COMPUTERS IN TRAINING

A PUBLICATION
BY

THE NATO TRAINING GROUP
WORKING GROUP ON
INDIVIDUAL TRAINING
AND
EDUCATION DEVELOPMENTS

NTG WG/IT&ED

PUBLICATION 6 - COMPUTERS IN TRAINING

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PREFACE

1. The NATO Training Group Joint Services Sub-Group established the Working Group on Training Technology (NTG WG/TT) in 1971 to foster the development and application of training technology within the armed forces of the members of the Alliance. The Working Group is now normally known by its title: The NATO Training Group Working Group on Individual Training and Education Developments, abbreviated to (NTG WG/IT&ED). Included in the Working Group's terms of reference are responsibilities for promoting a common understanding of training philosophies and terminology, exchanging information on applications of training technology, and reporting on the success of innovations.

2. Having accumulated considerable experience in the field, the Working Group decided to compile a series of papers and publications on various aspects of training systematics and technology. These documents are intended to summarise development and, where appropriate, to report on difficulties encountered and successes achieved and to offer advice and guidance.

3. It should be noted that the NTG WG/IT&ED produces two types of document: Publications and Papers. Papers are documents covering a topic formally agreed by the Working Group, but each has been written by an individual national delegation and may therefore reflect purely national perceptions. However, Publications are formally agreed NTG WG/IT&ED documents and represent the combined view of all delegates. Furthermore, Publications will be reviewed annually and updated when necessary and all additions and amendments remain the responsibility of the NTG WG/IT&ED.

4. This document is a publication. First Issue May 96.

INTRODUCTION

1. This publication is intended as an introduction to the subject of Computer Based Training (CBT) in general and the use of computers in military training in particular. It surveys current thinking and attitudes so as to emphasize those aspects having the greatest influence on decision making. Its contents should be directed at Training Managers and staffs having responsibility for training, resourcing and decision making.

2. As military weapons and support systems become more and more complex, the demands placed on their associated training systems rise exponentially. As these escalating demands must be faced in a climate of increased competition for the recruitable populations in most NATO nations, and limited defence budgets, more efficient training strategies and methods must be introduced. We must find ways to minimize the expenditure of manpower, time and money needed for high quality training.

3. The Working Group believes that CBT could play an increasingly important role in military training. In properly selected applications both the cost and effectiveness of training can be optimized. CBT implies a wide range of capabilities from fairly straightforward interactive computer-assisted instruction for teaching theory, low fidelity simulation (part-task, procedural trainers) for teaching operator and maintainer skills, to full mission simulators. This publication necessarily mirrors some of the advice provided in the earlier ones on Video and Simulation in Training (Publications 4 and 5 respectively). Application of the Systems Approach to the selection, development and implementation of CBT systems will be seen to be critical.

4. One way to improve the efficiency of training is through the judicious application of the principles of self-pacing. It has been shown in various applications of self-paced training, both in and outside military organizations, that when the target population and subject matter are carefully chosen, and the instructional materials well designed, course completion times can be reduced from those experienced in conventional instruction without loss of effectiveness.

5. At one end of the CBT spectrum, self-pacing using computers can be shown to have distinct advantages over the use of programmed text. Toward the other end, computer-driven simulations of operational equipment or situations can provide realistic training that would otherwise be impossible due to the non-availability of real equipment or the hazards of using it to its limits.

6. This publication will serve only as the most basic introduction, providing a summary of the main actors relevant to military training and offering guidance to those contemplating the introduction of CBT. The topics covered include the advantages, disadvantages and costs of CBT, courseware acquisition and development options, the criteria on which to base decisions concerning implementation, and lessons learned. Included as Annexes are CBT definitions and, a summary of broad areas of CBT application. The more technical aspects of hardware, software and courseware will be avoided, the aim being to give only that detail necessary to an understanding of lessons learned so that sound decisions can be taken by managers. However, appropriate literature, including CBT checklists, is available to help training managers in their decision making.

7. It should be emphasised that this publication does not recommend CBT as a universal answer to training problems. CBT may be quite inappropriate in some circumstances, and completely impractical in others. This publication will help decisions as to where and when CBT is an appropriate alternative to more conventional training. It will provide a key to answering such questions as: "What kind of learning tasks are suitable for CBT? Is CBT more effective than traditional classroom teaching in a particular situation?" "Why is a computer solution the best one for a specific training problem?" or "Which type of problem lends itself best to a computer solution?'

ADVANTAGES, DISADVANTAGES AND COSTS

ADVANTAGES

8. **Student-Centred Delivery of Instruction.** With the exception of a one-to-one tutor, CBT has the potential to deliver the most responsive and individualized instruction of any instructional alternative.

a. **Interactivity.** CBT's unique characteristic is its potential for high levels of interactivity. When a student finishes a well designed and implemented CBT session, the student has actively attended to the material each step of the way.

b. **Individualization.** CBT allows each student to learn at a speed and in a fashion most suited to his or her learning needs. It also permits easier and more accurate monitoring of student performance through automatic data collection. Further, research shows that well designed CBT courseware could even account for different learning styles.

c. **Timeliness and Availability.** CBT ensures more effective use of student time because it can be available on demand. It can permit flexible scheduling of students and classes if an adequate number of delivery stations is available. Travelling time may be eliminated and training can be interspersed with normal duties.

d. **Motivation.** A possible outcome of CBT is improved learner satisfaction and enjoyment: if the courseware is well designed, students typically find it more motivating than other forms of instruction. This is an important contributory factor towards the improvement of pass rates.

e. **Flexibility.** Well designed courseware can present material to each student in ways that match their learning styles and learning potential. This means that the way training objectives are presented and the sequence in which they are covered could differ from one student to the next because of the branching capability inherent in the courseware.

f. **Cost Emphasis.** The primary costs of CBT lie in its design and production not replication, distribution and delivery. Thus, the cost per student reduces as more students use the same program.

9. **More Interactive than Programmed Text.** CBT has some unique advantages over even the best-designed programmed text. By storing lessons in a computer rather than in the

pages of a book, some of the drawbacks of the branching program in print form may be removed. When students respond with reasonable but unexpected answers to problems in printed linear texts, there is no guidance. Such guidance can be provided through branching but to provide even a modest amount of remedial text requires a book of discouraging complexity. In a CBT system the complexity remains but is hidden from the student and is therefore not distracting.

10. **Management of Training**. A further major benefit of CBT is in the area of Computer Managed Training (CMT). Beyond instruction, the computer can serve a wider range of purposes in course management. For example:

a. **Response to Student Needs.** At the start of a course the computer can assist in diagnosing the student's specific knowledge and skill deficiencies. The student's performance on an entry test can determine whether further instruction in a particular subject is needed and, if so, to what depth. The form this instruction might take could be audio-visual, printed, computer-based or live instruction.

b. **Course Management.** A CMT approach provides training design staff and management with performance data far more easily than a paper-based system. Pre- and post-test results, gain scores and so forth from validated programs can establish the extent of trainees' success and their readiness for work in new procedures. At an earlier stage when programs are still in draft form, the computer can monitor student responses to every question or problem, and can record in free-format any opinions or comments students care to make. Such data are invaluable for effective lesson development.

c. **Evaluation.** The handling of statistical aspect of evaluation is easier and more accurate.

11. **Simulation.** The combined benefits of computer power and training technologies permit full or partial simulation. Such an advantage permits training to be developed when costs, danger or other constraints would otherwise be prohibitive. Simulation is addressed elsewhere in this booklet and in NTG WG/TT Publication 5.

12. **Possible Reduction in Training Time.** Studies across a variety of disciplines have shown that CBT can significantly reduce training time to criterion mastery. This is largely due to:

a. The individualization (self-pacing) of instruction.

b. Immediate feedback.

c. Better instructional analysis.

d. The fact that CBT encourages students to take the most efficient path to content mastery.

e. Personalized instructions accommodate different learning styles to maximize student learning efficiency.

f. Students being able to skip areas of strength while investing time in areas of weakness.

13. **Standardization of Course Content.** CBT allows increased control in terms of improving utilization or completion of learning materials, increasing standardization of instruction, (ie material and evaluation criteria are standardized) or monitoring of student progress. Through CBT, students cover the same relevant teaching points and do not study material irrelevant to the mastery of the learning objective. Instruction is therefore delivered in a consistently reliable fashion: trainee A receives the same instruction as trainee B.

14. **Instructor Resource Usage.** Qualified, experienced and talented instructors are an increasingly scarce NATO resource. The use of CBT has an impact on this resource.

a. **Instructor Role.** The role of instructors in a CBT environment will change drastically: instead of spending time presenting conventionally new knowledge and skills, instructors will spend virtually all of their time answering precise questions regarding the specifics and the difficult portions of the instruction.

b. **Cost Effective Employment of Instructional Expertise.** Using scarce and valuable experienced instructors for CBT design and development work can be a more economical use of their expertise and helps assure high quality of training delivery. Care should be taken, however, to ensure that these instructors are actually also good CBT designers; these two specialist abilities are not always present in a single instructor.

c. **Concentrated Use of Resources.** The need for both personnel and centralized training facilities can be reduced. A higher student throughput could be effected using the same level of resources as for conventional instruction. In essence, the output per instructor is increased.

d. **Real Equipment Availability.** Computer-based simulators can displace the need for actual equipment and enable training to take place where it would otherwise be restricted or not given. The talents of the instructor can thus be more widely applied unhindered by the geographic location and/or availability of the real equipment if appropriate CBT applications are available. This helps maximize instructor impact and minimizes travel and transportation costs.

15. **Technology Based.** Constant improvements in the performance and functionality of the technology increases display/interactivity capabilities and delivery options thus enhancing the scope and flexibility of CBT.

DISADVANTAGES

16. Researchers have described at length the numerous drawbacks of CBT. Some of the main disadvantages reported are:

a. **Development Time and Costs.** Developing CBT courses is complex and costly. Adding animations, simulations (to explain phenomenon or maintain students' interest) and branching will increase the cost exponentially.

b. **Reading Skills.** Text based CBT requires trainees to have good reading skills, something not always necessary in normal classroom environments.

c. **Compatible Software, Courseware and Hardware.** The authoring language, utility software, courseware and hardware must be compatible. Computer standards must be set very early in a CBT initiative to ensure, for example, that the courseware created on a development platform will run on the presentation platform, etc. Incompatibility problems also drive up costs.

d. **Courseware Maintenance.** Most military equipment undergoes engineering changes during its lifetime. These changes must be reflected in the courseware. Usually, the more technically advanced a piece of equipment is, the more changes will be required in the courseware. These potential changes drive up maintenance costs.

e. **Continuity.** "Corporate memory" is invaluable in every CBT initiative in order, among other things, to carry out training for the new staff members and troubleshooting hardware and software problems. Posting of personnel must therefore be planned accordingly and this, in a military environment, can be problematic.

COSTS

17. If training managers consider CBT to be an appropriate method for delivering some or all of the training, then it is necessary to determine its cost-effectiveness. It is therefore important that all cost aspects of introducing CBT are properly considered, particularly in relation to existing training. The factors to be considered fall into 3 categories of costs: cash outlay, unit cost per student and courseware development. The following paragraphs draw on general lessons gained from introducing CBT.

18. **Cash Outlay.** The enormous variety of CBT systems available and the rapid advances in the technology combine to make raw estimates on CBT development time highly variable. However, to assist training authorities who are considering CBT, Figure 1 provides a checklist of areas of potential expenditure which need to be considered. The checklist is not intended to provide a detailed breakdown of the cost of a potential CBT project. Instead, it is designed to create awareness of the various factors which must be considered when comparing the costs of CBT with those of more traditional training methods. Further, Figures 2 and 3 provide estimates for managers who would like some idea of the length of time required to design and create CBT packages and, computer graphics. It should be reiterated that these estimates are in fact estimates and as such could vary from one authoring system to the next and from one project to the next. Thus, care should be taken when using these figures.

Initial Expenditure (Development Phase)

Consider:

- Characteristics of the Target Population.

Instructional Development
  - Possibly using outside consultancy for some, for all, of the following:
    - analysis
    - design
    - development
    - production of instructional material evaluation
    - Stability of the material to be presented.

- Purchase of Software
- - Including licensing authoring language or systems and CMT software.

- Purchase of Courseware
  - "Tailor-made" or "off the shelf".

- Production of In-house courseware
  - Main cost is manpower

- Purchase of Hardware
  - Beware of the requirement for compatibility between the hardware, software and courseware

- Staff Training
  - Training or retraining instructors in the skills and attitudes required to use CBT

- Support Staff
  - The secretarial and administrative support required by the project

- Facilities
  - Officer and production space required by the project
  - Installation Costs

- Management/Administration/Supplies

- Funds available versus requirements versus "nice to have"

- Courseware length
  - maximum duration of the courseware

- Selection of the measure of interactivity
  - Such as total number of frames, number of interaction(s) per minutes, length of the package, trainees' success rate, etc

- Central versus distributed training

Figure 1 - **The potential cost of CBT**

On-Going Expenditure (Operational Phase)

Consider:

- Equipment Maintenance
  - Including eventual replacement of system (3 to 5 years).
- Software Maintenance
- Authoring
  - Of new courseware or amendment of existing material
- Staff Training
  - Of new instructional staff
- Long Term Evaluation of the System
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- Facilities
  - Properly equipped classrooms or learning centres

Administration
  - On-going consultancy, general administration and supply of consumable items

Figure 1 - **The potential cost of CBT**

Level of complexity	Number of frames	Development time for 1hr of CBT
Low	60 to 80	200 to 400 hours
Medium	80 - 120	400 to 600 hours
High	120 - 180	600 to 2500 hours

Figure 2 - Estimation of the time required to produce 1 hour of Multi-media CBT

Complexity of the Graphic	**Hours to produce**
Low	4
Medium	6
High	6
Schematics	15
Animations	10+ (varies according to difficulty

Figure 3 - Average graphic production length

19. **Unit Cost per Student.** The number of students is a very important consideration in deciding whether or not to employ CBT. The use of CBT on a small scale is extremely

expensive, often prohibitive. It is only when students approach a reasonable number (hundreds rather than tens) that the cost of CBT begins to compare favourably with conventional training. However, this does not take into account net cost savings due to increased performance as a result of better training. Managers must also consider that sometime, CBT may be the **only** way to deliver a particular piece of training effectively.

20. **Courseware Development.** Perhaps the most critical measure of CBT production is the "development ratio", that is, the number of man-hours it takes to develop one hour of CBT material. There are different opinions about what the term should cover. It will certainly include the author's time, but it is best to include everyone and anything else which is involved, for example, subject matter experts, secretarial support and time for design, documentation and evaluation. As described above in Figure 2, experience in developing CBT suggests that a ratio of 200:1 is the minimum expected for relatively simple CBT. Estimated ratios generally have to be revised upwards rather than downwards. The ratio will be influenced by a number of factors including:

a. **Mode.** Repetitive drill and practice will generally have a low ratio; highly individualized tutorials with branching logic or complex simulations will have a high ratio (up to 600-2500 to 1 development ratio; see Annex B).

b. **Staff.** The skill and experience of the production staff will be an important factor. The costs of recruiting or training the right numbers of people can only be justified in terms of the amount of course work to be produced.

c. **Resources.** The quality and sophistication of courseware development tools, particularly the authoring, computer, and graphics systems will influence the development ratio. To cut down in this area could prove a false economy.

d. **Graphics.** The requirement for graphics and animation techniques lead to a far higher development ratio than simple text. However, high quality graphics writing packages can significantly reduce preparation time whilst greatly enhancing the effectiveness of the course material.

e. **Documentation.** The amount and quality of existing training documentation, eg Instructional Specifications (IS), story boards, etc will influence the development ratio. It is well worth investing time to write a clear IS, as this will greatly reduce the time wasted in resolving uncertainties during the course development phase. However, with modern authoring systems it is possible to prototype quickly display and frame templates, thus easing some early specification and design work.

COURSEWARE ACQUISITION/DEVELOPMENT OPTIONS

21. Development issues must be well understood to make an informed decision on whether or not to adopt CBT. Whether the plan is to develop courseware in-house, to have lessons developed by outside contractors, or to purchase/use existing courseware, it is important to understand the courseware development process in order to realistically anticipate cost, development time, and staffing requirements. When considering the development of courseware by contractors, there will be a need to specify the requirements and evaluate the product. Production cost will be better understood if the resources required for the different

types of CBT are known. When considering in-house development of courseware, there will again be a need to specify requirements and to be able to evaluate the resulting product. In addition, there will also be a need to acquire CBT development staff with special skills to fill specific roles or train personnel for these staff positions.

22. **Off-the-Shelf Packages.** There is more and more commercial off-the-shelf CBT courseware ready for use by military organizations, particularly in the area of general knowledge and skills training (e.g. management, communications, ethics, gender sensitivity, harassment, etc.). These packages usually cost a fraction of what tailored packages would cost. Contractors could also tailor these existing packages to fit customers requirements.

23. **Tailor-Made Packages**. An increasing number of software houses offer a complete CBT development service including the initial analysis and specification of the requirement as well as the design, development and production of courseware. A complete, tailor-made package can be made to look extremely attractive, particularly by the software houses who put a great deal of effort into their marketing and selling techniques, but is often an expensive solution. It may, however still be the best solution where analysis shows a clear case for CBT and the required in-house expertise is not available. In addition, these projects have traditionally presented difficulties because of the problems of specifying Service requirements to civilian courseware developers. Military project managers frequently under-estimate the time and effort they must devote to guide contractors, and to evaluate deliverables as they are produced. With this development option, it is often appropriate to contract for a complete turn-key system that is, hardware, software, courseware, installation, short and long-term maintenance, etc.

24. **In-House Development.** The approach and process used to design and develop courseware will determine the specific roles and skills needed of in-house personnel. The development option chosen will depend on a number of factors. Questions one might ask could include:

a. **Staffing Resources.** Is there an existing CBT development infrastructure, or would this need to be developed?

b. **Courseware Development Ratio.** Will CBT be developed using a development system that includes authoring tools, or will staff work without these aids? How complex will the CBT be? Will sophisticated simulations or tutorials be developed, or will it be less complex CBT such as drill-and-practice?

Whichever approach is adopted, the most important thing to remember is that it should be controlled and systematic. If the project is systematic, then timely development of sound and cost-effective CBT will have been ensured.

AUTHORING

25. **Authoring Systems.** An authoring system provides a courseware development approach that requires little or no conventional programming skills as part of the process. Rather, an authoring system primarily involves the use of editors which contain a series of menus, prompts, and help sequences. The system elicits information from the "author" of a CBT lesson based on the instructional function to be performed. For example, a typical

authoring system would allow an author to enter the text question by simply typing in a dialogue box. After the text of the question is entered, the authoring system would then elicit information via a prompt asking which question alternative is the correct answer and where in the lesson the students should go if they answer either correctly or incorrectly. An authoring system will often include several different types of editors corresponding to specific lesson-writing activities such as creating lesson graphics or producing a lesson menu page.

26. **Authoring Languages.** An authoring language is a specialized programming language designed for creating CBT material which can sometimes be used by those with limited programming experience. It can possess most of the normal commands available to a programming language with enhancements which are designed to make the production of CBT material easier. Authoring languages are invariably supplied with a controlling environment which provides many aids to authoring. An authoring language of any real complexity and versatility requires a high degree of programming knowledge in order to use its full potential.

27. **Cost Requirements.** Authoring languages, with the exception of those developed in the Armed Services, are proprietary and usually involve the cost of licensing their use. The licensing cost of an authoring language is considerably more than that associated with a general purpose, higher order language. Licensing may be based on the number of user sites or organizations, regardless of the number of individual copies being used, or may simply be based on the number of individual copies. It is also very important that the courseware produced by any licensed authoring language or authoring system be free of any user fees ie there must be no limitation on the number of presentation stations.

28. **Staffing Requirements.** It is possible for instructional staff to use an authoring language which has a few basic commands to develop drill-and-practice and tutorial instruction. However, with more sophisticated authoring languages the level of programming skill required can become very high. Generally, trainers knowledgeable in the authoring language will be needed to code the lesson materials developed by subject matter experts and instructors. The staff who code CBT lessons using an authoring language need not be computer programmers, but will require specialized training in and experience with the authoring language.

29. **Training Requirement.** Most authoring languages allow two or more levels of application. At the novice level of application, instructors can learn a relatively small subset of commands that will allow them to develop some basic lessons. For an expert level of performance, time and experience is needed to become proficient with the full power of the authoring language.

IMPLEMENTATION ISSUES

30. The institutional impacts of implementing CBT are very great and must be carefully managed if the implementation is to be successful. There are two broad areas in which CBT development and implementation will impact upon and change most organizations:

a. Resource requirements.

b. Organizational infrastructure/technology adaption.

Each will be described separately; however, there is at least one overall management issue for both areas: the requirement for careful short and long range planning for project development, implementation, and ongoing support.

RESOURCES

31. The major resource categories include hardware, software, courseware, physical and human factors, and personnel. Some of the institutional impact concerns in each category are described below.

32. **Hardware.** It is essential to perform a needs assessment to determine hardware requirements even if only a small need is anticipated. How much hardware is needed for the short-term and for the long-term? What type of equipment will be required, from stand-alone microcomputers, to clusters, to a large networked timesharing computer with terminals? What functions will the system be required to perform? Is there a requirement for different operating software (DOS, UNIX, etc)? If so, what impact would this have on the compatibility issues?

33. The following is a small sampling of plausible trade-off scenarios that will result in differing hardware decisions. These will flow from the following types of question:

a. Will there be one course of 15 students of whom only a few will use CBT for basic skills upgrading, or will hardware be needed to support several courses with a large number of students who will use CBT for much of their normal curriculum?

b. Should equipment be leased because the need is limited, of short duration, or is it important to ensure the most up to date technology is used? Should the hardware be purchased because the need is substantial and is expected to be ongoing?

c. Does CBT software exist that can be used on existing hardware and at what cost to the other functions must the current system perform?

d. Will the hardware be required to support functions such as complex animation, graphics presentation, etc.?

e. Should the hardware be available in one training site or at several training sites (remote/distributed training)?

34. **Software.** Software decisions will also be based on the results of a needs assessment. Software is an essential part of the resource requirement as no amount of hardware will compensate for inadequate software. For CBT, software can roughly be categorized into the following: the **operating system** that gives instructions to the hardware allowing computer programs (including computer languages) to function; **authoring languages** that allow a programmer to address the computer efficiently; **authoring systems** which allow programs to be created without the need for access to computer languages; and **courseware** which is the final instructional programs created by the authoring system or language; and, finally, the **utility software** for statistics, graphics, etc.

35. Once the materials have been developed, evaluated and implemented, resource personnel for courseware revision and maintenance will need to be considered. This process

should be planned for at the beginning of a project. Modularisation of courses and courseware material improves flexibility of use and also eases maintenance. Recurrent need for courseware updating and revision will be an important input to the decision regarding in-house or outside development. It will also be a consideration in the decision as to how the courseware is produced (ie, via programming or through authoring editors).

36. **Physical and Human Factors.** The use of CBT requires special consideration for its housing and the housing of the necessary development and support personnel. The hardware, associated documents (eg, workbooks), furniture (eg, carrels, tables, chairs) all need to be financed and procured, and will require space. Most computers will require special electrical hook-ups and/or air conditioning. Changes to classroom facilities also have to be assessed (eg, room size, carrel layout, instructor station) as well as a variety of human factor issues in classroom design (eg. lighting, air quality, room colour, other comfort factors). All of these considerations have to be taken into account to some degree when planning for the development and implementation of a CBT project.

37. **Personnel.** People issues need to be considered: numbers, skills needed, roles and training. Consider this representative list of roles generally required in CBT development and implementation of any magnitude:

a. **Managers.** These personnel are in charge of developing the course training standards (including media selection decisions); keeping development on target, both in terms of development schedules and quality control; overseeing the CBT centre; and managing both courseware and hardware maintenance. Cost control and fiscal management are also the manager's responsibility.

b. **Developers.** Instructional designers, subject matter experts, programmers, and graphics artists. Personnel with these skills create and maintain the courseware.

c. **Advocate promoter.** If it is planned to have a viable CBT centre, research has shown that it is very important to have one or more people promoting project visibility within the organization top to bottom. Even within a small project, ie, with a single course, it is important to have a person responsible for "consciousness" of the potentials of the medium as new personnel rotate in and out of the course.

ADAP'IING FOR CHANGE

38. What organizational infrastructure does CBT require if it is to be an effective, efficient and accepted component of the training program? There are at least two requirements:

a. Facilities.

b. Communication among personnel affected.

39. Whatever the decisions are regarding hardware, it is absolutely essential that the users of the equipment have adequate access. In a comparative analysis of numerous successful and unsuccessful CBT projects, access to terminals was one of the major indicators of success. In assigning space in any facility for CBT, the access to the terminals must be maximized.

40. To illustrate this point, consider two options. Either might be the preferable one in this situation. Option 1 is to centralize access and put all terminals in a centre. Option 2 is to decentralize terminals or microcomputers in course classrooms or offices. If many of the courses will be 100 percent CBT, or if many of them will use CBT as homework outside of class, a centralized configuration of terminals might be preferable. But if a course is not totally CBT-based, a long trip down to the centre might dissuade course supervisors from a continued commitment because of the logistics problem.

41. The centralized approach is attractive in several ways. Maintenance and management of courseware and hardware by an infrastructure of CBT staff members can be more easily accomplished if the equipment and staff are in one location. But this centralized approach also has two potential drawbacks. These should be considered when planning facilities as well as the use of CBT in a particular course. In a study of the factors critical to the success or failure of self-paced instruction in one NATO Air Force it has been shown that courses that are 100 percent self-paced have seldom been successful. Self-pacing only that portion of a course that lends itself best to the self-paced format (and similarly utilizing group-pacing and all other instructional approaches where they appear best suited) yields superior results. With this in mind, very few courses should be 100 percent self-paced or 100 percent CBT, and this suggests only infrequent justification for a centralized room of student terminals. It also suggests the need for very flexible scheduling.

42. The second potential drawback is that CBT is still a fairly new medium for most instructors, developers, and adult students. In many ways it goes against the grain of established, instructor centred training practices. Given that a good case for this new medium has been built for the training, a plan must be made for overcoming a natural resistance to CBT in particular, and change in general.

43. Another important requirement is communication among the people involved. Unless a network of commitment to CBT is fostered, successful adoption will be in jeopardy, and may even be actively sabotaged. The designers, supervisors, instructors, students, and evaluation teams should be involved at the beginning of the project. No instructional approach will work if these groups of individuals are not committed to a common objective. The establishment of an infrastructure to support communication among these personnel is the most important challenge to face in successfully launching a CBT project.

44. Just as it is important that the various players have access to each other from the beginning, it is important that each player has convenient access to the CBT medium. If it is made difficult for instructors to "get-on-line", then it will be harder to win their commitment. It is necessary to work towards fostering a sense of "ownership" among the personnel.

45. In summary, the adoption of CBT requires easy access to the system and building of commitment and ownership.

LESSONS LEARNED

46. The military's experience of using CBT indicates that there are important lessons to remember whenever considering the implications of this training method. The principal ones are that a commitment to fund CBT must be made; the medium does not, of its own, offer a solution to training problems, and, that implementation brings with it a number of organizational chances and problems.

47. CBT cannot be adopted as a training method without additional cost. The outlay on procuring and, particularly not forgetting, the maintenance of CBT must be outweighed by the benefit gained from introducing it.

48. CBT is not suitable for all types of training. It should only be considered where front-end analysis determines CBT to be an appropriate training delivery medium or management tool. The possible CBT solution to a training problem should be evaluated against all other appropriate and available solutions before the decision is made to adopt it.

49. While CBT creates an individualized, interactive environment that can be very effective and efficient in many learning situations, it also may limit human contact and social interaction during the time a student is on the system. For example, if a course trains recruits new to the military, perhaps one of the objectives is indoctrination in values and attitudes, such as professional ethics. If recruits interact solely with the computer, such objectives may not be reached.

50. The role of the instructor can be very different in a training environment that uses computer-assisted instruction, but it is not necessary to view that changing role negatively. In fact the change in instructor role is more a matter of emphasis. In the individualized environment, the instructor’s role focuses on each individual student's learning needs and on integrating computer-assisted instruction with appropriate individual and group learning activities. It has been essential in most successful implementations to train instructors in their new roles, encouraging a creative and flexible approach to the more flexible training environment. Many factors go into successful projects, but especially important is instructor training and early inclusion of the instructor staff in project planning and development. It should be emphasised the individualized CBT environment permits the instructor to maximize one-on-one time with problem students. This is far better than the situation that normally exists in traditional group-paced environments.

51. Proper initial cadre training must be organized prior to using the authoring system/software in the training establishment. Further, formal regenerative training must be given every year to all new school personnel in order to prepare them for their duties and to avoid the "brain drain" phenomenon so typical of many well-intentioned CBT initiatives.

52. The authoring system/language must be easy to use yet comprehensive. If too difficult to use, staff members will be reluctant to create new lessons or even to update old ones. If advanced features are not included with the system then animations and simulations, among others, would not be updated or created as time goes on.

53. The training establishment must be manned appropriately. Manning should be higher than usual during the CBT development and implementation phases. After implementation, it could drop significantly below what would be required in a conventional training environment, particularly if the course material is very stable.

54. Courseware maintenance is a long term activity that could defeat a well-intentioned CBT initiative. Particularly in technical training, it is imperative that the courseware reflects closely engineering updates carried out on the real equipment in order to avoid discrepancies between the two. Further, there must be an element of continuity in the courseware maintenance section to simplify the troubleshooting process.

55. The content of the material to be transferred into a CBT package should be relatively stable, that is, there must not be too many engineering or content changes. For this reason, evolving new high tech equipment training is often not suited for CBT unless the development and update cell is manned accordingly and the authoring system/language is easy to use.

56. To summarize, CBT in and of itself does not guarantee quality training. Quality lies in the content, and in design of the courseware to take advantage of the medium's potential for interactivity. Also, the delivery of interactive instruction affects instructor roles and appropriate adjustments in these roles must be made. CBT cannot easily substitute for direct human contact in courses in which the goals are to teach values and ethics. Finally, CBT should be chosen based on its potential for best meeting instructional or institutional needs, and ample development time is essential.

ANNEX A

COMPUTER BASED TRAINING DEFINITIONS

1. Computer Based Training (CBT) is a generic term for the use of computers in any part of a training system. This can be categorized to:

a. **Computer Managed Training** (CMT). The use of computers to support aspects of training in which the student is not directly involved, for instance in the generation of student profiles and production of test statistics.

b. **Computer Assisted Learning Training** (CAL/CAT). A learning process whereby the student interacts directly with a computer which aids their learning by means of a combination of:

(1) **Drill and Practice.** The rehearsal of previously acquired skills and procedures.

(2) **Tutorial.** The transfer of new knowledge on an individual basis.

(3) **Inquiry.** The extraction of information from computer data files.

(4) **Simulation.** The representation of real working conditions to enable students to acquire and practise skills, knowledge and attitudes.

(5) **Modelling.** The construction by the student of a computer model to illustrate a concept or system.

(6) **Gaming.** The use of computer games to increase the motivation of the student during the learning process.

ANNEX B

BROAD AREAS OF APPLICATION

1. Computer Based Training (CBT) has evolved over the last two decades to take advantage of more and more sophisticated hardware and software as well as advances in learning theory and instructional design. The basic functions that CBT serves, however, have remained the same: the presentation of information, demonstration of the applications of skill and knowledge through examples, and opportunity for practice. Described and defined below are the broad areas of application or "modes" of CBT ie., the basic strategies or methods used. These modes are: "Drill and Practice", "Tutorial", "Inquiry", "Simulation" and "Gaming".

DRILL-AND-PRACTICE

2. In the drill-and-practice mode the computer is used primarily to administer exercises. The student is given a structured succession of exercises which are designed to allow him to achieve mastery in a particular area. Each successive level of difficulty is only embarked upon after the successful completion of the current level. Failure at any level in the program initiates a branching into remedial activities, which are continued until mastery is achieved. Trainers using computers to teach basic QWERTY keyboard skills and operation represents a good example of this particular mode. Other examples include ship/armoured fighting vehicle recognition training, and the reduction of sights in astro-navigation.

3. Drill-and-practice is often criticized as a simplistic way of using the power of a computer. However, the need to practice procedures, which are often mundane and repetitive, is very common in military training. The use of the computer in this role frees instructors to concentrate on areas where their expertise can be of more value to the students. Moreover, in dealing with student responses the computer is infinitely patient and can adapt to the learners' own pace.

TUTORIAL

4. The aim of CET in the tutorial mode is to emulate the interaction between a student and an instructor. Ideally the program permits a more genuine dialogue between computer and student than is allowed by the drill and practice mode. Answers to questions are more detailed than a simple YES/NO, and may include additional information or advice for the student. In addition, the program permits the computer to accumulate information about the student's progress and directs the learning sequences accordingly, either to more advanced levels or through revision or remedial work.

INQUIRY

5. The unique quality of inquiry mode CBT is that the student controls the interaction or dialogue; in tutorials, objectives have been defined by the author or developer. The inquiry mode allows the student to interrogate the computer's data files and, perhaps, to call up information from other linked sources. Thus, the computer is an information source which the student can use at will.

SIMULATION

6. The material in this section supplements NTG WG/TT Publication 5 (Simulation and Training), to which the reader should refer.

7. Simulation is probably the most widely used CBT mode in NATO. In this mode, the computer acts as a mediator between the student and a model of a real-life system or situation. In interacting with the model the student learns the rules which govern it, and so he should eventually become adept in manipulating the real situation or system (equipment). Simulations are particularly useful where learning in the real environment is too dangerous, too expensive, too time-consuming or otherwise unacceptable in the location where it would be carried out live. Part-task simulation can be used to provide training on one part of a more complex system such as an aircraft.

8. Simulations may be broadly classified under several headings:

a. Decision-making simulations;

b. Procedural simulations;

c. Equipment simulations; and

d. Computer system emulation.

9. **Decision-Making Simulations.** The use of simulation as an aid to decision making is long established. The attraction of the computer simulation over a paper exercise is that the complexity, the feedback, and ultimately the realism, can be greatly improved. For example, random events which occur by chance in the real world can easily be introduced into a computer driven simulation.

10. In this form of simulation it is usual to divide the real world situation being modelled into a series of discrete states. This is coupled with events which require decisions to be made and the decision which the student makes may then influence what happens next in the simulation. A student's performance may be measured either in terms of being on the correct path, or by a numerical score, or both. In general, each stage will be arrived at depending on decisions mode at previous stages.

11. An example of this category of CBT lies in war gaming. War games are used primarily to train military leaders to make decisions. The games also provide command, control and communications (C3) experience under conditions that do not consume men or resources such as aircraft or ammunition. War games which predominantly give decision-making experiences are called "instructional games" and aim to train "players" to make decisions based on the information provided in the course of the game. This information can be controlled and presented by the computer. 'Analytic games" are aimed at collecting information which may assist commanders in their decisions concerning the choice of plans, tactics, doctrines etc. These latter games provide a relatively cheap way of enabling the effect of plans and tactics to be tested in a variety of ways by repeating and replaying the scenario.

12. **Procedural Simulations.** Procedural simulations are broadly similar to decision-making simulations but present fewer chance elements and follow a more specific pattern. As such they are more often used to train technical or clerical staff rather than managers. Examples in current use in the military include clerical procedures, such as signal handling, and basic aircraft navigation.

13. A part-task simulation may be used to cover training in the procedural part of the whole task. Other parts of the task may require activities not compatible with the computer, particularly where they involve complex practical skills.

14. **Equipment Simulations.** Large light simulators have provided much experience in the design of sophisticated training aids and equipment, but much simpler programs can also be very useful. Nevertheless the realism of the controls, displays, machinery and environment are often very important. Computer graphics can be used to represent instrumentation and machinery; for example, aircraft control; panels can be copied with acceptable accuracy by computer graphics displays.

15. **Computer System Emulation.** It is relatively easy to use a computer to emulate another computer program or system. This may be of particular value for training in the use of computer systems, especially those designed to be used by staff who may be unfamiliar with many of the concepts.

16. The simplest technique for emulation is to use the operational equipment with a built-in training data base and perhaps a series of exercises. There is considerable scope for the development of training programs integrated into real weapons systems. These simulation possibilities range from laser engagement systems built into real weapons, to the stimulation of real target acquisition, tracking and fire-control systems with simulated threat signatures.

GAMING

17. The gaming mode incorporates elements of simulation, but there is no requirement for high fidelity in reproducing a real-life situation. Rather, the emphasis is on competition among participants or with the computer.

18. The wide appeal of computer-controlled video games demonstrates the powerful effects gaming strategies can have on student motivation. From an instructional design standpoint, gaming strategies can be simple or complicated; they can involve static or animated graphics; and they can be programmed for use by individual students or in a competitive team context. For example, for simple tasks in which students are required to learn lists of technical terms or steps in a maintenance procedure, a gaming technique which requires students to set and attempt to achieve goals within a time limit, where the computer keeps score and provides feedback, can increase student interest and learning in an otherwise monotonous task. More complex gaming techniques can include the use of animated cartoon characters that probe or prompt learners on tutorial or drill-and-practice lessons.

ANNEX C

COMPUTER MANAGED TRAINING

1. The broad area of application of Computer Assisted Training (CAT), described in the previous Annex, only addresses the highly visible component of computer training systems. Computer Managed Training (CMT) which is mainly invisible and perhaps least understood by both students and trainers provides substantial contributions to the management of instruction-related information. This non-interactive component performs such functions as recording, marking, assessing and reporting.

2. A CMT system can support any of the large number of possible instructional delivery resources and is often remote from the delivery station (see para 4). However, when CMT is fully integrated with significant use of CAT, the combination greatly increases the training potential of Computer Based Training (CBT).

3. **The Need for CMT**. The management requirements at training schools are as follows:

a. Training and domestic accommodation administration.

b. Recording and analysing student/course data.

c. Producing, marking and analysing examinations.

d. Producing statistics.

e. Resource planning and scheduling.

f. Developing and maintaining syllabuses.

g. Administering external examinations.

All these managerial functions can be undertaken manually, often with considerable replication. With increasing training tasks accompanied by more severe manning constraints, the pressure to automate some or all of these functions has been growing steadily. A well designed CMT system will reduce a school's operational and maintenance costs, while facilitating rapid responses to changing training requirements.

4. **CMT Systems.** The management function of a CBT system relates directly to the size and management needs of a school. Large comprehensive CMT systems generally have a large memory capacity which will permit a wide variety of management characteristics. On the other hand, smaller micro-computer based management systems may provide many of the same functions. Whichever system is used training management can be radically affected in four areas:

a. **Student Records.** The centralisation of student records on a computer management system allows the immediate access to information from student work stations throughout the school facility and so reduces considerable duplication of work

previously undertaken by administrative staff. In addition, the computer system increases the accuracy and consistency of student records by automating data capture.

b. **Examinations.** A major saving in the workload of a school can be achieved by automating and marking examinations. Whether the system marks the students responses to multiple-choice questions, or handles the list of results completed by the instructor, the subsequent savings in documentation are considerable. Essentially the computer:

(1) Stores examination questions.

(2) Produces new examination papers as required.

(3) Automatically marks multiple-choice questions, updates student records and produces results.

(4) Produces group and individual student examination results.

(5) Analyses the effectiveness of questions.

(6) Produces individual student profiles and provides diagnostic analysis for directing students to the next module.

c. **Time-tabling.** No fully automated time-tabling software is available on the market capable of solving the complex problems of a large training school offering a wide variety of courses. However, software packages do exist which permit the allocation of training resources such that the computer may be used to route students to resources appropriate to their needs.

d. **Statistics and Establishment Calculations.** The traditional manual process of capturing establishment data is both time consuming and prone to error. The introduction of CMT has increased the accuracy and consistency of training data by automating the procedures. Training management reports, which are timely and reliable, can be called up with relative ease. In addition, appropriate security measures can be incorporated into the management system to prevent unauthorized access to the system files.

5. **Summary.** For any training system to function efficiently, it must monitor student progress, evaluate the training, and manage all training resources. The complexity of the management requirement dictates the system technology to be used to manage the training resources efficiency.