specifically address the nine instructional events which are present in any learning situation.

Figure 4. The Instructional Events Present in All Learning Events (Gagné & Briggs, 1979, p. 165; Gagné, 1992, p. 1).

1. Gain attention
2. Inform the learner of the objective
3. Stimulate the recall of prerequisite learning
4. Present the stimulus material
5. Provide learning guidance
6. Elicit the performance
7. Provide feedback about performance correctness
8. Assess the performance
9. Enhance retention and transfer

The guidelines listed in Figure 4 ensure that course materials are presented in a manner which capitalizes on the current understanding of the mental processes involved in knowledge acquisition. Training effectiveness and efficiency are thus maximized. Further, like both Gagné &

Briggs (1979) and Dick & Carey (1985), concepts from several distinct areas of learning theory - i.e., the cognitive, affective, and psychomotor domains - are integrated into the courseware. It should be noted, that for CBT courseware, these activities fall within the parameters of the Design Phase and occur prior to the drafting of the Course Training Plan (CF, 1989h).

The Conduct Phase also includes the management of the learning process so as to ensure student motivation and the successful attainment of the stated performance objectives. Good order and discipline are enforced so as to maximize a productive learning environment and individual student progress is monitored and remediation provided where required. Individual counselling and progress reports are provided at regular intervals throughout the training (CF, 1987c.; Carter, 1989).

During the Evaluation Phase, students are assessed to determine if they have achieved the performance objectives defined in the Course Training Standard. This is accomplished by means of progress, enabling, and performance checks. The efficiency of the training is also examined at this time. Student prepared Course Critiques, and independent evaluations by the appropriate command, help to determine the effectiveness of the training. Student

evaluations are documented in the Individual Course Report form, while the efficiency and effectiveness of the training is incorporated into a Training Evaluation Report produced by both the school and the responsible command (Carter, 1989).

Validation is the very important final phase of the CFITS. This is the process by which the training structure verifies that the training provided has adequately prepared the graduate to perform his/her operational job (CF, 1989i). In effect, both the appropriateness of the performance objectives in reflecting the job requirements and the graduate's ability to satisfy them are verified. Changes in the job, and their subsequent impact on the training requirement, are also identified during this phase. Finally, validation data are used to identify problems in areas other than training which may also have an adverse affect on job performance (e.g., selection standards, design of equipment, career incentives, etc.).

Summary

The points of note from the literature review are as follows:

1. The CF have not been leaders with respect to the employment of CBT and CMI materials. The implementation and

utilization of a SCOMTS would, therefore, be a major change for a hierarchical and centralized organization dedicated to lock-step instruction.

2. There are differing views of the effects of CBT programs when compared to traditional, classroom courses. Houston (1988) found no significant differences between the two methodologies. Jones & Smith (1988) and Podagrosi & Taylor (1988), however, found that students who completed CBT instruction made one third the errors and completed the material in two thirds of the time it took the others. Moreover, they were more confident with the equipment and required less assistance from the instructor.

3. CBT has had a number of advantages. The technology permits designers to incorporate many types of media in their courseware (Chambers, 1987; Falk & Carlson, 1988). The materials themselves increased time on task thereby reducing the amount of time required to complete the lesson (Larsen, 1987; Peters & Ranger, 1988; Podagrosi & Taylor, 1988; Leonard, 1989; Reese & Sutherland, 1989). Further, it helped to reduce equipment breakage and economize on facilities and equipment (Podagrosi & Taylor, 1988; Leonard, 1989). Finally, these materials permitted the teacher to spend more time providing personalized assistance to students (Carpenter-Hoffman, 1980; Straker, 1988).

4. CBT offers large organizations the degree of control they demand of a training system. At the macro level, the control results in the degree of standardization of instruction required by the organization's needs (Ledeboer, 1988). At the intermediate level, CBT provides the instructor with the means of monitoring student progress and provide remediation where required (Semb et al, 1991). At the micro level, the student is permitted to set the pace of instruction to match his/her personal learning style and requirements. This increases motivation, comprehension, and retention (Gagné, 1985; Ledeboer, 1988; Kintsch et al., 1991; Thomas, 1991).

5. Properly implemented CBT can result in significant cost and resource savings over time. Depending on the cost benefit analysis model utilized, these savings will occur in the areas of time, money, personnel, and physical resources, plant, and lost opportunities (Head, 1985; CF, 1988b; Hansen, 1988; Palmarozza, 1990; Marrero & Chin, 1991). Further, CBT permits increased efficiency per designated resource parameter (Carter & Perkins, 1991) and permits the forecasting of resource requirements (Podagrossi & Taylor, 1988; Leonard, 1989). Finally, the use of CBT reduces the risk both to students and equipment (Podagrossi & Taylor, 1988; Buckley, 1991; Marrero & Chin, 1991).

Chapter 3 - Rationale, Definitions and Hypotheses

Rationale

The rationale for the study lies in the areas of knowledge and skill acquisition, and cost effectiveness. If a SCOMTS can produce a trained serviceperson with knowledge and skill levels equal to those of a serviceperson who receives instruction by formal classroom methodologies, unit commanders will have the means to increase equipment serviceability rates, reduce equipment down time, lower maintenance costs, and enhance unit operational effectiveness. This type of system could also be used in training centres, operational and Reserve units, static bases, or wherever military personnel are involved in maintenance activities. Finally, it could be employed as a continuation trainer or computer-based job performance aid (Anderson, 1987).

Definitions

Armoured Vehicle General Purpose (AVGP). A family of six wheel, all-terrain armoured vehicles used by the Canadian Army (Dominico, 1990, p.1).

Computer-Based Job Performance Aid. A computer controlled type of job aid that is both a detailed and a step-by-step algorithmic type of aid (Anderson, 1987).

Enabling Objectives (EO). State the performance, conditions and standard of a particular knowledge, skill or attitude essential to the attainment of the Performance Objective. They are a group of facts, information, or procedures that relate to performing a task (CF, 1989f).

Family of Vehicles. Two or more vehicle types based on the same chassis (CF, 1982). A category of vehicles, on the other hand, is a group of similar types of vehicles (e.g., tanks) based on different chassis.

First Parades. First Parades are those checks the driver, with the assistance of crew members, performs before driving a vehicle for the first time that day. The exterior and interior of the vehicle are inspected for fluid leaks and broken or damaged safety devices. Fluid levels are also checked to ensure that all are within the required ranges and are not contaminated with either dirt or water (CF, 1982).

Garrison Conditions. That situation whereby a unit is not deployed on operations but, rather, is occupying a set of barracks and base facilities. This state also exists when a unit occupies a set of buildings on a base other than its own (Hansen, 1989).

Halts (Halt Parades). Halts are those checks the driver, with the assistance of crew members, performs when the vehicle is going to remain stopped for an extended period of time, but will be used again later in the day. They are carried out prior to turning the vehicle off and include an inspection of the exterior, interior and engine of the vehicle (CF, 1982).

The Head Training Cost Analysis Model (Dependent Variable for Hypothesis 3). A practical guide for identifying and comparing student, instructor, instructional development, facilities, maintenance and lost opportunity costs (Head, 1985).

Information-Processing. "The processes that one must conceive in order to explain the phenomena of learning are those that make certain kinds of transformations of inputs to outputs in a fashion somewhat analogous to the workings of a computer (Gagné, 1975, p. 15)."

Interactive/Interactivity. This is used to refer to a set of learning experiences which require students to process information, participate in a learning activity, receive feedback to decisions made, and make further responses based on that feedback (Atkins & Blissett, 1989).

It is comprised of three basic intellectual skills:

- a. the ability to acquire information and make a response;
- b. the ability to anticipate questions and have a response; and
- c. the ability to apply knowledge learned from past experience (Woods, 1988).

Last Parades. Last parades are those checks the driver, with the assistance of crew members, performs when the vehicle is about to be shut down for the day. Again, they include an inspection of the exterior, engine and interior of the vehicle (CF, 1982).

Learning. "It is a process which typically involves interaction with the external environment. Learning is inferred when a change or modification of behaviour occurs, which persists over relatively long periods during the life of the individual. (Gagné, 1975; p.6)."

Land Forces Headquarters. That command structure responsible for the conduct and control of land or land related operations. It consists of all the elements of the field army and those air elements assigned to support army operations.

Occupation. Jobs of a general class regardless of command or organizational lines - eg., administrative clerk, vehicle mechanic, or supply technician. These would correspond to civilian trades (CF, 1988a).

On Job Training (OJT). OJT is comprised of two parts. First, it is that portion of training which falls between a formal training program and the final certification of a qualified tradesperson. It, therefore, involves training to develop job skills, enhance job knowledge, and provide job experience. Second, OJT is that training which provides a serviceperson with the specific knowledge and skills to fulfil the requirements of his immediate job (CF, 1987b, 1989a).

Performance Objectives (PO). The job-related objectives or goals that the servicemember works towards achieving while he/she is under training (CF, 1988c). The PO for this study is attached as Appendix A.

The Systems Approach to Training (SAT). The process of planning instruction which makes use of research and learning theory and employs empirical testing data as a means for the improvement of the designed instruction (Gagné & Briggs, 1979, p. 39)."

Vehicle Off Road (VOR) Status. The state whereby a vehicle is considered to be in an unroadworthy condition. This status may reflect safety problems or such a poor physical state of repair that any operation of said vehicle could result in damage to it or injury to its occupants.

Voice Interactive Maintenance Aiding Device (VIMAD). This is a maintenance course based upon "a carefully designed multi-media database that can be controlled by voice command. The courseware contains the required maintenance steps and explanations and is controlled by single word command menus. The video is supplemented by audio support which is synchronized to the appropriate video frame (Hawrylak, 1987)."

Hypotheses

The focus of this study was to determine if a self-paced CBT program would provide effective OJT. Specifically, it examined the following hypotheses:

- H-1. There will be no significant difference in the post-test written exam scores between those soldiers receiving instruction by means of a SCOMTS and those who undergo formal classroom instruction as measured by the Written Performance Check in Appendix G.

- H-2. There will be no significant difference in the practical maintenance scores, as measured by the Performance Checks in Appendices D-F, between those soldiers receiving instruction by means of SCOMTS and those who undergo formal classroom instruction.
- H-3. There will be no significant difference in resource costs between the SCOMTS training and the formal training as measured by the Head Training Cost Analysis Model (Head, 1985) as expressed in Appendices P & Q.
- H-4. There will be no significant difference in the amount of time a CBT student will require to complete the SCOMTS instruction and traditional instruction.
- H-5. There will be no significant difference in the student evaluation of the instruction between the SCOMTS training and the formal training as measured by the Student Evaluation of Course Materials survey at Appendix H.

Chapter 4: Method

Setting

The primary reason for this study was to determine if SCOMTS could produce as effective a serviceperson as formal, classroom training. As implied by this statement of intent, the setting for the training encompassed at least two locations. In fact, the formal training was conducted at 3PPCLI's home in Work Point Barracks in Esquimalt, British Columbia. The CBT, however, was conducted in a number of different locations in the provinces of Ontario and New Brunswick.

As noted, the training of the Control or Traditional Group occurred in the General Delane Building of Work Point Barracks, Esquimalt. The theoretical portion of the training was conducted in a normal classroom environment, while the practical instruction occurred in vehicle bays located in the lower part of the building. Classroom instruction was presented to the course as a whole while vehicle bay instruction was conducted in six man groupings called sections. The sections were further sub-divided into one instructor and three student groupings for the purpose of demonstrating vehicle parts and maintenance procedures.

All the instructors had taught on at least one previous AVGP course and had received instructor training at sometime during their careers.

The CBT occurred in the vehicle maintenance complex of the Combat Training Centre, Gaagetown, New Brunswick; at the Militia Training Coordination Centre, Petawawa, Ontario; and in the base maintenance facilities of base Borden, Ontario. All instruction took place inside adequately lit and heated buildings with washroom and canteen facilities readily available. The evaluating non-commissioned officer and the experimenter provided on-site supervision and assistance. The instructional materials were presented on up to five MS-DOS based 486 DX2 66 MHz personal computers, with VGA colour monitors, placed on trolleys beside either Grizzly or Cougar variants of the AVGP. Access to both the facilities and the training materials was limited to duty hours.

Subjects

The participants for this study consisted of 57 reserve and regular infantry privates and corporals who ranged in age from 17 to 25 years ($M = 19.95, SD = 1.52$) and had at least a grade nine education. Approximately two thirds of the participants had completed their basic army training within 18 months of the study. The remaining one third had

completed their training during the period 1988 - 1992 and had later attended advanced training of some type, including eight who had received training on cargo or tracked vehicles. Four fifths of the entire group had some contact with the AVGP prior to commencement of training. This contact ranged from riding in the vehicle to assisting with such tasks as washing the vehicles, stowing equipment and cleaning out the interior. Finally, only two participants indicated they had received extensive training on automotive mechanics in school.

Privates and corporals were chosen for this study because these are the working ranks in Reserve and Regular infantry units. Further, they have the least amount of contact or experience with the AVGP of any group in a battalion. Servicepersons of the master corporal or higher ranks were discounted because they are supervisors and are less likely to become involved in the regular, hands-on maintenance of the vehicles. Moreover, the majority of the supervisors will either hold the AVGP qualification or have extensive contact with the vehicle.

Intervention

The intervention consisted of a hypertext computer-based OJT package which had been prepared in Microsoft Word for Windows 6.0 and converted into CBT utilizing the Help

Assistant Authoring Software version 3.0 (St Pierre, 1993). The program taught members of the CBT group how to perform the First Parades, the Halts, and the Last Parades on the AVGP as described by Performance Objective 404 (Appendix A) and the Enabling Objectives contained in the course training package (CF, 1986b, 1989j). The program was organized in a manner that permitted the individual soldier to control both his/her own pathway through the materials and the level of the instruction required. The short path through the materials simply consisted of a checklist of the procedures to be completed. A Glossary Button provided the trainee with access to a glossary of both graphical images (where applicable) and textual explanations for unknown items, concepts, or words. Movement forward and backwards through the materials was controlled by two buttons. A Contents Button permits instantaneous access to the main and subsidiary menus. Finally, hot spots and hot words provided the trainee with hypertext-links to more detailed graphics, information and explanations.

Prior to the actual programming of the module, the storyboards and the concept were subjected to formative evaluation using nine members of the Naval Operations School, Halifax. Although not members of the target population, these sailors were able to provide feedback on

logic, flow, organization and reading level of text which resulted in a number of changes. Once compiled, the CBT module was tested on different members of the Naval Operations School to ensure the concerns of the first group had been adequately addressed. Again, modifications to the program were made, including the removal of the practice problems at the recommendation of the trial members. Although Montague (1988) and Terrell (1990) both indicated reviews and practice questions were important, the experimenter decided to remove them because the empirical evidence did not indicate how much review or how many practice questions were important. Time and a lack of subjects precluded a third trial before using the module for the study.

Instrumentation

Pre-test and post-test scores for this study were obtained from both skill and knowledge tests for First Parades, Halts, and Last Parades (Appendices D-F). A Student Evaluation of Course Materials, containing some attitude measuring questions, was also administered to the candidates (Appendix H).

Skill Test. The skill test for First Parades, Halts, and Last Parades was derived from an existing checklist

published in C-30-550-000/MS-000 First and Second Line Maintenance Instructions for Vehicle Hull on Car, Armoured Wheeled, 6X6, Diesel - AVGP (CF, 1982). This checklist contains the major items to be inspected during the various parades, but does not specify what corrective action must be taken in the event that a fault is discovered. It was, therefore, necessary to develop a more comprehensive error checkoff system which could be administered by an evaluator as the student performed the First Parades, Halts, and Last Parades on an AVGP (Appendices D-F). This was accomplished with the assistance of the 3PPCLI Maintenance Officer and his senior Non-Commissioned Officers.

The resulting draft test was examined by the Regular Support Transport Sergeant for the Halifax-based militia Service Battalion, and a Sergeant and a Warrant Officer from the Combat Training Centre vehicle maintenance establishment for both accuracy and suitability. The "approved" test was then subjected to a trial using three graduates of the AVGP Driver's Course. Minor modifications were made to the instrument and a second trial was conducted using 12 candidates of a course just being completed.

Two Master Corporals, not involved in the initial review and evaluation of the checkoff test, were chosen to validate the skill test instrument. Each Master Corporal

was asked to use the developed format to evaluate the drivers while they conducted First Parades, Halts, and Last Parades on three different vehicles. Both Master Corporals evaluated each of the candidates in turn as they performed First Parades on one vehicle, Halts on a second vehicle, and Last Parades on a third vehicle. The checkoff lists for each candidate were then gathered and the scores tabulated. Reliability was calculated by dividing the total number of agreements by the total number of agreements plus disagreements and multiplying by 100 (Secan, Egel & Tilley, 1989). This resulted in a reliability score of 96% for the instruments.

Knowledge Pre- and Post-Tests. The 3PPCLI AVGP Driver Wheel Course package contains a test bank of Threshold Knowledge Tests and final exams. Instructors randomly select one of each type of test for that particular course to prevent the handing down of questions from students on one course to those on the next. All test questions have been validated over time and have been the subject of test item analysis.

For the purpose of the experiment, those questions pertaining to the material covered by the SCOMTS module were extracted from the existing test bank. A pre-test and a

post-test were then compiled by randomly selecting questions from each knowledge area (Appendices C & G). For example, all questions pertaining to the types of fluids used during the various parades were identified and were assigned numbers. A set of dice were rolled to determine the number of the question to be used on the pre-test. The dice were rolled a second time to identify the question to be used on the post-test. In some instances, this resulted in the same question appearing on the two tests.

Unfortunately, the resulting tests contained mostly low level questions. It was, however, decided to use these instruments in order to derive an accurate comparison between the formal training, as it really existed, and the computer-based intervention. Further, it was felt that the skill pre-test and post-test would provide the indepth measure of student learning.

Both the pre- and post-tests consisted of 11 short answer and multiple choice type questions, some of which contained a number of sub-parts. Each answer, or appropriate sub-answer, had a one point value. The maximum score possible was 25.

Due to the distance separating the control and the experimental groups, the same set of pre- and post-tests were used in both instances. All 57 candidates completed

the knowledge pre-test immediately before attempting the skill pre-test, and the knowledge post-test prior to completing the skill post-test. Knowledge tests for both groups were completed in classroom settings, while the skill exams were conducted on the vehicles themselves. The knowledge tests were marked by the experimenter, while the skill tests were conducted by an examiner with the experimenter providing a reliability check.

Student Evaluation of Training Questions. The Student Evaluation of Course Materials Survey at Appendix H was produced from questions drawn from a number of other more complex surveys which had been developed for experiments designed specifically to examine candidate views regarding either traditional forms of training or CBT and the quality of the instruction presented. As such, individual items had been validated as part of the previous experiments.

The questions were specifically designed to assess the technical quality of the materials, derive candidate feelings as to the value of the module, and derive personal feelings about the method of training. Although the questions in the first two categories were designed primarily as check-off items, space was provided should the

candidate desire to elaborate on his/her observation. Items requesting personal feelings on the method of training were open-ended questions.

The appropriateness of the survey items were tested using naval personnel undergoing Ship's Communications System training for the new patrol frigates. A control group was established from personnel who completed the traditional standup training conducted by the Canadian Patrol Frigate Detachment in Halifax. The experimental group consisted of those candidates who took the same training using the Computer-Based Training System module.

Prior to employing the surveys, two experienced trainers were asked to rate each question as to what it would measure or what type of information it would provide. The same two individuals were then asked to examine the results. Where students responded, the type of information provided was generally of the type predicted from the initial review of the surveys.

Other Data. Each student completed a Personal Information Survey prior to commencing training (Appendix B). Other data available from these questionnaires included;

1. age
2. educational level in years of schooling
3. time in the military
4. previous military experience
5. previous contact with the AVGP

Time Required for Training

To ensure the consistent and accurate recording of how long it took a subject to complete the training, the instructors were directed to note the exact times and dates students initiated and ended each training session. The start time was then subtracted from the end time to derive a training time in minutes. A total training time (in minutes) was obtained by adding the total instruction time, the total practice time, the pre-test times and the post-test times.

Costing Model

The Head Costing Model (Head, 1985) was used in this study. The following general equation was derived from this model to summarize the costing of the training:

$$\text{Cost} = \text{Per student Cost} * \text{number of students} \quad (4.1)$$

The general equation was then broken down to the component parts which address the specific requirements of the two types of training as follows:

$$\begin{aligned} & \text{Cost of classroom approach (\$) -} && (4.2) \\ \text{Course cost} &= (((\text{WI} + \text{WS} + \text{CF} + \text{CT} + \text{CTOM} + \text{CE} + \text{CEOM}) \\ & \quad * \text{HR}) + (\text{CBSP} * \text{TD})) * \text{N} + \text{CTM} \end{aligned}$$

$$\begin{aligned} & \text{Cost of CBT approach (\$) -} && (4.3) \\ \text{Course cost} &= (((\text{WI} + \text{WS} + \text{CF} + \text{CCBT} + \text{CCOM} + \text{CCE} + \\ & \quad \text{CEOM}) * \text{HR})) * \text{N} + \text{CTM} \end{aligned}$$

where: N = number of students per course
 WI = Cost of wages per hour per student for instructors
 WS = Cost of wages per hour per students
 CF = Cost of facilities per hour per student
 CT = Cost of developing traditional courseware (amortized over 10 years) per hour per student
 CTOM = Cost of operating and maintaining traditional courseware per hour per student
 CE = Cost of equipment (amortized over 5 years) per hour per student
 CEOM = Cost of operating and maintaining equipment per hour per student

CCBT = Cost of developing CBT courseware (amortized over 10 years) per hour per student

CCOM = Cost of operating and maintaining CBT courseware per hour per student

CCE = Cost of computer equipment (amortized over 5 years) per hour per student

CCEO = Cost of operating and maintaining computer equipment per hour per student

CBSP = Cost for Base support per day per student

CTM = Flat rate cost of training materials/handouts per student per course

HR = Number of hours required for the training

TD = Number of full or partial training days required for the course

Procedure

The study consisted of the following six phases:

Phase I (Staff Training). As noted earlier, this study was conducted in four different areas of the country. To reduce the training requirement and to maintain consistency of trainee evaluation, only those personnel with previous instructional experience on the AVGP Driver Course were used as staff. Further, all instruction, training and evaluation procedures followed standard CF formats.

To minimize the threats to external validity due to reactive experimental arrangements and assessment procedures, the Deputy Commanding Officer of 3PPCLI directed that both the staff and the students comprising the Traditional group not be told they were participating in an experiment until the Student Evaluation of Course Materials were completed. The course was, therefore, conducted as per normal arrangements with the only changes being the introduction of the new data measurement instruments.

The staff for the CBT group required training in order to ensure the consistency of results from the three experimental locations. This training consisted of an explanation of the study and the instruments to be used therein. They were then introduced to the intervention package, worked their way through the materials and participated in a series of discussion sessions on how best to provide any assistance required by the trainee and the limitations to this assistance.

Three inter-observer agreement checks for each set of staff were conducted during the course of the study. Reliability was calculated by dividing the total number of agreements by the total number of agreements plus disagreements and multiplying by 100 (Secan, Egel & Tilley, 1989). The inter-observer agreement scores for the staff were: Gagetown 98%, Petawawa 93% and Borden 96%.

Phase II (Training of Control Group). This phase consisted of one regular training serial consisting of 16 Regular and 14 Reserve corporals and privates drawn from 3PPCLI and local militia units. The training of the Control Group followed standard military practice with, depending on the subject, theory being presented to either course or section groups. The demonstration and practice portions of the course occurred at the section and sub-section levels. The standard of instruction was monitored by the Course Commander and the Course Warrant Officer and resulted in the removal of one instructor for lack of motivation and for not preparing his lessons. Testing occurred at a site co-located with the training site. No instructor evaluated members of his section.

During testing, each subject was provided with a standard military Work Ticket and was then directed to perform First Parades on one vehicle, Halts on a second and Last Parades on a third. To ensure the evaluator understood what the student was examining and why, a talk aloud protocol was employed. The evaluator recorded all steps made, the order in which they were made, any errors made in those steps, any errors made in the student's explanations, and any outside errors.

Phase III (Treatment). The Treatment Phase consisted of one trial utilizing 15 Reserve and 12 Regular corporals and privates drawn from a number of Reserve and Regular infantry battalions. The entry level of each subject was determined through the use of both a knowledge and a skill pre-test. The subjects were then introduced to the SCOMTS and were briefed on the objectives and the organization of the course as per normal DND training procedures. Next, they were provided with individualized training schedules and dismissed to their normal duties or other training. Individualized schedules were utilized due to the existence of only five SCOMTS and the requirement not to interfere with normal unit operations.

As the name implies, the CBT module was designed to be used as both an OJT package and a job performance maintenance aid. Therefore, all of the instruction was completed beside an AVGP. The subjects were told to work through the package in the order of their preference. They were to read the materials and immediately relate the information to the vehicle to their front. Further, they were encouraged to perform the appropriate inspections as they finished a part of the module. In this way, it was hoped to increase the realism of the training, provide confirmation of learning and improve both retention and student motivation.

The subjects were allotted 13 training hours to complete the courseware, the practice sessions, the knowledge test and the skill performance check. They were permitted to proceed through the course at their own pace and were free to review the material in the order of their choice and as many times as they wished. Normal supervision and assistance was provided by the instructor. He also supervised the knowledge final examination. The experimenter and the evaluator conducted the skill check utilizing the instruments contained in Appendices D-F and followed the same testing procedures utilized for the Control Group.

Phase IV (Analysis of Results). During this phase, the data for the pre-tests, post-tests, times required to complete the training and the per student costs of each methodology were subjected to a series of statistical manipulations. All calculations were performed using two different computer-based statistics packages - MYSTAT and David P. Doane's program (Doane, 1988). The significance for this study was set at the $p = .05$ level.

Phase V (Analysis of Student Evaluation of the Training). The foundations for this analysis have been established in the literature review. Survey items were

drawn from studies described therein, were standardized, and were examined by Training Development Officers for validity (See Appendix H).

Students were asked to rate (on a scale ranging from 1 to 5) their feelings about the instruction in the areas of: program effectiveness, ease of use, the author's writing style, and the value of the program in preparing them for the Performance Check. They were then asked to rate their feelings about CBT as a learning tool. Finally, they were asked if other military courses should be taught by the CBT/SCOMTS method (Greene, 1991).

All student responses were then subjected to descriptive analysis. The overall instrument was subjected to a t-test with t-tests being conducted on the major grouped data.

Treatment of the Data

Descriptive statistics were used to determine each group's profile. Information tested included age and educational level (in years of education). This procedure was important because both the control and the experimental groups were not randomly selected (Campbell & Stanley, 1963). They were comprised of the entire student membership available for training at that point in time. Selection had

occurred by drawing a specified number of candidates from sub-pools for each company in 3PPCLI and militia units in the areas where the study occurred. Selected variables were, therefore, subjected to t-tests for independent samples to establish group equivalence (Perry, 1994).

The group means for the knowledge and the skill portions of the course were also subjected to t-tests to determine if the particular instructional method produced a significant change in knowledge and skill within each group. Next, the times required to complete the instruction and the practical portions of the module were subjected to one tailed t-tests to determine if the experimental strategy produced a significant saving in time to assimilate knowledge and to build skills. Finally, the per student per hour costs were subjected to a one tailed t-test to determine if the use of SCOMTS resulted in significant cost savings over the use of Traditional instruction.

Data obtained from the Student Evaluation of the Course forms for both groups were collated in one frequency table and were subjected to descriptive analysis. From this data, conclusions were drawn in the areas of presentation, support materials, perceived effectiveness of the instruction and student desire for more instruction in each methodology.

The open-ended questions were then evaluated to determine consistency with other data, and for the identification of areas where improvements can be made (Donnelly, 1993).

Assumptions

A number of assumptions were made prior to the conduct of this study. The major ones are listed below.

Reading Level. It was assumed that all subjects of this study could read at the Grade 9 level. Although not tested upon enrolment, all personnel currently being recruited must have at least a Grade 9 education. In fact, it has been the practice since 1983 to demand at least a Grade 10 academic standing for potential reserve recruits and a Grade 11 standing for potential regular recruits. A test for reading proficiency was not conducted prior to the study.

Language Capability. Similar to the first assumption, it was assumed that all subjects could understand both written and oral English at the Grade 9 level.

Motivation. It was assumed that all subjects would be motivated to learn independent of the group to which they were assigned.

Course Content. It was assumed that the testable content, as defined in the Performance Objective (Appendix A) was the same for both the CBT and Traditional courses.

Chapter 5: Results and Discussion

This chapter contains the results of both the descriptive and inferential statistical analyses of the data derived from the experiment. The level of significance throughout this study was set at $p = .05$. The raw data are contained in Appendices I-S.

Results

Determination of Equivalency

To lay the foundations for the testing of the hypotheses, the groups were examined to determine if they differed significantly. The variables used to establish the representativeness of the samples were Age, Educational Level (in years of schooling), Entry Knowledge (of AVGP parades) and Entry Skill (performing AVGP parades). Those students who received traditional classroom training were referred to as the Trad Group, while the experimental group was referred to as the CBT Group. The results are contained in Table 1 (on the following page).

Table 1

Determination of Group Equivalency

	<u>M</u>	<u>SD</u>	<u>t</u>	<u>df</u>	<u>p</u>
<u>Age</u>					
CBT	19.07	1.71	0.59	55	>.05
Trad	18.83	1.34			
<u>Educational Level</u>					
CBT	11.56	1.19	0.58	55	>.05
Trad	11.73	1.14			
<u>Entry Knowledge</u>					
CBT	2.07	1.75	2.01	55	<.001
Trad	3.27	2.84			
<u>Entry Skill</u>					
CBT	3.44	5.13	0.40	55	>.05
Trad	4.00	5.32			

$n_{\text{CBT}} = 27.$ $n_{\text{Trad}} = 30.$

As can be seen, when the data are subjected to a series of t-tests, the CBT and the Trad Groups exhibit no significant differences for the variables Age, Educational Level and Entry Skill ($p > .05$). The Trad Group, however, possessed significantly more Entry Knowledge than did the CBT Group ($p < .001$). Therefore, the two groups are equivalent in everything but Entry Knowledge.

Effectiveness in Facilitating Knowledge Acquisition

In Chapter 3 of this study, it was predicted in Hypothesis 1 there would be no significant difference in the

knowledge post-test scores for the two groups. The null hypothesis was, therefore:

$$H_0: u_1 - u_2 = 0$$

The results (see Appendices J-M) obtained from the knowledge and skill Pre and Post-tests (Appendices C & G) which were used to measure the student's understanding of and ability to perform the procedures for conducting First Parades, Halts and Last Parades are summarized in Table 2.

Table 2

Determination of the Effectiveness of the Intervention

	<u>M</u>	<u>SD</u>	<u>t</u>	<u>df</u>	<u>p</u>
<u>Exit Knowledge</u>					
CBT	21.22	2.55	0.46	55	>.05
Trad	21.50	1.96			
<u>Exit Skill</u>					
CBT	82.63	4.86	3.93	55	<.001
Trad	86.67	2.32			

$n_{\text{CBT}} = 27.$ $n_{\text{Trad}} = 30.$

Although the Trad group was determined to possess significantly more entry level knowledge than the CBT group ($p < .001$), both samples were determined to be representative of the population in other areas. It was therefore decided to use a two tailed, two sample t-test to test the null hypothesis. The results indicate that there

is statistically no difference in the quality of instruction between CBT and traditional classroom training in the area of knowledge acquisition ($p > .05$).

Effectiveness in Facilitating Skill Acquisition

It was predicted in Hypothesis 2 there would be no significant difference in the skill post-test scores for the two groups, as measured by the Performance Check at Appendices D-F. The null hypothesis was, therefore:

$$H_0: u_1 - u_2 = 0$$

As noted earlier, the results obtained from the skill Pre and Post-tests are summarized in Table 2. Again, the two samples had been determined to be representative of the population, therefore, a two tailed, two sample t-test was used to test the null hypothesis. The results indicate that there is a significant difference in the quality of instruction between CBT and traditional classroom training in the area of skill acquisition ($p < .001$). In this instance, the traditional instruction facilitated the acquisition of skill better than the CBT module.

Cost of CBT vs Traditional Instruction

It was predicted in Hypothesis 3 there would be no significant difference in resource costs for the two methodologies. The null hypothesis was, therefore:

$$H_0: u_1 - u_2 = 0$$

Both the per student cost and the completion time data contained in Appendices P-S are summarized in Table 3.

Table 3

Determination of the Efficiency of the Intervention

	<u>M</u>	<u>SD</u>	<u>t</u>	<u>df</u>	<u>p</u>
<u>Cost Efficiency (\$)</u>					
CBT	69.55	13.34	74.29	27	<.001
Trad	342.21				
<u>Time Efficiency (Mins)</u>					
CBT	206.20	59.50	50.37	27	<.001
Trad	780.00				

$$n_{\text{CBT}} = 27. \quad n_{\text{Trad}} = 30.$$

Because the formal training was group paced, lock-step instruction with each student receiving 13 hours of formal instruction and practice, there was no variance in the data for the Trad Group. A one sample t-test (df = 27) was therefore performed to determine if there was a difference in the per student costs between CBT and formal training (hypothesis 3). The per student figure of \$342.21 (Table 3) was used as the standard against which the per student cost for CBT was measured.

As reported in Table 3, the null hypothesis was rejected, p < .001. Therefore, it can be concluded the per

student costs for CBT are significantly lower than those for the traditional classroom training.

Learning Time Analysis

It was predicted in Hypothesis 4 there would be no significant difference in learning time between the two groups. The null hypothesis was, therefore:

$$H_0: u_1 - u_2 = 0$$

As noted in the previous section, the average amount of time students took to assimilate the materials is summarized in Table 3. The raw data are contained in Appendices R and S.

Because the formal training was group paced, lock-step instruction with each student receiving 780 minutes (13 hours) of formal instruction and practice, there was again no variance in the data for the Trad Group. A standard one sample t-test was therefore performed to test the null hypothesis. The 780 minutes classroom time (Table 3) was used as the standard against which CBT was measured. An observed value of $\underline{t} = 50.37$ with 27 degrees of freedom indicated that the null hypothesis could be rejected, $p < .001$. Therefore, it can be concluded that the average time to acquire both information and skills is significantly lower for CBT.

Student Critiques by Methodology

It was predicted in the final hypothesis there would be no significant difference in the student evaluation of the instruction for the two groups, as measured by the Student Evaluation of Course Materials Survey at Appendix H. The null hypothesis was, therefore:

$$H_0: u_1 - u_2 = 0$$

The data (Appendices N & O) obtained from the scaled responses to the questions of the Student Evaluation of Course Materials form (Appendix H) are summarized in Table 4 on the following page. The size of each group was 27 as three members of the Trad group did not submit Student Evaluation forms.

Table 4

Comparison of Student Evaluation of the Instruction and Method Used

	<u>M</u>	<u>SD</u>	<u>t</u>	<u>df</u>	<u>p</u>
<u>Overall Evaluation</u>					
CBT	47.56	8.64	1.29	52	>.05
Trad	44.89	6.44			
<u>Presentation</u>					
CBT	22.85	4.67	1.75	52	>.05
Trad	20.52	5.10			
<u>Support Materials</u>					
CBT	5.56	1.60	3.43	52	<.001
Trad	6.85	1.13			
<u>Assessment of Instruction</u>					
CBT	15.52	3.99	1.00	52	>.05
Trad	14.56	2.99			
<u>Student Desires</u>					
CBT	3.63	1.45	1.07	52	>.05
Trad	3.26	1.06			

$n_{\text{CBT}} = 27.$ $n_{\text{Trad}} = 27.$

From the data in Table 4, the null hypothesis could not be rejected at $p > .05$. Therefore, it can be concluded that there is no significant difference in the student evaluations of the instruction between the CBT and the Trad groups.

A closer examination of the results indicate that the four major components of the survey (as reflected in Table 4) generally support this finding. Specifically, no

significant differences between the two groups were found in the areas of Presentation ($p > .05$), Assessment of Instruction ($p > .05$) and expressed Student Desires for more of the same type of instruction ($p > .05$). There was, however, a significant difference ($p < .001$) for that section of the survey evaluating Support Materials. This difference was largely the result the CBT group's expressed dissatisfaction with the quality of the graphics contained in the intervention ($M = 2.41$, $SD = 1.05$, where a score of 1-2 indicates dissatisfaction and 3 indicates indecision/non-commitment). The Trad group expressed general satisfaction ($M = 4.04$, $SD = 0.34$) with any drawings or graphics used to support the instruction.

Discussion

Effectiveness in Facilitating Knowledge Acquisition

It was predicted in Hypothesis 1 there would be no significant difference in the post-test knowledge exam scores for those soldiers receiving instruction by means of SCOMTS and those who underwent formal classroom instruction. As noted, the results contained in Table 2 indicate that this hypothesis cannot be rejected. Descriptively, there is little difference in the mean exit scores for the Trad Group

($M = 21.5$, $SD = 1.96$) and the CBT Group ($M = 21.22$, $SD = 2.55$). Further, the results of a two tailed, two sample t-test ($t = 0.46$, $df = 55$, $p = .05$) also reveals no significant difference between the two groups. If, however, consideration is given to the fact that the Trad group possessed significantly more entry level knowledge than the CBT group, then it can be argued that the intervention facilitated significantly more acquisition of knowledge than did the traditional classroom instruction.

The latter finding is consistent with the research of Burns & Bozeman (1981), Skerrett (1985), Shlechter (1990), Marrero & Chin (1991) and Cowen (1994). They found that CBT actually enhances or improves learning to a greater degree than lectures. The studies of others such as Higginbotham (1990); Alessi and Trollip (1985 & 1991); Semb, Ellis, Montague & Wulfeck (1991); Spots (1992); Jelovsek and Adebonojo (1993); and Perry (1994) support the results of the t-test. They found that CBT (or Computer Assisted Instruction) was as effective as the lecture method for learning theoretical constructs, concepts and general information.

It is possible that the results of the t-test would have clearly indicated that the intervention significantly improved knowledge acquisition had the SCOMTS program

contained all of the elements of more traditional CBT programs. For example, in their meta-analyses of what is successful in CBT and adults, Montague (1988), Terrell (1990) and Montague & Knirk (1993) found that feedback and remediation have a positive affect on retention and transfer. As noted in Chapter 3, however, the practice problems were removed from the program at the suggestion of the personnel assisting with the formative evaluation of the materials. Therefore, students were not provided with either feedback or remediation as they progressed through the course. Only the revision of the SCOMTS courseware and a second study will determine the importance, and the effect on learning, of remediation and feedback in this type of program.

Effectiveness in Facilitating Skill Acquisition

It was predicted in Hypothesis 2 predicted there would be no significant difference between the practical maintenance scores for those soldiers receiving instruction by means of SCOMTS and those who undergo formal classroom instruction. The results of this study (Table 2) indicate that this could be rejected. The mean exit skill score for the Trad Group is significantly higher than that for the CBT Group ($t = 3.93$, $df = 55$, $p = .05$).

Does the rejection of the null hypothesis really mean that SCOMTS is less capable than the traditional method in the area of skill acquisition? If one examines the data from a normative testing and research perspective, such a conclusion could possibly be drawn. If however the data is viewed from a criterion referenced testing perspective, other factors impact on the final decision. For example, the standard is 60% for both the skill and knowledge portions of the course (CF, 1986b) and no member of either group failed to meet the standard. Although there was more variance in the scores for the CBT group (CBT = 23.63 vs Trad = 5.40), the overall group mean for the CBT group ($\bar{M} = 82.63$, $\bar{SD} = 4.86$) was only four percentage points lower than that for the Trad group ($\bar{M} = 86.67$, $\bar{SD} = 3.32$). Moreover, the CBT group completed the training in significantly less time and at a significantly lower cost than the Trad group. In light of the current economic climate, the increased commitments to the Army and the criterion referenced nature of the CF training system, it could be difficult to continue to justify the additional time and resources needed to support the traditional training methodology for such little gain. Therefore, the significant difference between the two methodologies assumes a different meaning.

Cost of CBT vs Traditional Instruction

It was predicted in Hypothesis 3 there would be no significant difference in resource costs between the SCOMTS course and the formal, lock-step training. The results of the t-test, however, indicate a significant difference in the per student costs between the Trad Group (\$342.21) and the CBT Group ($M = \$69.55$, $SD = 13.34$) ($t = 74.29$, $df = 27$, $p = .05$).

There is considerable support for this finding in the research literature, a point often cited by contractors and producers of CBT. Skerrett (1985), Shlechter (1986), Shlechter & Boldovici (1987), Palmarozza (1990), Marrero & Chin (1991) and Perry (1994), to name but a few, all found that CBT reduces both the direct and indirect cost of training. Some of the studies state that savings were only realized over a period of time due to the high initial costs associated with this methodology (Skerrett, 1985; Palmarozza, 1990). Other studies, however, found that cost and resource savings were accrued from the first day of the course (Marrero & Chin 1991; Perry, 1994). The difference in the findings depended on whether the CBT was amortized over a specified life span or one course (Shlechter, 1986; Shlechter & Boldovici, 1987).

In this study, all the costs associated with both the CBT and the traditional training were amortized over 10 years, as this is the life expectancy of a military training course (CF, 1993) (see Appendix P). In doing so, there were significant savings from the beginning. This was largely the result of the high direct and indirect personnel costs associated with military training. The formal, traditional training required a lower student to instructor ratio, as well as a larger administrative support staff, than did the CBT. Further, the self-paced nature of the CBT required significantly less time to complete ($M = 206.2$ minutes, $SD = 59.5$) than the traditional methodology (780 minutes/per student). As the cost of the training was calculated on a per student per hour per course basis, the greater the required training time and the larger the number of instructors and support staff, the higher the per student costs. An examination of the cost breakout sheets in Appendices P & Q reveal the source of the significance in the differences of personnel costs. It should be noted that this study did not attempt to identify and quantify the lost opportunity costs as described by Kearsley (1984) and Head (1985). If this were done, the difference in costs between the two methodologies could possibly be even greater.

Learning Time

It was predicted in Hypothesis 4 there would be no significant difference in the amount of time a CBT student would require to complete the SCOMTS instruction and a traditional student would require to complete the formal, lock-step training. The results contained in Table 3, however, indicate there is a significant difference in the per student per course time requirements between the Trad Group ($M = 780$ minutes) and the CBT Group ($M = 206.2$ minutes, $SD = 59.5$) ($t = 50.37$, $df = 27$, $p = .05$).

The studies cited in the discussion of the previous hypothesis, as well as a number of other reports, support this finding. CBT permits the student to bypass that knowledge and skill training which he or she has already acquired through collateral learning experiences or other courses. In short, student control over the training medium permits him or her to access only that material he or she may require, at that particular moment, for that particular job.

Control over the training medium also motivates the student to learn (Montague, 1988; Montague & Knirk, 1993; Terrell, 1990). Student motivation is often translated into time spent on task and concentration on the materials to be learned. This in turn results in less time to complete CBT when compared to traditional, lock-step instruction.

Student Evaluation of the Instruction

It was predicted in Hypothesis 5 there would be no significant differences in the evaluation of the instruction as expressed by those students receiving the CBT and those undergoing formal instruction. The results reported in Table 4 indicate that the null hypothesis cannot be rejected.

It was decided to breakdown the data into functional areas of assessment to determine if all segments of the survey agreed with the overall statistical analysis. The findings of the t-tests performed on the individual survey segments are discussed below.

Presentation. When examined in the context of how the instruction was prepared, the results of the t-test for this section produce no surprises. The recommendations contained in the meta-analyses of Montague (1988) and Terrell (1990), as well as the proposals contained in the guide produced by the National Association for Public Continuing & Adult Education (1974), were used when developing the SCOMTS package. Therefore, the courseware was consistent, focused on the required materials and was easily manipulated by the student. Further, the reading level of the text was standardized and confirmed at the grade 9 level of

understanding. Consequently, a large proportion of the CBT Group expressed satisfaction in the areas of clarity of aim (26 of 27 students), relation of course materials to lesson objective (22 of 27 students), logical sequence of instruction (18 of 27 students) and ease of comprehension (22 of 27 students).

The traditional lecture-based training was designed using CAMT 2-38, Principles and Methods of Instruction (CF, 1963). Although not based on educational research, this manual identifies many of the principles used in the development of the SCOMTS. It is, therefore, not surprising to find that, although fewer in number, the majority of the Trad Group students also expressed satisfaction with the areas described above. Specifically, 21 of 27 students felt that the aim of the instruction was clearly stated, 17 of 27 felt that the course materials were directly related to the lesson objective and 19 of 27 felt that the instruction was easy to understand. However, only 9 of 27 students felt that the instruction followed a logical path. Further, more Trad Group students (21 of 27) than CBT Group students (14 of 27) felt that the instruction provided enough information for the student to complete tasks.

The lower numbers of Trad group students expressing satisfaction with the instruction were the result of several factors. The sequencing and timing of instruction were

often based on the availability of specific instructors, training support equipment, training aids or facilities. When one or more of these were not available, the order of instruction was changed or the instruction was presented without the required aids and equipment. Depending on the capabilities or the inclination of the next instructor, the links between the out of sequence training and the objective, and the previous and the following lessons, were or were not made.

The observation that the Trad group were more confident than the CBT group about their ability to perform the maintenance is also understandable. As noted in Chapter 3, the feedback and remedial training functions had been removed from the SCOMTS courseware as a result of the comments received during the formative evaluation. Further, the CBT group spent less time on both the theoretical portion of the course and the practical portion than their Trad counterparts.

Support Materials. The finding that the Trad Group students were significantly more satisfied than the CBT students with the level and quality of the drawings, graphics and visuals used to support the training is at first glance surprising. If examined in isolation, this would suggest a problem which could impact on learning. However, if this finding is examined together with the

students' feelings vis a vis the overall effectiveness of the instruction, and their rating of the motivational value of the training, a different interpretation can be derived. Specifically, 18 of the 27 CBT instructed students felt the instruction was effective and 19 felt it was motivating. It is therefore suggested that, in this instance, the quality of the pictures had little impact on student learning.

Three studies conducted at the US Naval Training Systems Center (Garris, Mulligan, Ricci, Dwyer, McCallum & Moskal, 1990; Garris, Mulligan, Ricci & McCallum, 1990; Ricci, Garris, Mulligan & McCallum, 1990) support this contention. They suggest that the quality and the fidelity of graphics required to support CBT is a function of the item being taught, the type of learning desired, and the complexity of the equipment being represented. High fidelity is required for complex items such as circuit boards and the teaching of concepts. Lower fidelity, however, is both acceptable and recommended for less complex items such as equipment and for incorporation into job performance aids and low level CBT.

Assessment of the Instruction and Student Desires. The CBT group's satisfaction with the pace of the training, the motivating nature of the methodology, and the effectiveness of the instruction are supported by the research of Azbell

(1988), Packer (1988), Shlechter (1990) and Morrero & Chin (1991). The reason for the difference between the Trad group's expressed desire and the CBT group's desire for other courses using their particular methodology is also addressed in these studies.

Chapter 6: Conclusions

Summary of Descriptive Findings

The subjects were equal in the areas of age, number of years of education and pre-intervention skill in performing First Parades, Halts and Last Parades. The Trad Group students, however, possessed more entry level knowledge about the AVGP than the CBT Group students.

Summary of Quantitative Findings

The main focus of this research was to determine if there is a difference in the quality of knowledge and skill acquisition between on-site delivered CBT and traditional classroom instruction. The difference in time required for learning to occur and the cost of all aspects of the training were also examined. Finally, the results of the student evaluation of the training were analyzed.

There was a significant difference in the quality of instruction between CBT and traditional classroom training in the areas of knowledge and skill acquisition. Although all subjects met the criterion, the Trad students performed better on the practical post-test. The training establishment must now determine which is more important: equality with the traditional method of instruction or

accepting training which meets the criterion but is significantly cheaper in both time and resources.

The per student costs for CBT were significantly lower than those for traditional training. This occurred because the costs of both approaches were amortized over a five year period for equipment costs and a 10 year period for the courseware itself. Shorter amortization periods, however, could result in the reverse of this finding.

The average time to acquire information and skills was significantly lower for CBT. Because the student had control over his/her own learning, he/she tended to focus on only what was required and to the level necessary to gain the confidence to do the job.

Implications for Theory and Practice

The results of this study indicate that it is possible to teach basic knowledge, concepts and skill elements for the maintenance of armoured personnel carriers via on-site CBT. Since CBT can be just as effective as the lecture-demonstration method, but at a significantly lower cost, the Army needs to examine how best to incorporate it into its training milieu. The self-paced, learner controlled nature of CBT supports the introduction of high quality, cost-effective instruction to the job site. Further, it provides

consistency across course serials, allowing the same material to be taught without losing information. Moreover, CBT can be easily revised to incorporate equipment upgrades and procedural changes. In light of the military's stated intention to field Computer-based Personal Maintenance Aids with the Army's new communications system, Land Forces personnel need to become more familiar and comfortable with computers and their use as job performance aids in the field (PM TCCCS direction to the Deputy Project Manager Integrated Logistic Support, and the Training and Personnel Officer 12 October 1994 and 11 January 1995). The use of the SCOMTS module provides such an opportunity.

Attitude toward CBT and computers in general may be a major factor in soldiers utilizing this tool for instruction. Attitude measurement is necessary in order to determine motivation and receptivity of the learner to learn via this methodology. Knowing the attitude of the target population would help courseware developers to design programs which foster more positive attitudes and meet the needs of the learner.

Limitations of the Study

A number of limitations were identified during the conduct of this study. Most arose because the study was conducted in an existing training milieu and not in a

laboratory environment. It was, therefore, impossible to control all of the variables which could impact on, or pose a threat to, both the internal and the external validity of the study. Some of these limitations follow.

Ecological validity - Novelty effect. The design of the CBT program and the manner in which it was employed differed greatly from the methodology normally employed for training of this nature. Although the use of CBT is becoming more common in Canadian military training, currently no courses exist which employ this type of program in a distributed (on-site) training mode. Further, it is not normal Canadian military practice to learn from a computerized performance aid on equipment on the job - a situation well known to every military member. The results of the intervention thus may have been influenced by a novelty effect.

Ecological validity - Test sensitization. The method used to randomly select the test items for both the pre and post-tests resulted in more than one question appearing on both exams. The short period of time between the pre and the post-tests and the low level nature of the test items themselves could, therefore, have resulted in memory having an impact on post-test scores. Experience with the questions on the pre-test could also have focused student

attention on certain aspects of the training, thereby producing higher post-test scores. Finally, there were a number of students with experience on other vehicles which had identical or similar power packs, electrical systems and cooling systems. The pre-test items could, therefore, have stimulated the recall of this information or have served to link, in these students' minds, the similarities between the vehicles.

Ecological validity - History. Approximately 20% of the Trad group were adversely affected by the poor quality of training provided by their instructor. Although he was eventually replaced by a more competent instructor, these students were required to work harder in order to attain the standard. This had a negative impact on motivation which, in turn, could have affected their performance on the written post-test. Such an impact could have made a difference when determining whether or not the null hypothesis was supported.

Implications for Further Research

Based on the results of this study, additional research is required in several areas. Larger samples should be studied in order to apply the findings beyond a specific setting. Some of the areas recommended for further study follow.

Research is required to determine if the use of pictures of medium definition could result in the long-term retention and application of knowledge and procedures.

More study is required to determine if the consistent use of performance aids, with instruction on how best to maximize their effective employment, could result in long-term retention of knowledge and skills. A collateral topic involves determining how much job-aiding is required before retention is achieved.

A fourth area requiring additional research involves determining if the feedback and confirmation portions of traditional CBT are required in on-job performance aiding and learning situations.

Finally, more research is necessary to determine how much definition in pictures is required in order to facilitate cost effective learning. If learning can be achieved with pictures of lower definition, there would be a significant cost and time savings in the development of some types of CBT and computer-based job performance aids.

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Appendix A

PERFORMANCE OBJECTIVE 404

The following Performance Objective forms the basis of this study. It is drawn directly from the Course Training Plan for the Basic AVGP Driver Course and has not been amended so as to prevent contamination of the results (CF, 1986b, pp.4-2 & 4-3).

1. **PERFORMANCE** - Service an Armoured Vehicle General Purpose.
2. **CONDITION** - Given:
 - a. AVGP as per check list; and
 - b. servicing material;
 - c. daily, weekly and hourly maintenance sheet; and
 - d. supervision for safety.
3. **STANDARD** - Without critical error and in accordance with the references:
 - a. service the coolant and cooling fan drive system;
 - b. service the lubrication system;
 - c. service the fuel system;
 - d. service the air intake and turbo-charger system;
 - e. service the power steering system;
 - f. service the suspension system;

- g. service the power train;
 - h. service the compressed air system;
 - i. service the brake system;
 - j. service the electrical, lighting and fire-fighting system; and
 - k. conduct/perform periodic servicing.
4. **SPECIFIC REFERENCE NUMBERS:** A1, A4-A10 and A15-A17.
 5. **SPECIFICATION TASK NUMBER:** 2.1.
 6. **SUPPORTING KNOWLEDGE SPECIFICATION NUMBERS:** N/A.
 7. **TRAINING LIMITATIONS:** As per Chapter 1, NOTE.

Appendix B
Personal Information Survey

PRINCIPAL PURPOSE

The data collected with the following form are to be used for research purposes only.

ROUTINE USE

This is an experimental personal data collection form. When name and Service Number are requested, they are to be used for administrative and statistical control purposes only. Full confidentiality of the responses will be maintained in the processing of this data.

DISCLOSURE

Your participation in this research is strictly voluntary. Individuals are encouraged in the interest of research, but there will be no effect on individuals for not providing all or any part of the information. Write "NA" for each question that you cannot or do not wish to answer.

Please turn the page.

10. IF YES, HOW MANY? (Circle the letter of the appropriate answer)
- a. 1 - 5
 - b. 6 - 10
 - c. 11 - 15
 - d. More than 15
11. IF YOUR ANSWER TO QUESTION #9 WAS YES, PLEASE INDICATE THE TYPE OF MAINTENANCE WITH WHICH YOU ASSISTED. (Circle the letter of the appropriate answer(s))
- a. Daily/First Parade
 - b. Routine Halt
 - c. 50 hour/100 hour/500 hour
 - d. Other _____
12. HAVE YOU EVER RECEIVED INSTRUCTION ON THE MAINTENANCE OF THE AVGP? (Check the appropriate answer)
- Yes _____ No _____
13. IF YES, PLEASE INDICATE THE NATURE OF THIS INSTRUCTION. (Circle the letter of the appropriate answer(s))
- a. Reserve training.
 - b. Informal instruction by a driver, section commander or platoon warrant officer.
 - c. Attended a previous AVGP Driver Course but withdrew from training.
 - d. Other (Please specify) _____
14. DO YOU HOLD AN APC DRIVER TRACK QUALIFICATION? (Check the appropriate answer)
- Yes _____ No _____

15. HAVE YOU EVER ASSISTED WITH THE ROUTINE MAINTENANCE OF THE M113? (Check the appropriate answer)

Yes _____

No _____

16. IF YES, HOW MANY? (Circle the letter of the appropriate answer)

a. 1 - 5

b. 6 - 10

c. 11 - 15

d. More than 15

17. IF YOUR ANSWER TO QUESTION #15 WAS YES, PLEASE INDICATE THE TYPE OF MAINTENANCE WITH WHICH YOU ASSISTED. (Circle the letter of the appropriate answer(s))

a. Daily/First Parade

b. Routine Halt

c. 50 hour/100 hour/500 hour

d. Other _____

18. HAVE YOU EVER RECEIVED INSTRUCTION ON THE MAINTENANCE OF THE M113? (Check the appropriate answer)

Yes _____

No _____

19. IF YES, PLEASE INDICATE THE NATURE OF THIS INSTRUCTION. (Circle the letter of the appropriate answer(s))

a. Reserve training.

b. Informal instruction by a driver, section commander or platoon warrant officer.

c. Attended a previous AVGP Driver Course but withdrew from training.

d. Other (Please specify) _____

Appendix C

Pre-Test (Written)

1. During First Parades, the tires are inspected to ensure they have the following pressures: (2)
 - a. Front tires -
 - b. Rear tires -

2. What ratio of antifreeze to water is used in the AVGP? (1)
 - a. 50 - 50
 - b. 55 - 45
 - c. 60 - 40
 - d. 65 - 35
 - e. 70 - 30

3. How can you tell if the engine oil is contaminated with water? (1)
 - a. it turns a milky colour
 - b. it separates into globules
 - c. it turns black in colour
 - d. it turns frothy in texture

4. When performing First Parades, the Cooling Fan Drive Fluid Reservoir is inspected for: (3)
 - a.
 - b.
 - c.

5. Below is a list of five vehicle fluid reservoirs. Indicate the specific type of fluid used to fill each reservoir: (5)
 - a. Radiator
 - b. Power Steering Fluid Reservoir
 - c. De-icing Fluid Reservoir
 - d. Cooling Fan Drive
 - e. Hydraulic Brake Fluid Reservoir

6. What is the proper tension for the Cooling System V Belt? (1)

7. How many drain plugs are located on the underside of the AVGP? (1)
 - a. 5
 - b. 7
 - c. 9
 - d. 11

8. At normal state, the Air Pressure Gauge registers a pressure in the range of: (1)
- a. 2 - 3.5 kg/cm sq
 - b. 3 - 4.5 kg/cm sq
 - c. 4 - 5.5 kg/cm sq
 - d. 5 - 6.5 kg/cm sq
 - e. 6 - 7.5 kg/cm sq
9. When the engine is running, the normal operating oil pressure is: (1)
- a. .5 kg/cm sq
 - b. 1.5 kg/cm sq
 - c. 3.5 kg/cm sq
 - d. 5.5 kg/cm sq
 - e. 7.5 kg/cm sq
10. When lit, the Main Warning Light indicates one or more of five conditions within the vehicle. List four of these conditions. (4)
- a.
 - b.
 - c.
 - d.

11. What action must be completed immediately after draining the Air Reservoirs and before starting the engine? Why? (5)

Pre-Test Key

1. a. 55 PSI
b. 45 PSI
2. c - 60% ethylene glycol and 40% water
3. a - it turns a milky colour
4. a. leaks
b. bulges
c. chaffing
5. a. 3-GP-854 coolant
b. DEXRON II
c. Isopropyl Alcohol
d. DEXRON II
e. 3-GP-6C
6. 3/8 inches at 25 pounds of pressure
7. a - 11 (9 small and 4 large)
8. d - 5 - 6.5 kg/cm sq
9. d - 5.5 kg/cm sq
10. a. low oil pressure
b. low air pressure
c. high coolant temperature
d. Park Brake is engaged
e. Transfer Case Gear Lock is engaged

11. The Air Valve Levers must be switched off.

Failure to do so could result in severe damage to various components of the Air Pressure System and even the engine itself.

Appendix D

Performance Check - First Parades

Exterior Checks

TASK	Y	N	COMMENTS
1. Conducted walk around to check for puddles of oil or other fluids. a. checked gear box b. checked all differentials c. checked planetary wheel drive d. checked inside of wheel wells for leaks on backing plates e. annotated work ticket if leaks found			
2. Checked drain plugs (must be in at all times except when vehicle is parked for long periods outside). a. if drain plugs not in the vehicle, verified they were stored in the driver's tool box b. if drain plugs not in driver's tool box, approached Tpt NCO for replacements c. replaced missing drain plugs or annotated work ticket if replacements not available			

TASK	Y	N	COMMENTS
3. Checked wheels, tires, and rims for damage a. replaced lost or damaged wheel nuts b. torqued the wheel nuts to 265 Nm c. replaced seriously damaged tire(s) d. if no spares available, "grounded" vehicle and reported damaged tire(s) to Tpt NCO or noted damages on work ticket			
4. Conducted cold check of tire inflation pressure a. field conditions - tire pressure of 55 psi for front tires and 45 psi for rear tires b. highway conditions - tire pressure of 80 psi for all tires c. corrected all improper tire pressure readings			
5. Checked condition driver's vision devices a. cleaned dirty vision devices b. replaced broken or inoperable devices c. secured loose vision devices			

TASK	Y	N	COMMENTS
d. reported all broken or inoperable vision devices to Tpt NCO or annotated work ticket.			
6. Checked louvre vinyl covers for condition and security.			
a. removed covers			
b. replaced severely damaged louvre covers			
c. reported damaged louvre covers to Tpt NCO or annotated work ticket			
Additional Observations - Exterior Check			

Fluid Levels

TASK	Y	N	COMMENTS
7. Checked radiator coolant level a. verified that coolant was antifreeze b. if fluid level below acceptable limits, added correct amount and type of coolant c. annotated work ticket to reflect addition of coolant			
8. Checked engine oil level a. verified that oil was not milky, frothy, or required changing b. if oil level below acceptable limits, added correct amount and type of oil c. annotated work ticket to reflect addition of oil or requirement to change it due to milkiness, frothiness, or dirtiness.			
9. Verified cold transmission oil level (cold mark) a. verified oil was not milky, frothy or required changing b. if oil level below acceptable limits, added correct amount and type of oil			

TASK	Y	N	COMMENTS
c. annotated work ticket to reflect addition of oil or requirement to change it due to milkiness, frothiness, or dirtiness			
<p>10. Verified power steering fluid level (1 cm over full)</p> <p>a. if fluid level below acceptable limits, added correct amount and type of fluid</p> <p>b. annotated work ticket to reflect addition of steering fluid</p>			
<p>11. Checked the cooling fan drive fluid level</p> <p>a. if fluid level below acceptable limits, added correct amount and type of fluid</p> <p>b. annotated work ticket to reflect addition of cooling fan drive fluid</p>			
<p>12. Verified all hydraulic brake fluid levels (all reservoirs)</p> <p>a. if hydraulic brake fluid level below acceptable limits, added correct amount and type of fluid</p> <p>b. annotated work ticket to reflect addition of hydraulic brake fluid</p>			

TASK	Y	N	COMMENTS
13. Verified fuel tank full a. if fuel level below acceptable limits, added correct amount and type of fuel b. annotated work ticket to reflect addition of fuel			
14. Verified windshield washer fluid level a. if fluid level below acceptable limits, added correct amount and type of windshield washer fluid b. annotated work ticket to reflect addition of windshield washer fluid			
Additional Comments - Fluid Levels			

Power Pack

TASK	Y	N	COMMENTS
15. Verified belt tension a. if too much play, tightened b. if cracked or frayed, replaced c. if unable to replaced cracked or frayed belt, reported to Tpt NCO or annotated work ticket d. if belt replaced, annotated work ticket to reflect this action			
16. Checked fuse panel to ensured all fuses pushed in			
Additional Comments - Power Pack			

Interior Checks

TASK	Y	N	COMMENTS
17. Verified that horn and panel lights work			
a. if horn did not work, "grounded" vehicle and annotated work ticket. Annotated work ticket if panel lights did not work.			
18. Verified instrument panel worked and was secure			
a. "grounded" vehicle if panel neither worked nor was secure. Annotated Work Ticket to reflect status of instrument panel			
19. Verified status of driver's seat (condition, security, and operation)			
a. if broken, replaced or repaired seat and annotated work ticket			
b. if unable to repair seat, reported situation to Tpt NCO or annotated work ticket			
Additional Comments - Interior Checks			

Completes Work Ticket

TASK	Y	N	COMMENTS
20. Entered mileage from odometer			
21. Totalled all columns and ensured all vehicle annotations are in proper places on work ticket			
Additional Comments - Work Ticket			

Appendix E

Performance Check - Halts

Exterior Checks

TASK	Y	N	COMMENTS
1. Conducted walk around to check for puddles of oil or other fluids. a. checked gear box b. checked all differentials c. checked planetary wheel drive d. checked inside of wheel wells for leaks on backing plates e. annotated work ticket if leaks found			
2. Checked propellers, rudders, and trim vane for condition and security a. if damages noted, initiated corrective action or secured devices until returned to base b. annotated work ticket to reflect damages to noted items and informed the Tpt NCO			
3. Checked wheels, tires, and rims for damage and wear a. replaced lost or damaged wheel nuts			

TASK	Y	N	COMMENTS
b. torqued the wheel nuts to 265 Nm c. arranged for replacement of seriously damaged tire d. if no spares or assistance available, "grounded" vehicle and reported damaged tire(s) to Tpt NCO and noted it/them on work ticket			
4. Performed a visual check of tires for over/under inflation a. corrected all improper tire pressure readings			
5. Checked condition driver's vision devices a. cleaned dirty vision devices b. replaced broken or inoperable devices c. secured loose vision devices d. reported all broken or inoperable vision devices to Tpt NCO and annotated work ticket			
Additional Comments - Exterior Checks			

Fluid Levels

TASK	Y	N	COMMENTS
6. Checked engine oil level a. verified that oil was not milky, frothy, or required changing b. if oil level below acceptable limits, added correct amount and type of oil c. annotated work ticket to reflect addition of oil or requirement to change it			
7. Verified hot transmission oil level (hot mark) a. verified that oil was not milky, frothy, or required changing b. if oil level below acceptable limits, added correct amount and type of oil c. annotated work ticket to reflect addition of oil or the requirement to change it due to milkiness, frothiness, or dirtiness			
8. Verified fuel tank full a. if fuel level below acceptable limits, added correct amount and type of fuel b. annotated work ticket to reflect addition of fuel			

TASK	Y	N	COMMENTS
9. Verified windshield washer fluid level a. if fluid level below acceptable limits, added correct amount and type of windshield washer fluid b. annotated work ticket to reflect addition of windshield washer fluid			
Additional Comments - Fluid Levels			

Interior Checks

TASK	Y	N	COMMENTS
10. Verified instrument panel worked and was secure a. "grounded" vehicle if panel worked nor was secure b. annotated work ticket to reflect status of instrument panel			
Additional Comments - Interior Checks			

Appendix F

Performance Check - Last Parades

Exterior Checks

TASK	Y	N	COMMENTS
1. Conducted walk around to check for puddles of oil or other fluids. a. checked gear box b. checked all differentials c. checked planetary wheel drive d. checked inside of wheel wells for leaks on backing plates e. annotated work ticket if leaks found			
2. Checked propellers, rudders, and trim vane for condition and security. a. if damages noted, initiated corrective action or secured devices until returned to base. b. annotated work ticket to reflect damages to noted items and informed the Tpt NCO.			
3. Checked shock absorbers for condition and security. a. if damages noted, initiated corrective action			

TASK	Y	N	COMMENTS
b. if damages could not be corrected, grounded vehicle and initiated recovery action (if away from home unit) c. annotated work ticket to reflect damages to noted items and informed the Tpt NCO			
4. Checked wheels, tires, and rims for damage. a. replaced lost or damaged wheel nuts b. arranged for replacement of seriously damaged tire(s) c. if no spares or assistance available, "grounded" vehicle and reported damaged tire(s) to the Tpt NCO and noted it/them on the work ticket			
5. Performed a visual check of tires for over/under inflation. a. corrected all improper tire pressure readings			
6. Checked exterior lights and rear view mirrors a. cleaned dirty exterior lights and rear view mirrors b. replaced broken or inoperable light or mirror			

TASK	Y	N	COMMENTS
c. secured loose rear view mirror d. "grounded" vehicle if light or mirror cannot be replaced or fixed e. reported broken light/mirror to Tpt NCO and annotated the work ticket			
7. Checked condition of driver's vision devices (condition, cleanliness, and security). a. cleaned dirty vision devices b. replaced broken or inoperable devices c. secured loose vision devices d. "grounded" vehicle if vision devices cannot be replaced or fixed e. reported all broken or inoperable vision devices to Tpt NCO and annotated work ticket			
8. Replaced louvre covers to keep out water or snow.			
Additional Comments - Exterior Checks			

Fluid Levels

TASK	Y	N	COMMENTS
10. Checked radiator coolant level. a. if fluid level below acceptable limits, added correct amount and type of fluid b. annotated work ticket to reflect addition of coolant			
11. Checked engine oil level. a. verified that oil was not milky, frothy, or required changing b. if oil level below acceptable limits, added correct amount and type of oil c. annotated work ticket to reflect addition of oil or requirement to change it			
12. Verified hot transmission oil level a. verified that oil was not milky, frothy, or required changing b. if oil level below acceptable limits, added correct amount and type of oil			

TASK	Y	N	COMMENTS
c. annotated work ticket to reflect addition of oil or requirement to change oil			
13. Verified power steering fluid level (1 cm over full). a. if fluid level below acceptable limits, added correct amount and type of steering fluid b. annotated work ticket to reflect addition of power steering fluid			
14. Verified cooling fan drive fluid level a. verified that oil required changing b. If oil level below acceptable limits, added correct amount and type of oil c. annotated work ticket to reflect addition of cooling fan drive fluid			
15. Verified hydraulic brake fluid level (all reservoirs) a. if fluid level below acceptable limits, added correct amount and type of brake fluid b. annotated work ticket to reflect addition of brake fluid			

TASK	Y	N	COMMENTS
16. Verified de-icing reservoir fluid level (winter only). a. if fluid level below acceptable limits, added correct amount and type of fluid b. annotated work ticket to reflect addition of fluid			
17. Verified windshield washer fluid level a. if fluid level below acceptable limits, added correct amount and type of fluid b. annotated work ticket to reflect addition of fluid			
18. Topped up fuel tank (as required) a. if fuel level below acceptable limits, added correct amount and type of fuel b. annotated work ticket to reflect addition of fuel			
Additional Comments - Fluid Levels			

Power Pack

TASK	Y	N	COMMENTS
19. Visually checked the condition and tension of drive belts a. if belts too loose, tightened them to correct tension b. replaced all cracked or frayed belts c. annotated work ticket to reflect replacement of one or more drive belts			
Additional Comments - Power Pack			

Appendix G
Post-Test (Written)

1. During First Parades, the tires are inspected to ensure they have the following pressures: (2)
 - a. Front tires -
 - b. Rear tires -

2. List three things too low a tire pressure can result in: (3)
 - a.
 - b.
 - c.

3. When cold, the Radiator is checked to ensure the coolant level is approximately how far below the Filler Neck? (1)
 - a. 25.5 mm (1 inch)
 - b. 51.0 mm (2 inches)
 - c. 76.5 mm (3 inches)
 - d. 102 mm (4 inches)

4. When the engine is running, what three things is the Turbocharger checked for during First Parades?
(3)
- a.
 - b.
 - c.
5. Below is a list of five vehicle fluid reservoirs. Indicate the specific type of fluid, approved by both the manufacturer and the CF, used to fill each reservoir: (5)
- a. Radiator
 - b. Power Steering Fluid Reservoir
 - c. De-icing Fluid Reservoir
 - d. Cooling Fan Drive
 - e. Hydraulic Brake Fluid Reservoir
6. How many Master Hydraulic Brake Cylinders are there in an AVGP? (1)
- a. 1
 - b. 2
 - c. 3
 - d. 4

7. During First Parades, the four Air Valve Levers located in the driver's compartment which must be inspected to ensure they are switched off once the Air Reservoirs have been drained are: (4)
- a.
 - b.
 - c.
 - d.
8. When the engine is idling, the Oil Pressure Gauge should read (1)
- a. 2 kg/cm sq
 - b. 3 kg/cm sq
 - c. 4 kg/cm sq
 - d. 5 kg/cm sq
 - e. 6 kg/cm sq
9. During the First Parades warmup checks, what should the Voltmeter read? (1)
- a. 21 - 25 volts
 - b. 22 - 26 volts
 - c. 24 - 28 volts
 - d. 25 - 29 volts
 - e. 26 - 30 volts

10. In the winter, what is the MAXIMUM amount of Isopropyl Alcohol you can add to each tank full of diesel fuel? (1)
- a. 1/4 litre
 - b. 1/2 litre
 - c. 3/4 litre
 - d. 1 litre
11. When inspecting the Differentials, pay close attention to the presence of oil on or around which two parts of the Differential? (2)
- a.
 - b.

Post-Test Key

1. a. Front tires - 55 PSI
b. Rear tires - 45 PSI
2. a. tire overloading
b. abnormal tire wear
c. adverse vehicle handling
d. reduced fuel economy
3. a - 51 mm (2 inches)
4. a. air leaks
b. exhaust leaks
c. unusual noises
5. a. 3-GP-854 coolant
b. DEXRON II
c. Isopropyl Alcohol
d. DEXRON II
e. 3-GP-6C
6. b - 2
7. a. Trim Vane Air Valve
b. Six-Wheel Drive Air Valve
c. Marine Drive Air Valve
d. Driver's Seat Air Valve
8. a - 2 kg/cm sq
9. c - 24 - 28 volts
10. b - 1/2 litre

11. a. Differential Oil Plug
- b. Differential Seam

Appendix H

Student Evaluation of Course Materials

PRINCIPAL PURPOSE:

The data collected with this form are to be used for research purposes only.

ROUTINE USE:

This is an experimental data collection form. When name and Service Number are requested, they are to be used for administrative and statistical control purposes only. Full confidentiality of the responses will be maintained in the processing of this data.

DISCLOSURE:

Your participation in this research is strictly voluntary. Individuals are encouraged in the interest of research, but there will be no effect on individuals for not providing all or any part of the information. Write "NA" for each question that you cannot or do not wish to answer.

DIRECTIONS:

The first part of the questionnaire is designed to gather general information about how you viewed the course materials. You will find statements related to course organization and your general attitude to the computer-based training. Read each Evaluation Statement and place an (X) in the column which you feel most accurately describes the validity of that statement.

The second part of the questionnaire is comprised of open-ended questions. Read each question and note whatever comments you feel are applicable.

1 - Strongly Disagree 2 - Disagree 3 - Undecided
 4 - Agree 5 - Strongly Agree

EVALUATION STATEMENT	1	2	3	4	5	COMMENTS
7. Help materials/ refs/screens were easy to access and were useful in resolving areas of difficulty						
8. The instruction provided enough information for students to complete hands-on tasks.						
9. Students were not pressured to progress through course materials faster than they desired						
10. Students were able to perform hands-on tasks with minimal guidance.						
11. Time available for hands-on tasks was sufficient.						

1 - Strongly Disagree 2 - Disagree 3 - Undecided
 4 - Agree 5 - Strongly Agree

EVALUATION STATEMENT	1	2	3	4	5	COMMENTS
12. Instructor provided guidance when necessary during hands-on task(s)						
13. Instructor always answered students' questions.						
14. Module held the student's interest throughout the training.						
15. Overall, the instruction was effective.						
16. I would like to take another course using this type of instructional methodology.						

- 1 - Strongly Disagree 2 - Disagree 3 - Undecided
 4 - Agree 5 - Strongly Agree

EVALUATION STATEMENT	1	2	3	4	5	COMMENTS
17. I would recommended that others take this module of training.						

18. What did you like about the instructional materials?

19. What did you not like about the instructional materials?

20. What did you like about the method of presenting the instructional materials?

21. What did you not like about the method of presenting the instructional materials?

27. If you could change any aspect of the instruction to improve this course, what would you change?

Appendix I
Personal Information Survey Data

The Personal Information Survey was not administered until after all of the members of both groups had completed their training. This was done so as to prevent threats to, what Borg and Gall (1989) call, ecological validity due to the Hawthorne effect or novelty and disruption effects. In the case of the CBT group, the survey was administered after each portion of the sample (i.e., the Gagetown portion, the Petawawa portion or the Borden portion) had completed the training. The experimenter felt there was little risk to the validity of the information because of the separation, both in time and place, between each group.

The following abbreviations are used in the response summaries:

ID - identifying label for a participant

Ed - years of education

Asst - assisted with

Maint - maintenance

M113 - military number of a specific tracked
armoured personnel carrier

CBT Group

<u>ID</u>	<u>Age</u>	<u>Ed</u>	<u>Basic</u>	<u>Experience</u>
1	18	13	8/94	Cadets
2	21	10	8/92	Reserve
3	18	13	8/93	Cadets
4	19	9	4/93	None
5	20	11	8/93	None
6	21	12	8/94	Regular
7	19	13	8/93	Cadets
8	19	14	8/94	None
9	17	11	8/94	Cadets
10	19	11	6/93	Cadets
11	20	12	6/94	None
12	17	11	8/94	Cadets
13	18	13	8/93	Cadets
14	25	12	2/89	Regular
15	17	11	8/94	None
16	20	12	2/91	Regular
17	19	13	8/92	Cadets
18	17	11	8/94	Cadets
19	18	10	6/93	None
20	18	12	8/94	Cadets
21	20	10	8/94	Regular
22	18	12	8/94	None
23	19	10	8/94	None
24	18	12	8/94	Cadets
25	20	11	8/94	None
26	21	12	8/94	None
27	19	11	6/94	Cadets

Trad Group

<u>ID</u>	<u>Age</u>	<u>Ed</u>	<u>Basic</u>	<u>Experience</u>
30	20	12	3/91	Reserve
31	17	10	8/94	Cadets
32	21	10	4/93	Cadets
33	17	11	8/94	None
34	20	12	3/92	Reserve
35	21	11	6/90	Cadets
36	18	12	8/93	Cadets
37	17	11	8/94	None
38	20	11	9/90	None
39	19	11	3/91	Cadets
40	17	10	3/94	Cadets
41	20	10	5/93	None
42	21	12	6/91	Cadets
43	18	12	8/93	Cadets
44	20	14	8/93	None
45	17	11	6/94	None
46	21	12	3/90	Cadets
47	19	11	11/92	Cadets
48	18	12	8/93	Cadets
49	17	10	5/94	None
50	19	14	8/92	Reserve
51	24	13	10/88	Regular
52	19	13	1/93	Cadets
53	18	12	8/93	Cadets
54	19	12	8/93	Cadets
55	19	13	5/93	Cadets
56	18	13	8/93	Cadets
57	19	13	8/93	Cadets
58	18	12	2/94	None
59	18	12	8/93	Cadets

CBT Group

<u>ID</u>	<u>In AVGP Before</u>	<u>Asst Maint</u>	<u>Type of Maint</u>	<u>Instruction On AVGP</u>
1	2	6/7	General	None
2	>10	>10	Driver	Ad hoc
3	2	5/6	General	None
4	6/7	1	General	None
5	0	0	None	None
6	2/3	1/2	General	None
7	6/8	2	General	None
8	1	6/7	Engine	None
9	1	0	None	None
10	5/6	0	None	None
11	2/3	0	None	None
12	1	0	None	None
13	2/3	1	Driver	None
14	> 9	> 5	All	None
15	1/2	0	None	None
16	4/5	0	None	None
17	5/6	2/4	General	None
18	1/2	1	General	None
19	0	0	None	None
20	1/2	1/2	Driver	None
21	1/2	3/4	Radios	Regular
22	1/2	1	General	None
23	1/2	0	None	None
24	1/2	0	None	None
25	1/2	0	None	None
26	1/2	0	None	None
27	0	0	None	None

Trad Group

<u>ID</u>	<u>In AVGP</u> <u>Before</u>	<u>Asst</u> <u>Maint</u>	<u>Type of</u> <u>Maint</u>	<u>Instruction</u> <u>On AVGP</u>
30	> 9	0	None	None
31	1/3	3	General	None
32	8/9	0	General	None
33	1/2	0	None	None
34	2/3	0	None	None
35	0	0	None	None
36	> 9	> 3	General	None
37	0	0	None	None
38	4/5	4/5	General	None
39	6/9	3/4	General	None
40	1/2	1	General	None
41	0	0	None	None
42	8/9	2/3	General	None
43	1/2	0	None	None
44	0	0	None	None
45	1/2	1	General	None
46	0	0	None	None
47	4/5	> 5	General	None
48	5/6	2	General	None
49	1/2	0	None	None
50	0	0	None	None
51	0	0	None	None
52	>10	> 3	General	None
53	1/2	1	Driver	None
54	3	3	General	None
55	1/2	1	General	None
56	1/2	1	General	None
57	6/7	> 4	General	None
58	0	0	None	None
59	1/2	1	General	None

CBT Group

ID	M113 Qual	Asst Maint On M113	Type of Maint On M113	Instruction On M113
1	No	0	None	None
2	No	0	None	None
3	No	0	None	None
4	No	0	None	None
5	No	2/3	General	None
6	No	0	None	None
7	No	1	General	None
8	No	0	None	None
9	No	0	None	None
10	No	2/3	Track	None
11	No	0	None	None
12	No	0	None	None
13	No	0	None	None
14	No	0	None	None
15	No	0	None	None
16	Yes	> 9	Driver	Formal
17	No	0	None	None
18	No	0	None	None
19	No	0	None	None
20	No	0	None	None
21	No	0	None	None
22	No	0	None	None
23	No	0	None	None
24	No	0	None	None
25	No	0	None	None
26	No	0	None	None
27	No	0	None	None

Trad Group

<u>ID</u>	<u>M113 Qual</u>	<u>Asst Maint On M113</u>	<u>Type of Maint On M113</u>	<u>Instruction On M113</u>
30	No	0	None	None
31	No	0	None	None
32	No	0	None	None
33	No	0	None	None
34	No	0	None	None
35	Yes	> 5	Driver	Formal
36	No	0	None	None
37	No	0	None	None
38	Yes	> 5	Driver	Formal
39	No	0	None	None
40	No	0	None	None
41	No	0	None	None
42	No	0	None	None
43	No	0	None	None
44	No	0	None	None
45	No	0	None	None
46	Yes	> 5	Driver	Formal
47	No	0	None	None
48	No	0	None	None
49	No	0	None	None
50	No	0	None	None
51	Yes	> 8	Driver	Formal
52	No	0	None	None
53	No	0	None	None
54	No	0	None	None
55	No	0	None	None
56	No	0	None	None
57	No	0	None	None
58	No	0	None	None
59	No	0	None	None

Appendix J

CBT Training Data - Knowledge Tests

ID	Pre-Test Score (Entry)	Post-Test Score (Exit)	Improvement	Time to Complete Module (Mins)
1	3	22	19	45
2	5	25	20	25
3	3	22	19	47
4	0	14	14	180
5	3	21	18	42
6	5	23	18	33
7	1	18	17	28
8	4	25	21	30
9	0	18	18	48
10	0	19	19	63
11	1	19	18	25
12	0	19	19	73
13	3	22	19	82
14	4	24	20	25
15	2	21	19	65
16	6	25	19	27
17	2	24	22	49
18	2	20	18	66
19	0	20	20	69
20	1	23	22	45
21	4	23	19	48
22	1	23	22	25
23	2	21	19	46
24	2	22	20	37
25	1	20	19	45
26	0	20	20	50
27	1	20	19	22
<u>M</u>	2.07	21.22	19.15	49.60
<u>SD</u>	1.75	2.55	1.63	30.88

Appendix K
CBT Training Data - Skill Tests

ID	Pre-Test Score <u>Entry)</u>	Post-Test Score <u>(Exit)</u>	Improvement	Time In Practice <u>(Mins)</u>
1	5	87	82	82
2	6	87	81	79
3	5	86	81	82
4	0	72	72	179
5	4	86	82	79
6	3	84	81	100
7	1	79	78	84
8	6	88	82	93
9	0	68	68	44
10	0	77	77	101
11	3	81	78	88
12	1	80	79	116
13	2	84	82	98
14	7	89	82	91
15	1	82	81	122
16	27	90	63	64
17	4	85	81	87
18	2	81	79	127
19	0	78	78	130
20	3	85	82	76
21	4	85	81	113
22	2	83	81	183
23	3	84	81	111
24	2	83	81	87
25	1	82	81	119
26	1	83	81	111
27	0	82	82	69
<u>M</u>	3.44	82.63	79.15	100.56
<u>SD</u>	5.13	4.86	4.55	30.78

Appendix L

Traditional Training Data - Knowledge Tests

ID	Pre-Test Score (Entry)	Post-Test Score (Exit)	Improvement	Time to Complete Module (Mins)
30	1	18	17	80
31	5	19	14	80
32	1	20	19	80
33	0	20	20	80
34	1	20	19	80
35	13	25	12	80
36	3	23	20	80
37	1	19	18	80
38	4	23	19	80
39	5	21	16	80
40	2	18	16	80
41	0	19	19	80
42	6	24	18	80
43	2	22	20	80
44	0	22	22	80
45	2	20	18	80
46	8	24	16	80
47	3	24	21	80
48	6	22	16	80
49	2	22	20	80
50	2	22	20	80
51	1	23	22	80
52	4	21	17	80
53	3	21	18	80
54	7	23	16	80
55	4	21	17	80
56	3	21	18	80
57	5	25	20	80
58	0	20	20	80
59	4	23	19	80

<u>M</u>	3.27	21.50	18.23	80
<u>SD</u>	2.84	1.96	2.25	

Appendix M

Traditional Training Data - Skill Tests

ID	Pre-Test Score (Entry)	Post-Test Score (Exit)	Improvement	Time In Practice (Mins)
30	2	81	79	610
31	4	84	80	610
32	0	84	84	610
33	1	88	87	610
34	1	86	85	610
35	28	90	62	610
36	5	88	83	610
37	0	85	85	610
38	7	89	82	610
39	8	87	79	610
40	1	82	81	610
41	0	83	83	610
42	4	87	83	610
43	2	87	85	610
44	0	85	85	610
45	2	86	84	610
46	9	90	81	610
47	6	89	83	610
48	4	88	84	610
49	1	86	85	610
50	1	88	87	610
51	10	90	80	610
52	3	86	83	610
53	2	86	84	610
54	5	89	84	610
55	3	87	84	610
56	3	87	84	610
57	6	89	83	610
58	0	85	85	610
59	2	88	86	610
<u>M</u>	4.00	86.67	82.67	610
<u>SD</u>	5.32	2.32	4.43	

Appendix N

Student Evaluation of the Course - CBT Group Data

The Student Course Critique was administered after the student completed his/her training, the Written Performance Check and the Practical Performance Check.

The following abbreviations are used in the response summaries:

ID - identifying label for a participant

Aim - aim of training was clear

<u>ID</u>	<u>Aim</u>	<u>Materials related to objective</u>
1	5	5
2	4	4
3	4	4
4	3	3
5	4	4
6	4	5
7	4	2 - not everything required taught
8	5	4
9	4	4 - "I guess so"
10	4	3 - didn't understand this question
11	4	4
12	5	5 - didn't stray from topic
13	5	5
14	4	4
15	5	5
16	5	5
17	5	5
18	4	4 - not certain
19	4	3
20	5	5
21	4	4
22	4	4 - "I guess so"
23	4	4
24	4	3
25	4	4
26	4	4
27	4	4

<u>ID</u>	<u>Course topics followed logical sequence</u>
1	3 - did not follow sequence - could not say
2	3 - didn't look at all screens - couldn't say
3	5
4	3 - "Don't know"
5	4
6	4
7	4 - "What materials and topics there were"
8	4
9	4
10	4 - did not follow sequence - could not say
11	4 - did not follow sequence - could not say
12	5
13	4
14	4
15	5
16	4
17	3 - did not follow sequence - could not say
18	3
19	3 - did not follow sequence - did not know

20	4
21	4
22	3
23	4
24	3
25	4
26	4
27	3 - did not follow sequence - could not say

ID Course instruction easy to understand/follow

1	5
2	4 - "Agree. Program, however, is overkill."
3	5
4	1 - "Too much reading and pictures not clear."
5	5
6	4
7	4 - "What material there was."
8	4 - "Everything pretty straight forward."
9	2 - "Too much reading."
10	2 - "Too many things to remember."
11	5 - "Almost too easy."
12	5
13	5
14	4
15	5
16	5
17	5
18	3
19	1 - too much reading - his English not good
20	4 - "Seemed a little simplistic."
21	4 - reminded him of PIPs taken on tech training
22	4
23	4 - couldn't remember much, but easy to follow
24	4
25	4
26	4
27	4

ID Drawings/graphics clear/easily understood

1	2 - program only worked because beside vehicle
2	2 - some pictures not as clear as desired
3	2 - program only worked because beside vehicle
4	2 - some pictures not as clear as desired
5	2 - program only worked because beside vehicle
6	2 - presence of cougar helped clarify pictures
7	1 - most pictures not as clear as desired
8	2 - some pictures not as clear as desired

9 1 - most pictures not as clear as desired
 10 2 - some pictures not as clear as desired
 11 2 - some pictures not as clear as desired
 12 4 - related pictures to vehicle - no problem
 13 5 - related pictures to vehicle - no problem
 14 2 - some pictures not as clear as desired
 15 2 - should use 256 colour in super VGA
 16 3 - related pictures to vehicle - no problem
 17 4 - related pictures to vehicle - no problem
 18 2 - most pictures not as clear as desired
 19 2 - some pictures not as clear as desired
 20 4 - related pictures to vehicle - no problem
 21 1 - program only worked because beside vehicle
 22 2 - some pictures not as clear as desired
 23 3 - only a few were not clear - vehicle there
 24 3
 25 4 - "Not great, but clear enough."
 26 3 - "Pictures so-so."
 27 1 - definitely did not like quality of pictures

ID **Guide/Help materials were helpful**
 1 4
 2 3 - did not look at it
 3 4
 4 3 - did not look at it
 5 4
 6 3 - did not look at it
 7 2 - wanted more personalized guidance
 8 3 - did not look at it
 9 3 - did not look at it
 10 4 - provided some assistance
 11 3 - did not look at it
 12 3 - did not look at it
 13 3 - did not look at it
 14 3 - did not look at it
 15 4 - looked good but did not require it
 16 3 - did not look at it
 17 3 - did not look at it
 18 4 - it was what was required
 19 2 - yes but wanted outlines
 20 3 - did not look at it
 21 4 - wanted detailed outlines included
 22 3 - did not look at it
 23 2 - wanted detailed pictures in it
 24 3
 25 3 - did not look at it
 26 3 - helped some but not complete enough
 27 3 - did not look at it

<u>ID</u>	<u>Instruction enough to complete tasks</u>
1	5
2	3 - did not look at all of program
3	4 - worked for him - only driving 6 months
4	1 - "I would have done better if it was."
5	4
6	4
7	1 - "No way. Would have done better..."
8	4
9	2
10	2 - required instructor's help to finish
11	3 - did not look at all of program
12	4
13	5
14	5 - "No ___ like on my driver wheel course"
15	5
16	3 - did not look at all of program
17	5
18	3
19	2 - "...could not understand everything"
20	4 - Yes, however, wanted more details
21	4 - info good but wanted better pictures
22	4
23	4 - with instructor's help
24	3
25	4
26	4
27	2 - "Didn't give me what I needed."

<u>ID</u>	<u>Students not pressured to progress faster</u>
1	4 - personal pressure only
2	5
3	4
4	4
5	5 - liked doing things this way
6	5 - just like a PIP, no pressure
7	4
8	5 - afraid not taking enough time
9	4
10	4
11	5
12	4 - "I liked moving at my own pace"
13	5
14	5 - "lots of time - no worry"
15	5 - enough time therefore no pressure
16	4
17	5
18	4

19	5
20	4
21	5
22	5
23	5
24	4
25	5 - "Only self-generated panic"
26	4
27	5

<u>ID</u>	<u>Student can perform tasks with minimum guidance</u>
1	4
2	3 - for him yes, but could not talk for others
3	4
4	2 - no comment here but required help
5	4
6	5 - "...program made things easy to understand"
7	1 - "If they did, I would have done better"
8	5
9	2 - instruction did not work for him
10	2 - required some help to perform parades
11	5
12	4
13	5
14	5
15	5
16	4 - for him yes, but could not talk for others
17	5
18	4
19	2 - "maybe for les anglais"
20	4
21	3 - "With better pictures perhaps."
22	4
23	4
24	3
25	4 - "being able to repeat sections helped"
26	5 - "hands on learning by vehicle made it work"
27	3 - felt program did not work because he did not do well on the practical

<u>ID</u>	<u>Student's questions answered/guidance provided</u>
1	3 - never asked questions/required guidance
2	3 - never asked questions/required guidance
3	3 - never asked questions/required guidance
4	4
5	3 - never asked questions/required guidance
6	3 - never asked questions/required guidance

7 3
 8 3
 9 2 - "instructor too pushy, interfered too much"
 10 5
 11 3 - never asked questions/required guidance
 12 3 - never asked questions/required guidance
 13 3 - never asked questions/required guidance
 14 3 - never asked questions/required guidance
 15 4 - "when required"
 16 4 - he only saw one person request help
 17 3 - he saw no one ask for help/information
 18 3 - never asked questions/required guidance
 19 5 - instructor support excellent
 20 3 - never asked questions/required guidance
 21 4
 22 3
 23 5 - "Instructor was always there when required"
 24 3
 25 4 - saw instructor help others when required
 26 3 - never asked questions/required guidance
 27 2 - if true, he felt he should have done better

ID**Motivating**

1 4 - self-pacing and own direction motivating
 2 2 - did not require all of the training
 3 4
 4 2
 5 5 - wanted to see more of the program
 6 4
 7 2 - found it boring
 8 4
 9 4
 10 2 - too much reading
 11 5 - self-pacing and own direction motivating
 12 5 - liked idea and organization of program
 13 5 - self-pacing and own direction motivating
 14 4 - self-pacing and own direction motivating
 15 5
 16 4
 17 4
 18 4
 19 2 - too much reading
 20 5
 21 2 - quality of pictures made it amateurish
 22 4 - self-pacing and own direction motivating
 23 4
 24 3
 25 4 - self-pacing and own direction motivating

26 4
 27 1 - "too much time allotted, got bored"

ID Overall, instruction was effective.

1 5
 2 3 - could not say - did not look at much of it
 3 4
 4 1 - too much reading - likes formal instruction
 5 4 - learned much from it
 6 5
 7 1 - "No way!"
 8 4
 9 2 - "If it was, why didn't I do better"
 10 2 - had to remember too much
 11 5
 12 4
 13 5
 14 4
 15 5
 16 5
 17 5
 18 3 - could not really say one way or the other
 19 2 - too much reading
 20 4
 21 4
 22 4
 23 4
 24 3
 25 4
 26 4
 27 1 - blamed his poor performance on the module

ID Want more courses in this methodology

1 4
 2 4 - only if it was on a more difficult topic
 3 5
 4 1 - needs standup instruction to learn
 5 5
 6 5 - "beats some yahoo reading from a book"
 7 1
 8 5 - liked the freedom the program gave him
 9 4
 10 1 - "...not without talking explanations."
 11 5
 12 4
 13 5

- 14 4
15 5
16 5 - "...better than standup instruction with an
unprepared instructor."
17 4
18 1 - did not know if he learned with this type of
instruction
19 3 - must be in French
20 5 - for a more difficult topic
21 4 - would want better graphics and animation
22 3 - it depended on the quality of the program
23 4 - "Would like one of those multi-media efforts."
24 3
25 4 - "I would like to take the program home with me
so that I could prepare the lesson ahead of
time."
26 3 - "It would depend on the topic and how the
program was executed."
27 1 - would not consider this option again.

Appendix O

Student Evaluation of the Course - Trad Group Data

The Student Course Critique was administered after the student had finished his/her training, the Written Performance Check and the Practical Performance Check. Students number 44 and 49 failed to return their critiques while student number 52 returned his without completing it. Therefore, no reference is made to the data of these individuals.

The following abbreviations are used in the response summaries:

ID - identifying label for a participant

obj - objective

instr - instructor

pd - period

<u>ID</u>	<u>Aim of training was clear</u>
30	4
31	4
32	4
33	5
34	5
35	4
36	4
37	2 - never really explained to them
38	4
39	1 - not certain as "instr babbled alot"
40	1
41	2 - uncertain if first instr told them
42	3 - had talked to other instrs
43	3 - talked to other instrs and his buddies
45	4
46	4
47	5
48	4
50	4
51	4
53	4
54	4
55	4
56	4
57	2 - self-evident, but not explained
58	4
59	4

<u>ID</u>	<u>Materials related to objective</u>
30	4
31	4 - did not know about the written materials
32	3 - for most part, but not always
33	4
34	4
35	2 - not always - depended upon the instr
36	4
37	3 - hard to tell if you don't know lesson obj
38	4 - instr sometimes strayed from intent of pd
39	3 - not certain about first part of course
40	2 - alot of unnecessary information presented
41	3
42	4 - majority of second instr's, yes
43	3 - not with first instr
45	4
46	4
47	4
48	3 - not sure
50	4

51 4
 53 3 - not always
 54 4
 55 4
 56 4
 57 4
 58 4
 59 3 - uncertain in a couple of cases

ID Course topics followed logical sequence

30 2 - sometimes classes switched around and were out of order. Had to think how materials fit together.
 31 2 - except when schedules changed due to absence of instr, vehicles, training aids, etc. Sometimes missed an entire pd.
 32 4
 33 2 - questioned why they needed to understand coolant flow within engine in order to do First Parades. Same with information on electrical system.
 34 4
 35 4
 36 4
 37 3
 38 3 - not always
 39 4 - only after first instr was replaced
 40 1 - later in the course, yes
 41 2 - not during the first part of the course
 42 4 - "If you stand back and look at the global picture, yes. Some pds, however, were out of sequence for various reasons."
 43 4
 45 4
 46 4
 47 4 - better than some high school automotives courses
 48 3
 50 2 - sometimes had scheduling problems which resulted in instruction out of sequence
 51 4
 53 2 - questioned the logic of some of the materials and the importance of memorizing some types fluids
 54 4
 55 4
 56 2 - sometimes lessons out of sequence

- 57 2 - availability of equipments, training aids, etc dictated the sequence of instruction. Their instr made the link for them; others, however, did not.
- 58 4
- 59 3 - not certain - he would have taught it differently.

ID **Course instruction easy to understand/follow**

- 30 2 - sometimes instr spoke too fast
- 31 4
- 32 4
- 33 4 - except for the logic noted in previous question
- 34 4 - except when the one instr read out of the book, then he mumbled alot
- 35 4
- 36 5
- 37 4 - found the instruction boring and too full of unnecessary material to listen closely
- 38 4
- 39 4 - with second instr, yes. Not with first.
- 40 3
- 41 2
- 42 2 - instruction by first instr was confused, poorly organized, and poorly presented; therefore, hard to follow.
- 43 3 - once he talked to his buddies and they put materials into perspective for him
- 45 3
- 46 4 - encountered much of the material on his M113 course
- 47 5
- 48 2 - had to get help of student 55 - worked closely together whenever possible
- 50 4
- 51 4 - had most of it before
- 53 3 - did not agree with relevance of some of the materials
- 54 4
- 55 4
- 56 4
- 57 4
- 58 4
- 59 4

<u>ID</u>	<u>Drawings/graphics clear/easily understood</u>
30	4 - some of the charts require replacing
31	4
32	5 - drawings good but sometimes hard to read
33	4 - some of the charts require replacing
34	4
35	4
36	4
37	4
38	4
39	4
40	4
41	4
42	4
43	4 - visual aids getting old - need replacement
45	3
46	4
47	5
48	4
50	4 - need some new charts
51	4
53	4
54	4
55	4
56	4
57	4
58	4
59	4

<u>ID</u>	<u>Guide/Help materials were helpful</u>
30	3 - had problems with level of language used in texts, when he could find them
31	4 - did not really need them
32	3 - could not read the materials. Had others read them to him and he memorized what was said.
33	2 - sometimes a major effort to find the help materials. Often had to get them after class or during lunch pd.
34	2 - not always available
35	2 - not always available
36	3 - occasionally hard to find
37	3 - did not read them
38	3 - did not read them
39	1 - first instr did not issue any to class
40	3 - did not look for them
41	1 - first instr did not issue any to class

42 2 - none available until first instr replaced
 43 4
 45 4
 46 3 - did not look for them/did not read
 47 4 - helpful yes but manuals not really put
 together well
 48 3
 50 3 - did not read them
 51 3 - did not read them
 53 3 - did not read them
 54 4 - not as good as some of his school automotives
 texts
 55 3 - did not read them
 56 4 - would have preferred more detail
 57 2 - not enough to go around
 58 3 - did not require it - he listened in class
 59 5 - had his own references from a buddy at Base
 Maintenance - quite happy with them

ID **Instruction enough to complete tasks**
 30 4 - follow up instruction while doing maintenance
 helped to ensure job could be done
 31 4 - items missed in classed picked up during
 practice sessions. Problem seeing things
 being pointed out in tight spaces.
 32 4
 33 5
 34 4
 35 4
 36 4 - provided they listened in class
 37 2 - "If I hadn't talked to guys in other sections,
 I wouldn't have known what to do."
 38 5
 39 4 - with second instr only
 40 2
 41 4 - not with first instr
 42 2 - not with first instr
 43 2 - needed help of his mates as well as second
 instr
 45 3
 46 4 - encountered much of material on M113 course
 47 5
 48 2 - needed the help of student 55
 50 4 - experienced no difficulty with material
 51 4 - encountered much of material on M113 course
 53 4
 54 4
 55 4

56 4
 57 4
 58 4
 59 4

ID Students not pressured to progress faster

30 2 - too fast in some of the theory classes
 31 4
 32 4
 33 5 - sometimes too much time allotted for a pd
 34 2 - some slower students pressed for time
 35 4 - those with Driver Track and MLVW qualification
 frustrated with slow pace of instruction.
 36 5
 37 5 - sometimes too much time allotted for a pd
 38 5
 39 2 - "had to play catch up after first instr
 replaced"
 40 4
 41 3
 42 4
 43 4
 45 4
 46 4 - those with Driver Track and MLVW qualification
 frustrated with slow pace of instruction
 47 4 - sometimes too much time allotted for a pd
 48 4
 50 4
 51 4 - those with Driver Track and MLVW qualification
 frustrated with slow pace of instruction
 53 4 - "...if we would get rid of some of the
 unnecessary material, we would progress more
 quickly..."
 54 4
 55 4 - progressed too slowly - a lot of people slept
 in class
 56 4
 57 4 - sometimes too much time allotted for a pd
 58 4 - sometimes too much time allotted for a pd
 59 4

ID Student can perform tasks with minimum guidance

30 4
 31 3 - some students required alot of help due to
 weakness of one instr
 32 3 - if others had not read materials to him, he
 does not know if he could do tasks with what
 he learned in class

33 4 - most students yes - some, however, no
 34 4 - only the slower students required additional
 help or guidance
 35 4
 36 4
 37 4 - required assistance from his friends
 38 4
 39 4
 40 2 - he and his friends required alot of help
 41 2 - "...not after first instr screwed us up"
 42 3 - "I had no problems, but some of the others
 weren't so fortunate. Hard to say because
 I had help after class from my buds."
 43 4
 45 3
 46 5
 47 5
 48 4
 50 4 - if attention was paid in class
 51 5
 53 4
 54 5
 55 4
 56 4 - had no problems and requested no assistance
 57 4
 58 4
 59 4

ID **Student's questions answered/guidance provided**
 30 2 - questions not answered if time was short
 31 4 - sometimes questions not answered
 32 4
 33 4 - asked no questions/requested no assistance
 34 3 - some instrs only provided help when requested,
 others watched students closely and provided
 guidance as required
 35 2 - when time short, instr promised answers next
 next class but usually forgot
 36 2 - depended upon the instr
 37 2 - depended upon instr/time left in class
 38 3 - asked no questions/requested no assistance
 39 2 - second instr did not have time - had to
 rectify problems created by first instr
 40 1 - none of his questions answered
 41 2 - second instr did not have time - had to
 rectify problems created by first instr
 42 2 - second instr did not have time - had to
 rectify problems created by first instr

- 43 2 - second instr too pressed playing catchup as first instr did not care
- 45 3 - asked no questions/requested no assistance
- 46 3 - asked no questions/requested no assistance
- 47 4
- 48 3
- 50 4 - "I had no problems here because I didn't ask any questions; however, this was not always the case with the weaker members of course."
- 51 3 - asked no questions/requested no assistance
- 53 1 - first instr ignored many of his questions
- 54 4 - all of his questions answered
- 55 5
- 56 4 - all his question answered
- 57 3 - asked no questions/requested no assistance
- 58 4
- 59 2 - not when instr pressed for time

ID**Motivating**

- 30 4 - this is the basis of all our maintenance
- 31 3 - some lectures were boring
- 32 4 - liked to work with vehicles
- 33 2 - boring because some parts too slow
- 34 2 - those with parallel qualifications were frustrated due to the repetitiveness of material
- 35 2 - much of the theory was boring
- 36 4
- 37 2 - too much unnecessary theory
- 38 2 - holds parallel qualification - bored
- 39 3 - first instr ruined the course for him
- 40 1 - first instr ruined the course for him
- 41 2
- 42 3 - "If I was not personally interested in vehicles, I don't think the instruction of the module would have peaked my interest."
- 43 4 - self-motivated; therefore, found ways of making the materials interesting to him
- 45 3 - it was acceptable
- 46 4 - bored with the theory he had already had, but liked the practical
- 47 5 - liked to work on vehicles
- 48 4 - working with student 55 made it interesting
- 50 4 - no different than his college courses
- 51 3
- 53 2 - too much unnecessary theory
- 54 4
- 55 3 - not particularly motivating

56	4
57	2 - some material dry and of questionable value
58	4
59	4

ID **Overall, instruction was effective.**

30	4
31	4
32	4
33	4
34	4
35	4
36	5
37	3
38	4
39	3
40	3 - second instr had too much catching up to do for an unqualified yes
41	2
42	3 - "Hard to say because I talked with other students, instrs, Battalion Tpt NCO..."
43	4 - felt he could do the job
45	3
46	4
47	4
48	3
50	4
51	3
53	3
54	5
55	4
56	4
57	4
58	4
59	4

ID **Want more courses in this methodology**

30	2 - no choice in the matter
31	3 - would prefer something different
32	3 - wants video with closeups
33	4 - does not matter to him
34	4 - would like variety if possible
35	3 - wants something that offers more variety
36	4 - no choice in the matter
37	3 - no choice in the matter
38	3 - no choice in the matter
39	3 - not without a decent instr

40 1 - not without a decent instr
41 2 - not without a decent instr
42 3 - no choice but would like better instrs
43 3 - depends on topic and nature of material
45 3
46 3 - no choice in the matter
47 3 - no choice in the matter
48 3 - no choice in the matter
50 3
51 3
53 2 - would like variety if possible
54 3
55 2 - no choice in the matter
56 4
57 4
58 3 - only if the material suits methodology
59 3 - no choice in the matter

Appendix P

Costs Per Student - CBT Training (N = 27)

Cost Factors	Cost Per Hr Per Student	Module Total (Av 3.44 Hrs)
Course Warrant	0.93	3.19
Instructors (3)	2.78	9.58
Student (Cpl/Pte)	13.76	47.34
Base Support (per day per student)	0.00	0.00
Facility Costs		
Building Maintenance	0.56	1.91
Janitorial Services	0.23	0.78
Electricity	0.13	0.45
Heating	0.20	0.69
Water/Sewage	0.11	0.37
CBT Courseware (amortized over 10 years)	0.06	0.22
O&M on Courseware (20% per year)	0.01	0.04
Computer Costs (amortized over 5 yrs)	0.01	0.04
O&M on Equipment (20% per year)	0.01	0.04
Training Aids and Materials	1.42	4.90
Average Cost Per Student	20.22	69.55

Source of Costing Formulae and Data

The formulae contained herein were derived from the Head Costing Model (Head, 1985). The data itself and the determination of amortization periods were drawn from the Directorate of Costing Services handbook for 1993/94 (CF, 1993).

Interpretation of Figures

1. Instructional Staff Costs - The instructional staff is comprised of the following:

- a. Course Warrant
- b. Instructors (3 X WO/Sgt)

Because this is a self-paced package, the course was run at the section level with a maximum of five students undergoing training at any one time. This required one instructor. Three instructors are indicated because the training took place at three distinct locations with some overlap of training time. The Course Warrant was the evaluator.

2. Student Costs - Because the samples for both the Trad and the CBT groups were composed of Reserve Cpls and Ptes, and Regular Cpls and Ptes, a combined average wage was used (CF, 1993).
3. Base Support - This was unit conducted OJT; therefore, no Base support of any type was required.
4. Facility Costs (CF, 1993) - This figure is actually the sum of the following:
 - a. Building Maintenance Costs;
 - b. Janitorial Service Costs;
 - c. Electricity Costs;
 - d. Heating Costs; and
 - e. Additional Per Person Costs (water, etc.).

5. CBT Courseware Costs (Per Hour) (Head, 1985) - This figure is determined using the following formula:

$$\text{Cost Per Hr} = \frac{\text{(Development Costs)}}{\text{(Per Yr Trg Hrs) (Amortization Pd)}}$$

- a. Development Costs - The 1993 CBT Report (Blumberg, 1993), the NIDA Corporation (NIDA, 1994), and ADGA Consulting Services (Gilles Napier, personal communication January 19, 1995) indicated that low to middle level CBT and hypertext CBT can be produced by an experienced contractor for approximately \$10,000 US (\$13,899 Cdn) per courseware hour. Ninety minutes of courseware would, therefore, cost approximately \$20,833.50 Cdn to produce.
- b. Training Time Per Year - In the AATE Report (CF, 1990b), ADM (Per) indicated there are 189 real training days per year (i.e., that time assigned to non-operational and administrative time). This translates into 1228.5 training hours per year.
- c. Amortization Period - The average life expectancy of a course in the CF is 10 years (CF, 1993). This is not an unreasonable amortization period for DND courses and courseware. For example, the Course Training Plan upon which this study is based was first produced in 1974 when the AVGP was purchased for the army. As noted in the Bibliography, the course design document was modified in 1986 to reflect amendment to the training (CF, 1986b). A second example involve the QMath program used by Donnelly (1993) in his study on predicting achievement in a Computer Assisted Learning environment. The QMath courseware was produced in 1981, introduced into the Canadian Navy in 1984 and remains in use unchanged to this day.
6. Operation and Maintenance Costs - A figure of 20% of the Courseware Costs per year is used to determine the O&M Costs for the courseware (CF, 1993).

7. Equipment Costs (Head, 1985) -

$$\text{O\&M Per Hr} = \frac{\text{(Purchase Cost)}}{\text{(Per Yr Trg Hrs) (Amortization Pd)}}$$

- a. Purchase Costs - The cost of the computer and support hardware and software.
 - b. Training Time Per Year - See paragraph 5.b.
 - c. Amortization Period - The average life expectancy of computer equipment in the CF is five years (CF, 1993).
8. Operation and Maintenance Costs - A figure of 20% of the Equipment Costs per year is used to determine the O&M Costs for both the hardware and supporting software (CF, 1993).
9. Training Aids and Materials - This is the per student cost of the handouts, pens, paper, etc. normally issued during a course (Head, 1985).

Appendix Q

Cost Per Student - Traditional Training (N = 30)

Cost Factors	Cost Per Hr Per Student	Module Total (Av 13.0 Hrs)
Course Commander	0.97	12.57
Course Warrant	0.84	10.86
Instructors (3)	2.51	32.57
Assistants (5)	3.88	50.43
Adm NCO	0.78	10.09
Student (Cpl/Pte)	13.76	178.91
Base Support (per day per student)	0.47	6.13
Facility Costs		
Building Maintenance	0.50	6.50
Janitorial Services	0.20	2.65
Electricity	0.12	1.54
Heating	0.18	2.34
Water/sewage	0.11	1.38
Trad Courseware (amortized over 10 years)	0.61	7.91
O&M on Courseware (20% per year)	0.12	1.58
Equipment Costs (amortized over 5 years)	>0.01	0.04
O&M on Equipment (20% per year)	>0.01	0.04
Training Aids and Materials	1.28	16.67
Average Cost Per Student	25.04	342.21

Source of Costing Formulae and Data

The formulae contained herein were derived from the Head Costing Model (Head, 1985). The data itself and the determination of amortization periods were drawn from the Directorate of Costing Services handbook for 1993/94 (CF, 1993).

Interpretation of Figures

1. Instructional Staff Costs - These are the sum of the following costs:
 - a. Course Commander (Capt);
 - b. Course WO (WO/Sgt);
 - c. Instructors (3 X WO/Sgt);
 - d. Assistant Instructors (5 X Sgts/MCpls); and
 - e. Administrative NCO/driver.

The manning level of the course is dependent upon the number of students attending training. The working areas inside the vehicle and the engine compartment are cramped; therefore, only one student and an instructor can peer/climb into them at a time. This necessitates a higher instructor to student ratio so that the required training can occur in the allotted time.

2. Student Costs - Because the samples for both the Trad and the CBT groups were composed of Reserve Cpls and Ptes, and Regular Cpls and Ptes, a combined average wage was used (CF, 1993).
3. Base Support - This was a formally conducted course comprising both Reserve and Regular Force personnel; therefore, a Base Support Cost was incurred. CFB Esquimalt and 3PPCLI were required to provide additional administrative support to the course in the form of in- and out-clearance of Reservists, the tracking of Reserve pay and allowances, providing rations and quarters, etc. (CF, 1993).

4. Facility Costs (CF, 1993) - This figure is actually the sum of the following:
- a. Building Maintenance Costs;
 - b. Janitorial Service Costs;
 - c. Electricity Costs;
 - d. Heating Costs; and
 - e. Additional Per Person Costs (water, etc.).
5. Trad Courseware Costs (Per Hour)(Head, 1985) - This figure is determined using the following formula:

$$\text{Cost Per Hr} = \frac{\text{(Development Costs)}}{\text{(Per Yr Trg Hrs) (Amortization Pd)}}$$

- a. Development Costs - Traditional training in the CF is usually designed by a team consisting of a captain and two Sgts/WO. These personnel are generally not training developers although training development support is available. The CF, therefore, uses the figure of 10 hours development time for every hour of training courseware (CF, 1987d). This figure does not, however, include the cost of administrative support staff and Audio Visual support staff. The development costs, herein, reflect sum of the costs of all these personnel (CF, 1993).
- b. Training Time Per Year - In the AATE Report (CF, 1990b), ADM (Per) indicated there are 189 real training days per year (i.e., that time assigned to non-operational and administrative time). This translates into 1228.5 training hours per year (CF, 1990b).
- c. Amortization Period - The average life expectancy of a course in the CF is 10 years (CF, 1993). See Appendix P paragraph 5.c. for explanation of 10 year amortization period.

6. Operation and Maintenance Costs - A figure of 20% of the Courseware Costs per year is used to determine the O&M Costs for the courseware (CF, 1993).

7. Equipment Costs (Head, 1985) -

$$\text{O\&M Per Hr} = \frac{\text{(Purchase Cost)}}{\text{(Per Yr Trg Hrs) (Amortization Pd)}}$$

- a. Purchase Costs - The cost of overhead projectors and other classroom instructional support equipment.
- b. Training Time Per Year - See paragraph 5.b.
- c. Amortization Period - The average life expectancy of training support equipment in the CF is five years (CF, 1993).
8. Operation and Maintenance Costs - A figure of 20% of the Equipment Costs per year is used to determine the O&M Costs for both the hardware and supporting software (CF, 1993).
9. Training Aids and Materials - This is the per student cost of the handouts, pens, paper, etc. normally issued during the course (Head, 1985).

Appendix R

Training Time (Minutes) Per Student - CBT Group

<u>ID</u>	<u>Theory</u>	<u>Practical</u>	<u>Test</u>	<u>Total</u>
1	45	82	55	182
2	25	79	54	158
3	47	82	55	184
4	180	179	77	436
5	42	79	54	175
6	33	100	55	188
7	28	84	40	152
8	30	93	65	188
9	48	44	32	124
10	63	101	59	223
11	25	88	53	166
12	73	116	56	245
13	82	98	62	242
14	25	91	53	169
15	65	122	55	242
16	27	64	63	154
17	49	87	60	196
18	66	127	59	252
19	69	130	47	246
20	45	76	61	182
21	48	113	65	226
22	25	183	56	264
23	46	111	59	216
24	37	87	52	176
25	45	119	56	220
26	50	111	62	223
27	22	69	46	137
<u>M</u>	49.60	100.56	55.96	206.15
<u>SD</u>	30.88	30.78	8.44	59.48

Appendix S

Training Time (Minutes) Per Student - Trad Group

<u>ID</u>	<u>Theory</u>	<u>Practical</u>	<u>Test</u>	<u>Total</u>
30	80	610	90	780
31	80	610	90	780
32	80	610	90	780
33	80	610	90	780
34	80	610	90	780
35	80	610	90	780
36	80	610	90	780
37	80	610	90	780
38	80	610	90	780
39	80	610	90	780
40	80	610	90	780
41	80	610	90	780
42	80	610	90	780
43	80	610	90	780
44	80	610	90	780
45	80	610	90	780
46	80	610	90	780
47	80	610	90	780
48	80	610	90	780
49	80	610	90	780
50	80	610	90	780
51	80	610	90	780
52	80	610	90	780
53	80	610	90	780
54	80	610	90	780
55	80	610	90	780
56	80	610	90	780
57	80	610	90	780
58	80	610	90	780
59	80	610	90	780
<u>M</u>	80	610	90	780

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