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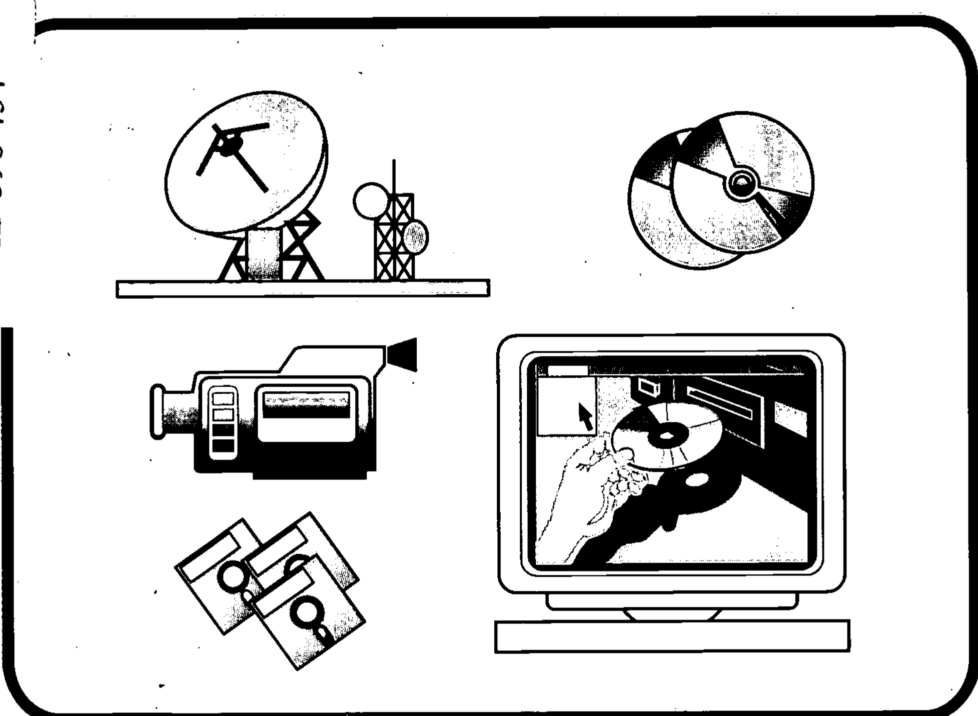
ABSTRACT

This book is the second in a series aiming to promote international exchange of ideas, experiences, and studies relating to technical and vocational education. Information provided is designed to help educators and trainers plan for an intelligent use of new training technologies (NTTs) to improve the access to basic and advanced lifelong learning that will make it easier to get a job and continue to find employment. Chapter 1 discusses the reasons why NTTs may be used in education and training. Chapter 2 presents information on how NTTs can be used in group and individual learning. Chapter 3 suggests a methodology to select the most appropriate NTT for a particular curriculum or course. Chapter 4 offers practical hints for introducing NTTs in a training institution. Chapter 5 mentions trends for the next few years to help make the best possible investment in NTTs. Eight appendixes present technical aspects of NTTs' descriptions: (1) compatibility (personal computer buses/architecture; microprocessors; operating systems; graphic modes; digital images, sound, and video files; color standards; and videotape formats); (2) suggested PC configurations; (3) laser technology; (4) digital versus analog; (5) digitizing; (6) telecommunications and training; (7) more technologies for training; and (8) training the disabled. Contains a glossary. (YLB)

Studies on Technical and Vocational Education ◆ 2

New Training Technologies

A. Herremans



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UNEVOC International Project on Technical and Vocational Education

New Training Technologies

by

Albert Herremans

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Introduction

It is now a commonplace to say that we are living in a fast changing world, but do we have the needed resources and infrastructure in place in order to cope with this situation? In particular, do we have the education and training systems offering everyone the possibility to be retrained as many times as necessary in the best possible conditions according to his or her specific situation? And where this system is offered, have people changed their mentality, their approach to learn permanently in accordance with changing jobs in an active life?

New Training Technologies (NTTs) are not the panacea, but they may contribute to a large extent to the development of both the necessary attitudes and educational opportunities for lifelong learning. They may help to provide students with the necessary knowledge and skills to access the labour market or to retrain people so that they can adapt to evolving jobs.

Technologies have progressively invaded our life, sometimes to our surprise! The television brings to everybody, at home, world news, movies, culture, entertainment, and sometimes education. Banking operations and more recently telebanking can be performed using credit or bank cards. Computers control city traffic, capture satellite images for the weather forecast, and now control "intelligent" buildings. Teleworking becomes another possibility, either to avoid losing time in heavy traffic, or work at home when access to the workplace is not necessary.

Adults sometimes find it difficult to accept, absorb, "digest", use new technologies, but interestingly enough young people do not. They were born in our technological world and easily find their way: they use television and audiovisual equipment, they play with video games, they use computers without any preconceived ideas.

Business and industry have adopted most of existing technologies, and this is probably a matter of survival for them. Well used, technologies indeed improve effectiveness and may be necessary to fight competition.

But strangely enough, education and training do not yet use technologies intensively. When discussing the reasons for that, one generally says that education budgets are too small to afford technologies, that teachers are not trained to use them and have the impression that technologies will replace them, or at least considerably change their role, etc.

This is partly true, but we have to take two facts into consideration:

- the irreversible move from teaching to learning (sometimes called the **new paradigm**). Those who need to know, adults or young people, have to learn through all their life and may not have the opportunity to take formal courses at school or university. Part of their additional education or training will be performed at home, at the workplace, or anywhere else (continuing education, open learning, just-in-time training, self-study). Hence the importance of "learning how to learn" to be taught at school and at the university, and then to have in place the necessary infrastructure for a lifelong training;
- the borders between learning, playing games, or discovering cultural subjects are becoming fuzzier and fuzzier, and this induces the production and distribution of educational packages which are appreciable different from what they used to be: multimedia interactive packages about various subject matters replace more traditional educational material and render learning easier and more pleasant

In this document, we shall first discuss the reasons why NTTs may be used in education and training (Chapter 1: "*New Technologies and Training*"). Chapter 2: "*Delivery mechanism and available NTTs*" presents information on how NTTs can be used in group and individual learning. A methodology is then suggested to select the most appropriate NTT for a particular curriculum or course (Chapter 3: *"Selecting the right NTTs"*). Chapter 4: *"Implementing NTTs in a Training environment"* offers practical hints for introducing NTTs in a training institution. Finally, trends for the next few years are mentioned in order to help make the best possible investment (Chapter 5: *"Trends in NTTs"*). Technical aspects of NTTs description are presented in the *Appendices* in order not to disturb the reader who does not need them. A *Glossary* briefly describes the most important terminology used in the document.

Chapter 1
New Technologies and Training

The reasons for using NTTs in Education and Training are multiple. They may help in improving the quality of the teaching/learning process, reducing training time and costs, complementing the lack of education opportunities in certain places at certain times.

Improving quality is probably the most important reason. The introduction of NTTs increases learning attractiveness and therefore its effectiveness. Tests have demonstrated that an improved quality of training material and media increases the retention rate by 30 to 40%, which is not negligible![1] This may be due to different factors, such as better adaptation to the individual learning styles. Increased retention may reduce failure rates[2] and consequently training length and costs.

For young people, used to playing with technology outside the school, the use of NTTs in education creates or maintains motivation to learn; it also indicates the necessity that schools should not remain behind the rest of the world but should keep abreast with it, and prepare learners to use technology in their working life.

Another aspect is the opportunity offered by NTTs to provide certain learners with the prerequisites required to enter a course of study; the teacher then has a more homogeneous class, which works faster and better.

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1 Interactive videodisc for management training in a classroom environment - Judith VADAS - Paper presented at the 8th Conference on Interactive Videodisc in Education and Training, sponsored by the Society for Applied Learning Technology (SALT), Washington DC - August 1986.

2 Evidence mounts on merits of classroom technology - Gary BORICH - Multimedia Solutions magazine - 1990 - Volume 4 Number 6, page 1.

Quality may also result from the simulation of reality, where complexity, cost and/or danger would make it difficult to undertake training in real-life conditions. Typical examples are simulating econometric models of the economy, aircraft flight simulators, chemical experiences with explosive products, etc.[3] The importance of simulation in education and training is growing. It allows the learner to test several sets of parameters, and to create various environments whose effects can be computed and studied until the optimal solution is found.

Quality training may considerably reduce the dropout rate. Increased quality of training media motivates learners who generally accomplish their training up to the end, which is not always the case, for example in distance-learning courses using only printed materials.

Finally, quality may also be induced by the learners' opportunity to discover the subject matter, by means of additional and complementary material, and by easily accessing and querying encyclopaedias, multilingual dictionaries, data bases, hypertexts, etc.

Reducing training time and costs may be as important as quality in many cases. And this may cover different aspects.

NTTs may reduce development costs by allowing for the reutilization of teaching material, faster and more frequent updates, and joint development by multidisciplinary teams[4] whose members are not working close to each other, and are not necessarily available at the same time.

Distribution costs may also be reduced; digital learning material can be easily accessed on networks or sent very fast and at low

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3 Lights, camera, reaction! The interactive videodisc: a tool for teaching chemistry - Loretta L. JONES & Stanley G. SMITH - in Working papers in Multimedia solutions: Series "Instructional applications in higher education" (Institute for Academic Technology, University of North Carolina, USA) - 1991 - pp. 23-34.

4 Final Report on the DELTA exploratory action - Commission of the European Community - Ref DE2205 - May 1991, 98 pages.

cost to multiple locations using computer networks; this is also true for educational material updates.

Delivery costs, i.e. costs related to the teaching/learning process when it really takes place, are frequently forgotten, or at least underestimated. NTTs may offer savings in travel and away from home living expenses (thanks to distance learning) for both the teachers and the learners. In adult continuing education the salary of learners while retrained represents an important percentage of the overall cost, not to speak about the working hours lost for productive work.

Complementing the lack of education and training opportunities in certain places at certain times is another reason for using NTTs. In some cases, and more particularly in some regions of the world, the use of NTTs will help solve the problem of lacking the right teachers (having the right skills and communication ability) at the right place and at the right moment.

Chapter 2
Delivery mechanisms and available NTTs

Learning may be delivered in two ways or mechanisms: individual learning or group learning. NTTs may be used in both types of delivery: although one generally thinks at first glance that they only apply to individual learning.

We shall first discuss the advantages and limitations of different delivery mechanisms and then see which available NTTs can be combined in order to reinforce their advantages or counterbalance their limitations.

Delivery mechanisms

1. Group learning

Group learning may take place in a **local** or **remote** (supposing travel and possibly lodging) **classroom** or **auditorium**, or via **distance learning**. When the learners and the teacher are not in the same room, the learners are geographically spread and follow the course live with the possibility to interact as if they were in a classroom; one speaks then about virtual classroom.

The **classroom** is the usual learning environment for many people in the world. It has undoubtedly irreplaceable advantages:

- having a live teacher in the class offers a great deal of interaction (between teacher and learners, but also between learners themselves), the possibility to have personal attention (if the number of learners is reasonable) and also to get an immediate answer to the learners' questions;

- possibility to use all senses (hearing, sight, touch, smell, taste), to organize group discussions, role-playing or hands-on exercises, to learn by doing;
- the development and update cycle is shorter for a classroom course than for any other form of delivery discussed hereafter;

but it also has limitations:

- if learners are dispersed geographically, the same course has to be given by several teachers in different places, or alternatively the teacher or the learners have to travel (travel and lodging expenses);
- the class size is seldom the right one: too many learners in the class, or too few to justify the course;
- the learners have to follow the course when it is offered; this is particularly constraining in continuous education, where the course may be offered too late (what will the worker do in the meantime?) or too early (and there is a risk of forgetting part of its content before it is applied).

The classroom may be local, i.e. the course is given close to the place where the learners live, or remote, i.e. the teacher and/or the learners have to travel and stay in another location for the course length (several days or weeks) in a residential training centre.

In the **distance learning** environment, the teacher and the learners are not at the same location, sometimes even very far from each other. The course is given once, at a certain location, and broadcast to many locations. The important characteristic of this approach is that the classroom conditions are reproduced, even if sometimes in a limited way.

Broadcasting may happen in two ways:

- the teacher delivers the course in a classroom (sometimes called "*candid classroom*"), with some learners in it, and the broadcasting equipment is used by a specialized crew. In this case, the teacher does not take care of the transmission and teaches as usual. However the teacher should learn how to behave in front of a camera and how to prepare visuals for a good transmission. This may be convenient for improving teachers' presentation skills;

- the teacher may also be trained (about one week training) to use the equipment of a studio from which the course is delivered. No learners will be physically attending the course in this case, no specialized crew is around, only a technical support. This is a good approach for teachers who are technology-oriented and will use this system regularly (not to have to be re-trained every time).

On the reception side, the course may be followed live or deferred:

- if followed live, the learners watch the course on a screen or TV monitor at their location and may interrupt the teacher, who normally does not see them, with a feature sometimes called "student-response unit". The system does not only allow an audio interruption but allows learners to answer multiple questions shown by the teacher on the screen. The results of all locations are consolidated and shown to all. The teacher has a view of how the learners are following and may decide to go on or to return to topics not well understood;
- if the course is followed in a deferred mode, it is first recorded on videotapes and later watched by small groups of learners, if possible with the help of a tutor or facilitator who answers questions, clarifies some topics, gives homework, etc.

Distance learning has its own limitations, specially when used in deferred mode:

- interaction is limited;
- hands-on training is difficult and role-playing is practically impossible to organize;
- not all senses can be used, only sight and hearing;
- development and update cycles are longer than for a classroom course, because the developers have to think

carefully to present everything in a way that can be understood remotely, with possible interaction and feedback;

- learners may need more time to master the course content, because they have to rely more on themselves; this is particularly true for those who are used to learning with a permanent supervision.

2. Individual learning

Individual learning (also called "self-study") has a number of advantages, even more when considering continuing education:

- the learner proceeds at his or her own pace, may review part or all of the course as many times as necessary, anywhere and any time;
- training is provided, if possible, on a demand basis, not on an offer basis, and is available, if possible, at any place, any time;
- training is provided in a consistent manner; all learners will receive the same messages expressed exactly in the same way;
- learning time may be reduced according to the learner's previous knowledge of the subject, learning skills, preferred learning styles;
- more attractive courses are offered, based on new concepts (multimedia, hypermedia), so learners follow them with more motivation, and the result is an increased retention rate;

but it has of course some limitations:

- development and update cycles are considerably longer than for a classroom course on the same subject, making it not very suitable for subjects having a short life expectancy, or needing frequent updates;
- it can not easily be used to learn subjects like human relationship, affective behaviours, selling skills, confidence

building, corporate culture, etc., although some experiences have been made with a certain success;

- it can not be used by learners who need to be regularly supervised by another person.

Available NTTs

1. NTTs and group learning

NTTs used in a classroom or in distance learning can be subdivided into three categories: presentation tools or techniques, PC-based, and non PC-based.

The oldest **presentation tool** in use in classrooms is undoubtedly the **chalkboard**; it is an essential teaching tool and will remain so in many places and circumstances. It has been replaced, or complemented, by "flip-charts" and white boards, and/or by transparencies ("foils") and overhead projectors.

The use of **transparencies** by the teacher is quite popular. However, in many cases its use could be improved by writing in big enough characters, using the right colours, reducing the number of lines per page and the number or words per line, etc. NTT now offers the opportunity to prepare and print very attractive transparencies, even in colour, and to update their content in a very short time. All it needs is a PC, wordprocessing or graphic software, an inexpensive colour ink-jet printer and transparent foils which can be directly printed.

The **whiteboard** is another tool that shows an evolution versus the chalkboard. Nowadays there are white boards with built-in features which allow the teacher to print what is written and drawn on the board, and distribute a copy to the learners.

Slides are rather cheap and can be of high quality, and be an interesting tool for course illustration (e.g. in sciences). However their projection lacks flexibility: it is difficult to come backwards to a slide seen half an hour before, or to change quickly the order of a series of slides, or to select a few in a long series. Slide projection has the disadvantage of necessitating a rather dark room and a good projection screen.

Audiocassettes, and more seldom **audio compact disks (Audio-CD)**, can also be used in the classroom to illustrate an event or introduce a discussion. Audiocassettes have the same disadvantages as all similar sequential systems: it takes some time to locate the exact place where we can find what we need to listen to. But they are cheap, and so is the equipment to produce and use them. NTTs now offer audio compact disks which provide a random access allowing the teacher to immediately find the track that interests the students.

Videocassettes or **tapes** are also used in classrooms; they are interesting to represent a live situation, to introduce realism in a course; they are a low-cost tool, but sequential; they may cover the essential educational needs in many cases. Videocassettes may contain up to four hours of educational material. However the existence of different standards (NTSC, PAL, SECAM; VHS, Video-8, U-MATIC, etc.) could be a limiting factor for the user, who may not have the right equipment to view the content of a videocassette.

NTT again offers the **video disk,** also called "**laser disk**" (not to be confused with the compact disk), used in the classroom as a powerful teaching and learning tool. The video disk has a diameter of 30 cm and records *analogue* audio and video. It exists in different standards (NTSC, PAL, SECAM) but it has all the advantages of random systems: one can access any sequence of images, or even a specific image, in a very short time, anywhere on the disk. Each face of the disk may contain 30 to 36 minutes (depending on the standard) of learning material. Video disk players exist in stand-alone mode, generally controlled via a remote controller, and connected to a TV monitor. They may also be connected to a PC as we shall see later on.[5]

We shall look at some additional NTTs used by the teacher to support his/her presentation in order to better preview the subject matter or to increase the flexibility to answer questions, or to report what was said before, or to increase the access to additional material (e.g. data base, dictionary, encyclopaedia, etc.).[6]

Some NTTs use personal computers. These are **PC-based NTTs** and depending on the number or learners and the size of the classroom, a projection system on a bigger screen or TV monitor may be used. The simplest use of the PC-based NTTs is offered by an **electronic transparency** but it offers in fact much more possibilities when using multimedia. In addition to text, the presentation may contain images, sound, animation and video at the appropriate time. A series of software helps develop attractive and flexible classroom presentations, and also allows an easy and quick update of courseware. This is nowadays done using **multimedia PCs** equipped with a sound blaster and speakers, a high quality colour display screen, and possibly a CD-ROM player (on which audio, images and video files are recorded), a video disk player and a videotape player (controlled by the PC if they have been recorded with the index system allowing to find a sequence, backwards as well as forwards).

Individual keypads may also be used in the classroom in order to verify at any moment if the learners follow the teacher, how much they understand, if it is necessary to repeat or re-phrase the

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5 Report to Congress on the potential of interactive videodisc technology for defence training and education - J.D. FLETCHER - The Videodisc Monitor - June 1989, pp. 20-21.

6 Answers on the disc: general encyclopaedias on CD-ROM - Deborah HOLLENS & Jim RIBLE - The CD-ROM Professional - July 1991, pp. 54-61.

subject, or just to re-capture their attention.[7] Connected to and controlled by a PC, these keypads provide both teachers and learners with an immediate feedback.

If the use of all these NTTs in the classroom is too difficult for the teacher who, on top of concentrating on his presentation needs to monitor student's learning, some universities and companies have implemented **technological classrooms.** They may contain all possible NTTs controlled by PCs which are used by trainees and teachers. These NTTs are loaded with a choice of programmes and are user-friendly[8].

The last category of NTTs one can use in the classroom are the **non-PC based** presentation tools which have recently been introduced in the classroom as well:

- the **Compact Disk Interactive** (or CD-I) is a player connected to a TV monitor; the CD-I player (a trademark of PHILIPS) exists in different versions (consumer player, professional player and portable player) and can also play audio-CDs. CD-I disks (titles) may, for example, be used in a classroom either for group instruction or for individual learning. Although it does not require a PC, an in-built micro-processor performs the functions for interactive learning, even with a group.
- the **Photo-CD** player (a trademark of KODAK) is connected to a TV monitor and allows one to show images in different formats (zoomed or not, contact size, etc.), in any order. Photo-CD are presented by KODAK with pictures taken by the users (photographs or slides) up to about 100 high quality images on one disk. The Photo-CD player cannot play CD-I's; but the Photo-CD can be read on any CD-ROM player. Connected to a computer it allows pictures to be captured on

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7 Experimenting with the Student Learning System (SLS). - Albert HERREMANS - Education and Computing - Elsevier Science Publishers BV - 1990 - pp. 187-190 (Actes de l'IFIP Working Conference WG 3.4 - Helsinki - Juillet 1989).

8 Master Classrooms: classroom design with technology in mind - Kathryn CONWAY - Institute for Academic Technology (IAT) - Series "Technology in Higher Education: current reflexions".- 1990 - 26 pages.

the hard disk, copied, exchanged, introduced in a multimedia application. The photo-CD can also play audio-CDs.

Besides the last three types of NTTs, personal computers as stand alone or connected to a Local Area Network (LAN) may be used for learning in a laboratory of the training Centre. Such workstations allow learners to practice immediately after the theory is given. Hands-on sessions may be organized on PCs, for example, to develop and test a computer program, to write the sequence of commands necessary to control a machine tool, to practice word processing or spreadsheets, etc. This may or may not require the control of the teacher, depending on the courseware.

Group learning may also take place in a **distance learning** environment. All NTTs mentioned above for use in classrooms can of course be used by the teacher who sits in a remote studio. Distance learning can be delivered **live** (learners are watching and listening to the course while it is given by the teacher) or **deferred** (learners are not able to watch the course "live"; the course is recorded on videotapes, and the learners use them at convenient times). When the course is delivered live, the classroom may be equipped with the already mentioned individual keypads (generally referred to as **student response units**) combined with an audio system that allows the remote learners to interact with the teacher in a two-way communication.

Courses may be delivered at a distance via terrestrial networks (telephone network, cable TV, etc.) or via satellites, or a combination of both (e.g. video and audio satellite broadcast and terrestrial audio feed-back). The recent evolution of NTTs has allowed the implementation of various types of distance learning, using terrestrial fast lines (optical fibres, ISDN lines) and the audio and video compression techniques. If using computer networks, the remote learners may see the teacher on their PC display besides what he or she is showing them, but also the teacher can see the remote learners, what they are doing cn their PC, and can correct a student's work.[9]

A combination of PC, video, telephone lines and/or satellites may also be used in a "**teleconferencing**" mode, including the PC-to-PC conferencing mode. In this case, two users may not only see each other (on the PC display) and discuss via the audio two-way connection, but also show each other documents and see what the correspondent wishes to show on the same document...

When the course is used in a deferred mode, tutors may help (informal) groups of learners who work individually but need somebody who can answer their questions, correct homework, etc. This is possible through an electronic "forum", which enables students to correspond and discuss with other learners, tutors and teachers, via electronic mail.

2. NTTs and individual learning

Generally speaking, group learning takes place at school and at the university. We have seen how NTTs can be used in this environment. But once this stage is over, out-of-school learning will still be required in order to maintain or increase an individual's value on the labour market. This is where individual learning or self-study becomes important.

The NTTs used for individual learning are almost the same as those illustrated for group learning, except that the way they are used will be different: instead of being used by the teacher for his presentations or by students in class, NTTs can be used by individual learners to acquire new knowledge, review courses already followed, acquire the necessary basic skills or keep pace with the level of knowledge of others. This can be done in learning centres, at the workplace, at home or while travelling.

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9 Education TeleVision Network (ETVN) - Barry SCOTT: Proceedings of the 7th International Conference on Technology and Education (Brussels - March 1990) - Ed. N. Estes & al. - Edinburgh - CEP Consultants - 1990.

This means that NTTs have to be even more user-friendly. Their utilization must be made very simple and attractive.

Books have been and will continue to be an utmost important means of learning, very easy to carry and to be used everywhere. It is not likely that NTTs will replace them. Books and NTTs are complementary. But new forms of books are coming on the market, on an electronic support, based on the "hypertext" concept which we shall discuss later.

Courses are offered on **audiocassettes** and **videocassettes**, which can easily be used just about anywhere; including in the car (for audiocassettes!).

Personal computers (PCs) are used by schools and universities in so-called self-learning laboratories where students can go anytime to learn individually, reviewing some courses, learning more in depth, at their own pace.[10] Businesses adopt a similar approach in their Learning Centres.

The access to **portable PCs** now offers the possibility to learn anywhere: in the train, at the airport (while waiting for a plane) or in the plane itself. Courses on audiocassettes may be used in the car, while driving long distances. More recently, networks have been installed in hotel bedrooms in order to provide the travellers a way to use a PC that can work either as a TV monitor (to watch TV programmes) or as a learning tool by giving access to a "server" on which a series of Open Learning courses have been stored (locally or remotely).

Before personal computers were born, **Computer Assisted Learning (CAL)** had been developed and offered on mainframes. The quality of CAL courseware could now be largely improved; hardware and software could allow more flexibility, friendliness, power (colours, resolution, etc.). It followed the rapid evolution of the PC: faster microprocessors, better displays and printers

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10 Lights, camera, reaction! The interactive videodisc: a tool for teaching chemistry - Loretta L. JONES & Stanley G. SMITH - in: Working papers in Multimedia solutions, Series "Instructional applications in higher education" (Institute for Academic Technology, University of North Carolina, USA) - 1991 - pp. 23-34.

resolution, bigger storage capacities, etc.. associated with a fast decreasing price. Needless to say, CAL courses became more attractive, cheaper and more efficient. Rather boring "text page turning" learning programmes were replaced by exciting multimedia courseware, using text, images, sound, animation and video.

The relatively recent introduction of **multimedia** (control by the PC of text, images, sound, animation, video) has been vital in this process. The problem of creating and storing large files (quality images and sound) was very quickly solved thanks to the introduction of **compact disks "read only memory" (CD-ROMs)**. These disks have a diameter of 12 cm and record digital material: text, sound, images, video). All these media can be stored on CDs using compression techniques (for both audio and video files) and easily accessed. Up to 72 minutes of compressed images, sound and full motion full screen video can be stored on CD-ROMs. These are produced by specialized companies. The market nowadays offers CD production devices, allowing one to produce his or her own CD-ROM. **Optical read/write diskettes,** a new digital storage system, allows users to record and update large files.

Individual learning can also be performed with the help of the already mentioned **CD-I,** using titles published by specialized companies, mainly for entertainment and culture, but also for education and training; a title may represent up to 72 minutes of compressed images, sound and video. CD-I titles can be produced by universities or companies, in exactly the same way as any other CAL courseware. The only difference is that it will only be possible to run the resulting educational material on a CD-I player, not on a CD-ROM player connected to a PC. The CD-I player is different from other players and has built-in PC functions. The interactivity is rather limited on a consumer model, because the system does not contain a keyboard. Menu choices and data entry are done via the CD-I remote controller (a kind of a remote mouse). The professional model has a keyboard and more memory; a printer can be connected to it. CD-I players also read audio-CDs and photo-CDs, explained hereafter. It is connected to a TV monitor. A portable version also exists, with a built-in flat display.

The **photo-CD** cannot be considered as a self-study tool because there are no PC functions in its player; but the content of its disks can be read by a CD-I player or a CD-ROM player connected to any PC. This means that it can be used in a CAL courseware, but not as a stand-alone system.

All these technologies can be used on **individual work stations**, but they can also work in connection with others on **LANs** or even **WANs (Wide Area Networks)**, which give them more power because they can access a lot more information when needed. Terrestrial lines, today considerably improved where ISDN or optical fibres are already available, are used to implement such networks. Satellites are also used to transmit courses, live or deferred; they can also be used to send data and update regional or local data bases, which can be accessed from different LANs and WANs.

The technological evolution of personal computers, as well as their decreasing price, allow more and more people to have a PC **at home**, which they can use for CAL in addition to their other preferred activities (accounting, playing games, etc.). Programs provided by the teachers, or bought off-the-shelf from publishers (language courses, basic courses in mathematics, electronics, etc.) facilitate computer-assisted learning.

PCs, working in a stand-alone mode or in LAN, are also used **at the workplace**; learners can use their own workstation, or those installed in a **learning centre**, which is sometimes organized within the company or outside, by a group of companies or a professional association. When PCs are available at the workplace to provide training when needed, one speaks about "just-in-time-training". It allows access to training at the moment it is required and at the time at which the learner has to put his or her knowledge into practice. CAL courseware, tutorials, on-line help, data bases, etc. may be available on the user's workstation, or via a network. It also allows one to reduce the basic training time, by eliminating commuting and waiting time to attend courses if and when they are available. This approach is sometimes referred to as **Electronic Performance Support System (EPSS).**

The following table summarizes what has been described so far, showing which NTTs may be used in relation with each delivery mechanism:

	classroom	distance learning	learning centre	work station	at home	while travelling
transparencies	X	X				
slides	X	X				
audiocassettes					X	X
audio-CDs	X		X	X	X	
videocassettes	X	X	X	X	X	
videodisk	X	X	X	X		
photo-CD	X	X	X	X	X	
CD-I	X	X	X	X	X	X
PC	X	X	X	X	X	X
PC+videodisk	X	X	X	X		
PC+CD-ROM	X	X	X	X	X	
PC+multimedia	X	X	X	X	X	X
CAL			X	X	X	X
keypads		X				
technology class	X	X				
telecoms		X	X	X		X

Soft technologies

Besides the NTTs mentioned earlier, new approaches have been or are being progressively implemented, which may deeply change the way we learn, and which we would call "**soft technologies**".

Hypertext (or **hypermedia**, when more than just text is involved) is the first example of such technologies. It might change the traditional way of learning which is

- linear, sequential,
- very "directive",
- the same for every learner (whatever his or her learning style, previous knowledge, available time, etc.),
- hardly interactive (a program can hardly be labelled interactive if it only offers a selection from a menu).

The Hypertext or Hypermedia offers a way of "**navigating**" in the subject matter, closer to a personal, empirical and exploratory way of learning.[11] The educational role of hypertext and hypermedia is nevertheless not recognized by everybody. It is considered more as an information tool, a discovery system, because the links between objects are difficult to control and may lead to wrong associations[12]. The learner may never be sure of having seen or learned the whole subject. One can of course use, after having explored the subject matter, a knowledge verification system, but such an evaluation program is seldom offered in Hypertexts.

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11 Hypermedia navigation as a central concept for instructional tool environments - Max MULHAUSER - Proceedings of CALISCE 91 - Lausanne - September 1991, pp. 177-184.

12 Windows 3.1 et le multimédia - Jean-Pierre LOVINFOSSE - Marabout Informatique - 1992.

Intelligent tutoring systems, an improvement of traditional CAL courseware based on the introduction of **artificial intelligence (AI)**[13], is probably the future individual learning system. At the moment it exists on a research and prototype basis. An intelligent tutoring system progressively builds and updates a learner's model, and adjusts the way one uses the program to his or her model detected via the man-machine interaction (questions, answers, errors, etc.). This is certainly not yet totally ready for implementation on a large scale, but more work is being done which opens very interesting prospects[14]. Courses developed this way are necessarily more expensive, because their design is considerably complex. However, the result expected should be so greatly rewarding that it is worth the effort.

Another approach has been recently implemented, which can help develop and update courses faster and cheaper. The subject matter, which is embedded in the course structure and organization in a traditional CAL, is "atomized" in a separate data base (called "**knowledge base**") which means that it can be used for different courses, by different people, and be updated in a central place. Courses update in this way is made much simpler and cheaper. The implementation is too recent to judge the approach. The remark expressed about AI-based courseware also applies here: longer and more complex design and development, but much better results expected with regard to learning quality.

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13 Towards integration of multimedia and artificial intelligence in courseware production. SHIVA: a step in a European context - Jean-Louis LEONHARDT, M. BAKER & C. BESSIERE - Proceedings of CALISCE 91 - Lausanne - September 1991, pp. 35-42.

14 La contribution du profil de l'élève dans un didacticiel intelligent de lecture - Marc MEURRENS, Colette DUBUISSON & Marie NADEAU - Actes du 2ème Congrès Européen "Multimedia, Intelligence Artificielle et Formation" - APPLICA90 - Lille - Septembre 1990.

Virtual reality (VR) is another concept which is still at the research stage for training applications, but which is very promising for certain aspects of learning. It requires very powerful and expensive work stations, at least if one wishes to take full advantage of the so-called fully immersive VR. Flight simulators in training pilots use some concepts of VR. A limited version now exists for high-end PCs, called the "desktop VR". For training, virtual reality will most probably be particularly powerful in the area of 3D simulation. The learner will no longer change parameters with the keyboard or the mouse, but will really (or better, virtually) walk into the system or room, turning knobs, touching objects, which offers an almost perfect realism. VR software currently offered on the market implies quite a bit of additional programming (e.g. in C++ language) which not everybody is likely to afford. On top of that, VR supposes the use of rather expensive equipment: special gloves, helmets with built-in small screens for every eye, 2D/3D mice, etc. But prices will decrease as progress is made, which seems to go rather quickly. Another aspect of VR that might be interesting for training is the possibility, via networks, to have several persons working remotely but simultaneously at a VR application, the possibility of generating 3D group work in real time!

Chapter 3
Selecting the appropriate NTTs

The decision to use one or more NTTs, and which ones, is essential because once the decision has been taken it will have an impact on the teaching/learning process for many years. Selecting NTTs becomes one small part of an educational system's approach which will focus on what education and training to offer to whom, where, when, how and why!

Among the suggested approaches, one starts[15] with a needs' analysis: how many people do we need to educate or train, for what skills. The needs analysis may be based on national or regional development planning, on projections for business and industry for the next few years, or on the business targets for a specific company. It results in training goals (see Figure 3.1).

Clearly defined objectives help to establish performance requirements which, compared to the current level of knowledge and skills, indicate precisely the training requirements. The analysis of the training requirements results in a curriculum, divided into courses or modules. For each module, the decision about how to deliver it (group or individual learning) has to be taken and then, but only then, the use of NTTs may be considered. To close the process loop, one has to set up in place measurement and evaluation systems in order to be able to verify whether the objectives have been reached.

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15 A Systems' Approach to Education (SATE) - A compendium - IBM Europe Education - 1991.

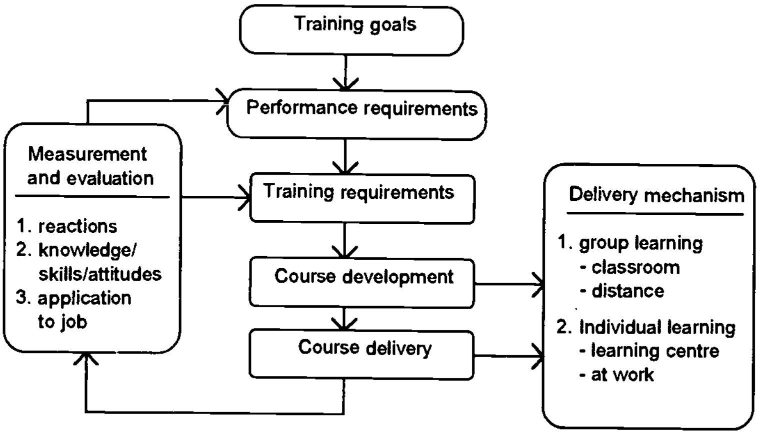

Figure 3.1

When looking at the **delivery mechanism** to be used for a course or for a particular course module, three steps may be identified:

- a **political or strategic** decision to use or not to use some NTTs for education and training needs to be taken from the outset;
- if the decision is "yes, we wish to use NTTs", a **non-quantitative analysis** of the education and training environment will help to select either group or individual learning;
- **a quantitative analysis ("cost model")** will then be applied to the selected delivery mechanism in order to decide whether the training material will be bought off-the-shelf, custom developed or developed in-house and what type of NTT should be considered.

Political or strategic decision

This decision has to be taken at the national or regional level by the highest authorities in charge of education and training, at management level for business concerns. Taking the right decision implies a serious analysis of needs, target population, existing resources and to be well informed about the most recent NTT applications, advantages, limitations and costs. Decision-making requires access to a network of updated information, success stories, demonstrations, and exchange of ideas with professionals.

The decision to use NTTs implies that appropriate measures need to be taken to make the necessary resources available (money, people, equipment); and to provide the trainers in charge of the implementation with appropriate training.

The availability of technologies in a certain place at a certain point in time is another essential parameter, and of course the availability of funds and the political willingness to invest in NTTs.

The teaching/learning environment analysis

This analysis takes into consideration the particular learning situation for which the decision has to be taken. A series of parameters may be examined, at different levels of details:

- The **learners**: it is important to know as accurately as possible their number, their age range, their geographic dispersion, their level of knowledge of the subject matter, their learning skills, their availability, their attitude towards technology in general, their preferred learning styles (alone or in a group, using visuals or not, by doing, through discovery, etc.);
- The **teachers**: their number, their technical experience and teaching skills and communication ability, their availability,

their attitude towards technology, their mastering of technology, etc.;

- The **subject** of the course (or module): the decision to adopt NTTs depends on whether the subject matter is stable or changing fast. It is therefore necessary to know how frequently the course (or module) will have to be updated and how complex it is;
- The **required competency**: should the learners be able to identify components, or list them, or interpret a situation, or co-ordinate different activities, or manipulate objects, etc.;
- The **interaction level**: is interaction necessary among students, between student and teacher, between student and equipment (simulation exercise), or between student and an expert?
- The **delivery requirements** can take many forms: there might be pedagogical reasons for using or not using hands-on, visuals, audio, video, role playing, simulation, etc.
- The **time**: the decision may have to be based on when the first course has to be delivered, how many times it will be given and over which time period.

Figure 3.2 shows an example of a selection matrix. It is inspired by a suggested methodology[16] and compares group learning (classroom and distance learning) and individual learning (in a learning centre, using a work station). Users may adapt the suggested matrix, according to their specific training situation. More parameters may be added, or more details may be introduced for certain parameters. When applying the matrix to a concrete case, one can either place a cross in every column corresponding to the analyzed situation or, if possible, a weighting factor showing the relative importance attributed to each parameter, which may vary from situation to situation.

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16 Education Delivery System Selector (EDSS) - IBM Corporate Education - 1986 - document # ZR70-3010.

	classroom	distance learning	learning centre	work station
learners number:				
total	<500	<500	>500	>500
largest location	<50	<50	>50	>50
smallest location	<20	<20	>20	>20
learning styles:				
without direction			x	x
as part of a group	x	x	x	
by doing	x		x	x
by discovery			x	x
subject:				
complexity	high	high	low/medium	low/medium
updates frequency	<1 year	<1 year	>1 year	>1 year
interaction level:				
teacher/learner	x	x	x	
learner/learner	x	x		
with expert	x		x	
with simulation	x		x	x
course:				
development	<6 months	<6 months	>6 months	>6 months
life time	<1 year	<1 year	>1 year	>1 year
delivery requirements:				
hands-on	x		x	x
live supervision	x		x	
hearing/seeing an expert	x	x	x	
role playing	x			
Total:	10	4	10	5

Figure 3.2

The delivery mechanism which ends up with the highest number of crosses (or the highest value if crosses are replaced by weighting factors) will be selected, if no other aspects need to be taken into consideration.

An example:

Let us fill in this table for the following supposed situation:

- 2000 learners have to be trained, spread over 150 locations; the smallest one has more than 20 potential learners, and the biggest one more than 50;
- learners prefer to learn as part of a group, even if occasional (e.g. in a learning centre);
- the subject is not very complex, and does not need frequent updates;
- learners need the interaction with a teacher, or a tutor (e.g. in a learning centre);
- learners would also benefit from a contact with an expert;
- the best way to master the subject is to use simulation;
- the course development will take one year; the expected course lifetime is three years.

	classroom	distance learning	learning centre	work station
learners number:				
total			x	x
largest location			x	x
smallest location			x	x
learning styles:				
without direction				
as part of a group	x	x	x	
by doing	x		x	x
by discovery				
subject:				
complexity			x	x
updates frequency			x	x
interaction level:				
teacher/learner	x	x	x	
learner/learner				
with expert	x		x	
with simulation	x		x	x
course:				
development			x	x
life time			x	x
delivery requirements:				
hands-on	x		x	x
live supervision	x		x	
hearing/seeing an expert	x	x	x	
role playing				
Total:	8	3	15	10

Figure 3.3

In this particular case, the learning centre seems to be the best choice, followed by individual self-study on a workstation; classroom comes next, and distance learning would not provide a satisfactory solution to the described problem.

Cost/benefit analysis

Once the delivery mechanism has been selected, decision makers are confronted with the choice between:

- buying the training material **off-the-shelf;**
- contacting an external institution or company to develop it (**custom development**);
- developing it in the institution or company itself (**in-house development**).

This decision is based on a cost/benefit analysis, or a cost model. Costs and benefits should be analysed at different levels: courseware development, learning material distribution, education delivery and update are the most important ones. Intangible costs and benefits should not be neglected, because they may be very important in a certain number of situations. For each stage of the learning material development, distribution, delivery and update, different types of costs and benefits have to be considered: personnel costs (salaries of developers, teachers but also learners when already at work, travel and living expenses), equipment costs (computer hardware and software, telecommunications, audio and video equipment) and others (e.g. buildings).

1. Courseware analysis and development

To analyze and develop a course, multiple skills are needed: instructional design, subject matter knowledge, pedagogical approach, and possibly computer science and graphic arts. These skills are generally found in a multi-disciplinary team. Sometimes a few persons may combine the most important ones, however a single person will seldom offer all the necessary skills.

The **instructional designer** sets the scene, determines the teaching and learning strategies that will be used; his or her role is essential, even more so when NTTs allow for different pedagogical strategies according to different learning situations.

The **subject matter expert** has the knowledge, but not necessarily the skills to develop the learning material. Subject matter experts may have absolutely nothing to do with education and training (researchers, technicians, experts, social or political personalities), hence the need for them to accept to transfer their knowledge to those who will develop the course.

The course development itself is the work of the **developer**. If multimedia is used to make the course more attractive and effective, a **graphic artist** and a **specialist** who is familiar with developing multimedia courseware will be necessary. Modern software for developing courseware is increasingly user friendly and does not require programming language skills.

Development cost is calculated in terms of the number of hours multiplied by the cost per hour. The more complex the subject is, the more interactive the course has to be and the more it involves multimedia, the longer and the more expensive the development will be. Hence the need to think in terms of reusability and cooperative development.

Course development may be done in such a way that it will induce benefits for further developments. Courseware may be designed in such a way that it is easily translated into other languages, or adapted to other cultures with a minimum effort. Or it may be designed in such a way that learning will be quicker.

2. Course distribution

A course may be developed for commercial distribution. If it takes the form of a book, a CAL package or a CD-ROM, it will be distributed via the publisher's distribution channels. If it is composed of computer files, it can be distributed electronically via computer networks. Each distribution channel has its own costs, which have to be taken into account. Printing a book, and its subsequent updates, pressing a CD-ROM and new versions or updating computer files have different associated costs.

3. Delivery costs

Having analyzed the development and distribution costs, one should not neglect the delivery costs which may be very substantial and influence the final decision.

The personnel costs may represent a significant percentage of the total delivery cost: the number of teaching (and/or tutoring) hours multiplied by the cost per hour. When learners are at work, their salary during training time is an important factor, on top of the fact that they are not productive during that period. Trainers may have to repeat the same course to different groups of employees (e.g. maintenance procedures of a new product).

Travel and living expenses (in an hotel or residential learning centre) may be very heavy if learners are geographically spread in a big country or region. The choice of the appropriate NTTs may considerably decrease travel and living expenses of both teachers and learners, which may represent appreciable savings.

Then come the infrastructure and equipment costs. If classrooms or an auditorium are not available, the cost of building or renting them should be considered. If computers and computer networks have to be installed, their cost should be considered, as well as the cost of their use (telecommunications, leased lines, satellite broadcasting time, etc.). If courses are based on multimedia courseware, some equipment will be necessary to use them. However NTTs hardware costs should be considered as an investment, not as an expense as it is too frequently the case. NTTs will be depreciated over several years as are the other investments (buildings, class and laboratory equipment, etc.).

4. Update costs

As already said, costs of updating courseware may vary considerably from one programme to another depending on the dynamics of the subject matter.

5. Intangible costs and benefits

It is always difficult, if not impossible, to put a value on an intangible cost or benefit, but they are important in a decision-making process. How to estimate the value in monetary terms of the quality and user friendliness of a learning material, and of the social, cultural and political benefits of a training programme is indeed difficult. Intangible costs and benefits are generally not inserted in a cost model, but they have to be taken into consideration when interpreting the results of using the model.

6. A simplified cost model

Different cost models have been suggested[17]. Three simplified possibilities are presented below.

- buy the course **off-the-shelf**, which is a good solution for CAL courseware when one finds the exact course one needs. The purchase price may considerably increase if it is necessary to adapt it to specific needs of the target learners (language, culture, etc.). Fortunately the market offers more and more educational material which may satisfy basic needs, because publishers only offer courses which have a chance of being

17 e.g., in The Training Technology Monitor - Vol. 1 Number 2 - January 1994, or in Interactive Video Yearbook 1990 of the National Interactive video centre (NIVC) - UK.

sold in large quantities. They also offer additional material, like dictionaries or encyclopaedias, which are not learning material *per se* but help the learners to understand the subject matter;

- ask for a **custom development**, which is necessary if: *a)* specific CAL courseware is not available off-the-shelf (or cannot be modified to meet one's requirements); *b)* the institution or the company does not have a development team; *c)* if it has its own development capacity but cannot develop the course in the allocated time frame or at a lower cost. This can easily be computed with a cost model;
- consider **in-house development** of courseware for individualized CAL or for group training. In-house development of a CAL courseware must be compared with customized development, provided that in-house expertise is available. The development cycle is very long for a CAL courseware, which makes it expensive to develop it in-house for a rather small number of learners. The in-house development cycle of a classroom course is quite shorter than for a CAL courseware, which makes it economical for courses that will not be followed by large numbers of learners.

A certain number of parameter values have to be collected before filling in a cost/benefit analysis matrix, which offers the possibility to simulate different sets of values where the parameters can not be quantified in a precise manner. Computer spreadsheets are the appropriate tool to do so.

General data which are needed are:

- the number of potential learners over the supposed lifetime of the course;
- the course length (delivery hours if given in a classroom);
- the development effort (number of hours spent by several persons for analysis, development and foreseeable updates to develop one hour of classroom delivery);

- the number of development hours to develop a classroom or CAL courseware corresponding to a delivery of one hour in a classroom (e.g. the development of a CAL courseware to replace a one-hour classroom course would be five or ten times longer);
- the number of hours a learner would spend to learn with a CAL courseware what he or she would learn in a one-hour classroom activity (e.g. the learner using a CAL may master the subject in 75 percent of the time he or she would spend in a classroom)

Fixed costs (not related to the number of learners):

- purchase price of a course bought off-the-shelf;
- or contract price of a custom-made course developed outside the institution;
- or the in-house development cost (average cost for one hour of development, analysis or update, spent by the different persons involved in the process multiplied by the hours of development work);
- other costs when developing in-house may include travel, mail, etc.

Variable costs (related to the number of learners):

- the teacher delivery cost (salary plus benefits), assuming e.g. one teacher for 25 learners;
- the learner delivery cost, if the learner receives a salary while trained;
- travel and living expenses related to the development, the analysis and the updates;
- the learners' travel and living expenses, when appropriate;
- the depreciation of the total NTTs equipment cost (PCs, multimedia, CD-I, photo-CD, videotape player, videodisk player, keypads, etc.); this type of cost should indeed not be considered as an expense, but as an investment, so that the depreciation only should be included in the calculation.

An example

These data being collected, they can be entered in a spreadsheet. The following values have been used (and can of course be changed in order to represent any real situation):

General data:

- 2000 learners will follow the course
- the course length is 40 hours (one week) if delivered in a classroom
- the development time is 40 hours for one classroom hour, and 200 hours for one CAL hour corresponding to one classroom hour
- using CAL courseware, learners will master the subject in 0.75 times the classroom delivery time.

Fixed costs (not related to the number of learners):

- purchasing the course off-the-shelf costs 60,000
- asking an outside institution to custom develop the course costs 150,000
- developing the course in-house costs 70 per development hour
- other development costs (travel, etc.) amount to 2,000.

Variable costs (related to the number of learners):

- teachers are paid 70 per hour; one assumes one teacher for 25 learners
- teachers travel expenses amount to 400 for the week (the classroom is assumed to be at a distance)
- learners' salary amounts to 50 per hour
- learners' travel expenses amount to 400 for the week (the classroom is assumed to be at a distance)

- NTT depreciation amounts to one per learner/hour calculated as follows: every NTT work station costs 6,000 and is used for 1,500 hours a year; the depreciation is calculated over four years.

Figure 3.4 shows what the matrix will look like if we present the above example, beginning with the assumption that the learners are not yet at work, and so are not paid while trained. The model can of course be further detailed if necessary.

COST MODEL

		Classroom in-house	CAL in-house	CAL custom dev	CAL off-shelf
General data					
Number of learners	2 000	2 000	2 000	2 000	2 000
course length (hrs)	40				
development hrs/ class hour		40	200		
delivery hours	0,75	40	30	30	30
Fixed costs					
purchase/contract price				150 000	60 000
development cost/hour	70	112 000	560 000	0	0
other costs		2 000	2 000		
Total fixed costs:		114 000	562 000	150 000	60 000
Variable costs					
teachers' salary/hour	70	224 000			
learners' salary/hour	0	0	0	0	0
teachers' travel/week	400	32 000			
learners' travel/week	400	800 000			
NTT depreciation	1	0	60 000	60 000	60 000
Total variable costs		1 056 000	60 000	60 000	60 000
Total cost		1 170 000	622 000	210 000	120 000
Total cost/learner		585	311	105	60

Figure 3.4

In this particular case, off-the-shelf CAL courseware is less expensive if it is available and corresponds to the requirements (language, culture, etc.). If not, custom developed CAL is the best solution. In-house development is more expensive. Classroom is only mentioned for the sake of completeness, but was not considered after the pre-selection (in our example).

If only 500 learners were to follow the course, the total cost per learner would be as follows:

	Classroom in-house	CAL in-house	CAL custom dev	CAL off-shelf
Total cost/learner	756	1154	330	150

Figure 3.5

Would the decision be different if the learners were already at work and continued to be paid while trained? Figure 3.6 shows the result, again for 2,000 learners:

COST MODEL

		Classroom in-house	CAL in-house	CAL custom dev	CAL off-shelf
General data					
Number of learners	2 000	2 000	2 000	2 000	2 000
class course length (hours)	40				
development hours/ class hour		40	200		
delivery hours	0,75	40	30	30	30
Fixed costs					
purchase/contract price				150 000	60 000
development cost/hour	70	112 000	560 000	0	0
other costs (travel, etc.)		2 000	2 000		
Total fixed costs:		114 000	562 000	150 000	60 000
Variable costs					
teachers' salary/hour	70	224 000			
learners' salary/hour	50	4 000 000	3 000 000	3 000 000	3 000 000
teachers' travel/hour	400	32 000			
learners' travel/hour	400	800 000			
NTT depreciation	1	0	60 000	60 000	60 000
Total variable costs		5 056 000	3 060 000	3 060 000	3 060 000
Total cost		5 170 000	3 622 000	3 210 000	3 210 000
Total cost/learner		2 585	1 811	1 605	1 560

Figure 3.6

In this example the conclusion is the same; the cost per learner has been increased by the learners' salary and benefits.

If only 500 learners were to follow the course, the total cost per learner would be:

	Classroom in-house	CAL in-house	CAL custom dev	CAL off-shelf
Total cost/learner	2 756	2 654	1 830	1 650

Figure 3.7

It should be noted that the NTTs depreciation cost only represents a low percentage of the total cost. And that fixed costs are generally lower than variable costs, except for rather small numbers of potential learners. Of course, changing one or more parameters (e.g. development cost per hour, teachers' and/or learners' salary, etc.) would probably lead to another conclusion. Hence the necessity to consider this example as a pure exercise, and reproduce the same spreadsheet with real figures. And if appropriate, one can add some lines (e.g. depreciation of NTTs used for the development, buildings depreciation) and/or change some others (e.g. depreciation of some NTT equipment used in the classroom).

Chapter 4
Implementing NTTs in a training environment

Once the decision has been taken to implement NTTs, it is essential to be sure that those who will have to use them, teachers and learners, are convinced that NTTs will improve their teaching or learning process. If this is not the case, it is worthless to invest time and money in NTTs because the equipment would be under-utilized.

This process generally takes some time and is done step by step:

1. Demonstrations

Examples are shown, which are as close as possible to the problem the participants will have to solve; everyone expects to see examples of someone who did a successful use of NTTs in his or her domain of interest.

2. Order and install equipment

If it is decided to develop the titles oneself, one has to decide which hardware (computer and audiovisual) and software (authoring and/or presentation systems, graphics tools) has to be ordered. Ordering, receiving and installing hardware and software, not to speak about training those who will have to use them, usually takes longer than is generally expected; hence the necessity to do it as soon as possible in the overall process.

3. Hands-on workshops

If the institution has decided to develop titles itself, the next step generally consists of organizing hands-on workshops for those who will develop; it is indeed different to watch something done by somebody else (demonstrations) from being allowed to actually practices; which generally suppresses a great deal of fear towards the difficulty of using NTTs.

4. Train the trainers and developers

Most trainers/teachers and courseware developers probably do not know NTTs, or at least those NTTs which will be used. Their training for a good utilization is essential to the success of the whole operation. Again, this is by not means a waste of time but a good investment in staff development.

5. Prototypes

Prototype courses, or modules, will then be developed and tested on a representative sample of learners. This will help answer those questions the teachers and developers are asking themselves, and allow them to check whether the learners' reactions are what they thought they would be. Lessons gained from this test will be more than useful in the development of courses.

6. Develop titles

Usually this is performed by a multi-disciplinary team. People who are not used to working together will have to learn to do so! Graphic artists, computer specialists, subject matter experts, etc. are indeed not used to speaking to each other, and have very different points of view, which may enhance their interest in a common undertaking.

7. Organize help, support

Whatever the solution adopted, an organizational support should be available in order to help teachers, developers and learners to use correctly the NTTs at any time and any place; otherwise, interest and motivation will disappear as soon as problems arise that are not quickly solved.

Chapter 5
Trends in NTTs

It is important to look at the trends in order to invest in such a way that it will be easy to follow the evolution without having to throw away relatively recent investments. Some trends about new technologies and education for the next few years are already visible in the most recent hardware and software announcements, research and experimental applications, educational titles offerings, debates in international conferences.

Some of the trends mentioned below are already being implemented on a restricted basis, as prototypes or experiments; it is wise to consider them as trends for as long as they are not generalized.

More **"edutainment"** (a combination of **education** and **entertainment**) will be offered, at low prices on small and cheap equipment. These titles are generally not educational tools, but the same equipment and approach can be employed to use and develop relatively simple training material at a reasonable price and with easy access everywhere, anytime. This is hopefully going to happen.

NTTs will be **more and more powerful** (faster microprocessors, faster and bigger memories, faster and larger storage systems, better display quality, faster and more complex printers, etc.). The same applies to software: easier to use, more functions, etc.

Standardization will improve, in all domains: audio and video files, compression techniques, file formats, etc., which means faster and cheaper development of additional learning material, easier translation into other languages, easier adaptation to other cultures, etc.

The move **from analogue to digital** will continue and probably go as far as possible. This will increase the possibility to exchange learning material, to send it via computer networks, to store it in computer data bases, etc. It also allows the use of compression techniques.

The teachers' role will undergo a change from what it is today, it will be seen more as that of a guide, a counsellor who helps learners to discover, understand the subject matter, delivered by NTTs. This supposes a considerably different approach to teachers' training and re-training (including self-training[18]), and, even more important, acceptance of the new role by the teachers themselves. This is probably a critical challenge for the years 90's. Some people say that teachers should become chameleons to adapt themselves to NTTs. Retraining of teachers already at work might have to be done on the job with the support of NTTs.

Learners will of course have to change their **way of learning** from a rather passive mode to a very active one, helped by teachers and tutors in their new roles, and by NTTs. Teachers and learners will have to be part of a multimedia-literate educational community, in order to get the most from the use of NTTs.

All this will be possible, or at least easier, thanks to the implementation of networked multimedia, also called multimedia distributed computing[19]: as a first step, multimedia capabilities are extended from stand-alone PCs to the whole range of products (workstations, minicomputers, mainframes) allowing the same software to be used on all of them; then, the connection of hardware through networks (LANs and WANs) opens the way to distributed, networked client/server-based multimedia for communication and delivery of information in all its forms to those who need it, anytime and anywhere. Such multimedia networks have already been implemented in a few schools, universities and enterprises[20].

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18 Multi-media training, trainers' skills, D. LERCLERCQ: Vocational Training, 1/1991.

19 Multimedia distributed computing - IBM White paper, November 1992.

20 Burnaby South Secondary School (British Columbia), James Madison University (Virginia), or Caterpillar - in Enterprise multimedia - IBM - March 1994.

Cooperation is going to increase at all levels: cooperative design and development of educational material (the term "**virtual faculties**" has been used) will be possible using the same networks; the result will be more material produced faster, at lower cost, and easily updated every time it is necessary.

Information highways are discussed in the USA and in some European countries; they will offer any type of information (including video, interactive TV, etc.) to everybody in a country or in a region; this will transform learning at home in a dramatic way. This includes the expected merger between the computer and television, already perceptible on a small scale through multimedia where the computer tends to become a TV, but this time on a very large basis (TV sets are available in many houses throughout the world) and the other way round: the TV set will become a computer. Computer manufacturers, TV producers, software developers, cable TV carriers are already working on this[21]. This means training at home, upon request and at a reasonable cost.

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21 PC et télévision: tout ce qui va changer sur vos écrans - Gilles FOUCHARD et Alain BARITAULT - Multimedia Solutions - May 1994.

In our fast changing world, invaded by technologies, education and training have to plan for an intelligent use of NTTs in order to improve the access to basic as well as advanced lifelong learning which will make it easier to get a job and continue to find employment.

This implies a considerable amount of effort from everyone:

- **decision makers** have to know how to make decisions related to investments in NTTs. They also need information as to what types of NTTs are available and how to best implement them in education and training; their knowledge has to be permanently updated;
- **teachers** have to be trained in the effective use of NTTs in their teaching activity. Their tasks and responsibilities will considerably change as supply-driven education is replaced by a demand-driven education, the teacher becoming more of a guide, a motivator, an integrator of learning activities in which learners will play a more and more active role. Teachers and training institutions will have to adapt their programmes accordingly. Teachers' knowledge about NTTs will have to be permanently updated;
- **learners** increasingly will have to learn to use technologies in order to get the right training at the right place and at the right time. They will have to be more active in the learning process, more specific in requesting the knowledge needed, not just wait for the education and training institutions to offer it;
- **educational material producers** and **publishers** will have to develop titles in a flexible way, allowing for easy, fast and cheap adaptations to other languages and cultures;

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- **software and hardware manufacturers** will have to constantly offer cheaper and easy-to-use material and programs, authoring systems, mass storage media, etc.;
- **distributors** will need to make a greater effort to make their available multimedia packages known, especially to developing countries which are interested but have no access to information and exhibitions.

All this is already on its way. There is no reason to wait for the ultimate version of hardware and software (the process of offering new ones will never end!), but one should start implementing the current technologies having in mind their compatibility with the next generations or versions, in order to invest rationally in human and physical resources.

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Appendix A
Compatibility

Compatibility (or should we rather speak about "incompatibility"?) is a major concern for users in order to protect their investment. Standards are dramatically lacking, and when they exist they come too late and are not necessarily accepted by all manufacturers. Some have been defined by one or a small group of manufacturers, others by international bodies.

So, users need to keep themselves informed and be particularly careful when buying a new equipment. Here are a few points to help them:

PC buses (architecture)

Within a PC, data circulate between various components (memory, disks, etc.) through a so-called "extension bus" which may be of different types:

- the **ISA (Industry Standard Architecture)** bus, also called **AT** bus, equips most of the IBM-compatible PCs. It works on 16 bits, giving access to more substantial memory addresses than the original 8-bit bus which equipped the very first PCs;
- the **EISA (Extended Industry Standard Architecture)** bus was designed by a group of manufacturers in order to work on 32 bits, but this is only an advantage if one uses EISA adapters on one's PC. This bus accepts adapters and programs written for the AT bus, but then works as a 16-bit bus;
- the **MCA (Multiple Channels Architecture)** bus is an IBM bus installed on its PS/2 series (not on the lower end of it) and works faster because the use of multiple channels allows multitasking and multiusers (on a network); only MCA

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adapters will work with this bus, and inversely these adapters will not work on another type of bus;

- the **local bus** provides a direct connection between the video controller and the CPU, making the graphic functions work much faster.

Microprocessors

The engine of a PC is its microprocessor. Several manufacturers are producing them; INTEL is currently equipping most of the IBM and compatible PCs:

- the very first PCs were equipped with **8088** microprocessors, sending and receiving 8-bit data;
- the **8086** came later, sending and receiving 16-bit data;
- the **80286** is also a 16-bit data microprocessor, which can work in two modes: the "real mode" used with DOS based applications, and the "protected mode" used with software which allows parallel processing of different applications (e.g. the OS/2 of IBM). When in real mode, the 80286 may address 1 Mb of memory, and when in protected mode, 16 Mb. To run a program like WINDOWS, a 80286 is a minimum configuration;
- the **80386** is a 32-bit data microprocessor, offering extended memory processing functions. A simplified version (**80386SX**) only uses 16-bit data for the bus, and 32-bit for the other functions;
- the **80486** is a 32-bit data microprocessor, with a built-in arithmetic co-processor, which takes over a certain number of tasks from the microprocessor itself. It offers much more powerful memory management functions than the 80386; a **80486SX** version does not have the built-in mathematical co-processor, for those who do not have intensive computing applications. The so-called **DX2** microprocessors double the internal clock frequency of the 80486, but they cannot be installed on all mother boards (on a 80486SX one has to

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install an "overdrive" on the arithmetic co-processor support, which plays the same role);

- the **Pentium** has been recently introduced on the market; it is a 32-bit microprocessor. It has **RISC (Reduced Instructions Set Computer)** characteristics, as opposed to the usual **CISC (Complex Instructions Set Computer)**. The data bus is a 64-bit bus; it has two different 8 Kb cache memories and works at very high frequencies (60 or 66 MHz). It is one of the most powerful computing microprocessors in use at the moment;
- the **Power PC** microprocessor is the very first result of the work done in collaboration between APPLE, IBM and MOTOROLA. It equips recently announced PCs (e.g. Power Mac of APPLE, Enterprise Desktop of HP) which process all kinds of operating systems (APPLE, IBM, MICROSOFT, UNIX) and all kinds of application programs (IBM compatible, WINDOWS, APPLE); this is a remarkable advancement towards compatibility!

MOTOROLA microprocessors equip the APPLE and the ATARI computers:

- the **68000** model works with 16 bits;
- the **68020** model is a 32-bit one working at 12 to 25 MHz;
- the **68030** model is an improved 32-bit microprocessor;
- the **68040** model is a faster and more powerful 32-bit microprocessor.

Operating systems

All PC functions are controlled by an operating system (OS); applications are written to run under a specific OS; it is therefore important to know what is necessary to run a specific PC and a specific application:

- the **DOS (Disk Operating System**) is the oldest OS; it works on small equipment; its different versions followed the market trends and technological improvements (e.g. bigger memory management, etc.).

- **WINDOWS** is not really an OS in itself; it is a powerful graphic interface for DOS users, which makes their work much more friendly. It helps to manage extended memory; to integrate various applications, exchanging files via its clipboard. Different versions exist, as well as multimedia extensions;
- **OS/2** is a multitasking and multiusers IBM OS which means that the user can execute different programs simultaneously (e.g. printing a file while working on another one, or formatting a diskette while updating a data base or a spreadsheet). It allows DOS and WINDOWS applications to be run under its control; different versions are available, as well as multimedia extensions;
- **APPLE System 7** runs on the Apple series of computers;
- **UNIX** is a multiusers, multitasking operating system, mainly used on workstations. More powerful than usual PCs; multimedia capabilities have been added to the software.[22]

Graphic modes

The graphics adapter that equips a PC determines the quality of text and images one can show on the display screen:

- the **CGA (Colour Graphics Adapter)** adapter is cheap and offers a rather poor quality; 320x200 pixels and four colours, or 640x200 pixels in black and white; WINDOWS does not support this type of graphics adapter;
- the **MCGA (Multi Colour Graphics Adapter)** adapter is offered by IBM with 320x200 pixels and 256 colours out of 256,000; or 640x480 pixels and two colours (black and white);
- the **EGA (Enhanced Graphics Adapter)** adapter offers 640x350 pixels with 16 colours out of 64;

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22 Multimedia premières on UBIX workstations - David SIMPSON - Systems Integration - January 1992.

- the **VGA (Video Graphics Array)** adapter is offered by IBM with 640x480 pixels with 16 colours out of 256,000 (262,144), or 64 grey shades on a mono display;
- the **VGA8** adapter is offered by IBM with 360x480 pixels and 256 colours out of 256,000; it works on VGA display screens;
- the **8514/A** adapter if offered by IBM with 640x480 and 256 colours, or 1024x768 and 256 colours when the application supports it;
- the **XGA (Extended Graphics Adapter)** adapter is offered by IBM with 1024x768 pixels and 256 colours out of 256,000;
- the **SVGA (Super VGA)** adapter is offered by all other manufacturers and works with 1024x768 pixels, with 256 colours.

Quality images recorded with a certain resolution can be converted by certain software into a lower resolution; the reverse is unfortunately not possible. Compatibility always exists downwards: a SVGA screen may show a VGA image, but the reverse is not possible.

Digital images, sound and video files

1. Images

Not only can image files have different resolutions but they are saved by different software in different file formats: file name extension may be PCX, BMP, WMF, TIF, etc...

Software exists that can translate, convert a certain number of file formats into others, but not all conversions are possible. Such a conversion necessarily induces a quality loss. Software also exists that handles images in many ways: rotating, resizing, etc., with a possible quality loss, which means that whenever possible, one should directly digitize the quality and size one intends to use, in order to get the best possible result.

Image files may be uncompressed, or compacted or compressed. Compacted images are slightly compressed without quality loss; it is only another way of recording areas of similar colour; the compression ratios are rather poor. Compressed images, with the current state of the compression algorithms, may have a compression ratio as high as 140:1 (about 2:1), but this always represents a loss of quality.

2. Sound

Digital sound also exists in different qualities expressed in sample width (bits) and in sampling rates (samples/sec or Hz); the higher the quality, the bigger the file; compression techniques may be applied, but their results are less spectacular than those for images. Sample width (8 or 16 bits) is combined with the sampling rate (8, 11, 22 or 44 million samples/sec or MHz), which produces files of 8 to 44 Kb/sec for 8-bit mono sound, and 16 to 22 Kb/sec for 16-bit mono sound; stereo sound is represented by files twice as big!

Sound files are also saved in different formats (e.g. AUD, WAV); software exists that can convert them into another format.

3. Video

Digital video data can be saved and played in different sizes (e.g. full screen, 1/4 screen) and resolutions (320x200, etc.); they exist in different formats (e.g. AVS, AVI); they are generally compressed because of their rather huge size, using different compression algorithms (e.g. DVI, MPEG, etc.). As an example, the Digital Video Interactive (DVI) system of INTEL allows the user to compress "live" (if the PC is equipped with the adequate compression adapter) in Real Time Video (RTV) mode, with a low compression ratio, or to get the file compressed by a specialized company in Production Level Video (PLV) with a ratio around 140:1 and a much better quality.

Video decompression needs on every work station a decompression adapter, or a decompression software (much cheaper) provided the PC is equipped with a fast enough microprocessor (a 486 as a minimum).

Colour standards

Analogue TV sets, videodisks and videotapes exist in different standards:

- **PAL** is used in most of Western Europe, Africa and Latin Americas;
- **SECAM** is used in France, most of Eastern Europe and French Africa;
- **NTSC** is used in the USA, Canada, Japan.

Nowadays, most videotapes or disk players are multistandard; tapes can be converted from one standard to the other, disks as well but this is more expensive.

Videotape formats

Videotapes exist in different sizes (1/2", 3/4", 1"), different formats (VHS, 8mm, U-MATIC) and different qualities (S-VHS, Hi8); camcorders, cameras and videotape players are specific and can only be used with a specific videotape size and format.

A videotape can be converted from one size and format into another, but with more quality loss than that obtained when copying a tape onto another with the same characteristics (a new "generation" of the tape).

Appendix B
Suggested PC configurations

CAL courseware may be used on rather small and cheap PCs, but if one wishes to take advantage of the existing off-the-shelf titles and of multimedia in general, one needs to acquire a minimum configuration.

In 1990, a certain number of companies agreed on a common standard configuration known as **MPC** (for Multimedia PC). IBM did not join, estimating that the suggested configuration was not powerful enough.

This standard has already been upgraded twice since, following the market trends and the applications offered. Today it includes:

- a 486 microprocessor
- 4 Mb of memory
- 160 Mb of hard disk
- a 16-bit sound adapter
- a CD-ROM XA drive (300 Kb/s)
- VGA display (64,000 colours)
- WINDOWS and its multimedia extensions.

Although this configuration represents a considerable enhancement of MPC, since it can run applications bought off-the-shelf, it may not be powerful enough to develop one's own multimedia applications.

A reasonable development work station should comprise:

- a 486DX2 microprocessor
- a 8 to 12 Mb memory
- a 200 Mb hard disk
- a SVGA display
- a CD-ROM XA drive (300 Kb/s)
- a 16-bit sound adapter

to which one may connect, depending on the technologies one wishes to use:

- a videodisk player
- a video compression/decompression hardware and/or software
- a still frame (image) capture adapter
- a scanner

and the appropriate software:

- presentation and/or authoring system
- graphics systems
- image handling
- sound processing
- video processing
- animation production and processing.

Existing PCs can be transformed at a reasonable price into a multimedia station in order to take advantage of offered titles without having to invest too much:

- adding a CD-ROM drive is probably the first step to consider; it may be important to make sure to have a CD-ROM drive from the last generation (called "multi-session")
- a sound adapter can then be added (or at the same time as the CD-ROM with which it is frequently offered as a package); the highest quality is currently obtained with 16-bit adapters.

With this equipment one can use most of the existing titles, noting however that:

- if compressed images and/or video files have to be used, a decompression adapter and/or software has to be added;
- if the learning material is offered on a videodisk, a videodisk player and an overlay adapter will be necessary;
- if one wishes to digitize images and/or video, a digitizing adapter and/or a compression/decompression adapter will be necessary.

Warning: remember that adapters are different according to the PC bus used.

Appendix C
Laser technology

Laser technology refers to the way disks are written and read:

- the **videodisk** (30 cm diameter) is an analogue technology; it allows one to record 54,000 high quality images on each side, as well as two sound tracks. There is a considerable amount of educational material recorded on videodisks; some of it has been recently digitized on other supports;
- the **audio-CD** was launched with the success we know. It contains high quality sound (44 Mhz) but can record nothing but sound. Little educational material exists on this support;
- the **WORM** was the first digital disk written (once only) and read (many times) by a computer. It had a rather small capacity of 200 Mb and a slow transfer rate; but a new generation of WORMs now records 400 or even 600 Mb;
- the **CD-ROM** came later; it contains all types of files: text, images, sound, compressed video, up to 600 Mb. Its transfer rate was 150 Kb/sec, but this has been doubled and even tripled in some recent drives. Data are not interlaced, which makes it almost impossible to run video and audio at the same time (loss of synchronization);
- the **CD-ROM XA ("extended architecture")** is more recent; its characteristics are close to those of the CD-ROM, but this time the data are interlaced, which means that one can use them for perfectly synchronized video and audio. It has been presented as a bridge between the CD-ROM and the CD-I;
- the **CD-I** (a proprietary system of PHILIPS) is used for the same applications as the CD-ROM XA, with the particularity that it does not operate connected to a PC. It consists on a specific player which contains the necessary PC functions. The unit is connected to a normal TV set. This has the

advantage of low cost but some limitations in interactivity compared to a PC;

- the **photo-CD** is a CD containing up to 100 high-quality images, which can be recorded by KODAK only, starting from existing slides or negatives of photographs. It is possible to add images up to the maximum in different "sessions"; which makes it important to use a player that runs multiple sessions, otherwise only the images written the first time can be accessed. It can be played on a KODAK specific player, on a CD-I or on a computer via any CD-ROM player, preferably multisession. The photo-CD player also plays audio CDs;
- the **read-write optical diskette** is a magneto-optical device, which records 127 Mb of data and needs a special drive to be written and/or read; it also exists in a "write once" form to store data. Its size is that of a 3.5" diskette, and its thickness is about twice the usual diskette; a very convenient system to transport or send multimedia applications; no standard is needed here: the optical diskette works like any diskette or hard disk.

Appendix D
Digital versus analogue

Sound and video we enjoy every day are generally analogue: radio, TV, videotapes, videodisks, cameras, camcorders. By contrast, sound and video recorded on and played from audio CDs, CD-ROMs, CD-Is are digital; and so are images recorded on and played from photo-CDs.

Analogue sound and video are of high quality, but one cannot handle them in order to copy them, send them via computer networks, combine them with digital data (text, presentation techniques). This can be done after transforming analogue data into digital data, which are stored on CD-ROMs, hard disks or diskettes (e.g. optical ones), or on CD-Is and photo-CDs. They can therefore be used in developing learning material (after having settled the copyright problems, if necessary).

Digital sound has the high quality everyone knows from using audio-CDs. Compressed digital images and video do not quite equal analogue images and video, but progress is quick and they may soon reach the same level.

The problem is mainly due to the fact that fast recording of digital sound, images and video creates huge files; here is an example:

- a videodisk contains 54,000 images per side, which means 36' of video in the PAL or SECAM system (25 images/min) or 30' in the NTSC one (30 images/min);
- an equivalent digital image, full screen (1024x768) with only 256 colours represents a file of 786,432 bytes (786 Kb); if 65,536 colours are needed, the size of the file is doubled;
- in a PAL or SECAM environment, we need 25 times more disk space for one second, which means that only 30" of full screen full motion video would be recorded on a CD-ROM (600 Mb);

- but thanks to the compression techniques (e.g. MPEG, DVI, etc.) we are able to save about 140 times more, which means 72' instead of 30" on the same CD-ROM.

Appendix E
Digitizing

Digitizing images, sound or video can be done if the necessary hardware and software is available; here is an example of what is needed:

digitizing audio (sound, music, voice):

Computer hardware is composed of an audio adapter that is placed in the PC; the same adapter is necessary to record and play back the sound. Appropriate software generally comes with the adapter and allows one to record, control the volume, etc. Audiovisual equipment consists of a microphone (some are directional, some are not, in which case one records all ambient noises, as with a camcorder) or any "line" equipment: audiocassette, radio, audio CD, CD-ROMs, videotape, videodisk, TV, camcorder, etc. Appropriate cables are needed to connect the different items together.

digitizing images, still frames:

Digitizing images requires an image capture adapter placed in the PC, which will not be needed to subsequently display the captured images, whatever the number or delivery work stations used. Software generally comes with the adapter, but is usually limited to capturing the image. If one wishes to modify the image (rotation, re-sizing, special effects, etc.) one will probably need to acquire additional specialised software.

Sources of images can be multiple: cameras, camcorders, still video cameras (e.g. ION from CANON), videotapes, videodisks, TV, CD-ROMs, scanners, slides, negatives of photographs, etc.

Compression techniques can be applied to images (still frames), but in this case a decompression hardware or software will be necessary on every delivery work station. Software decompression is only possible with PCs equipped with fast microprocessors (at least a 486).

digitizing video:

Digitizing video is also done with a special adapter placed in the PC, generally compressing at the same time (it is also possible to do it in two steps, but recording uncompressed video on hard disks before digitizing it creates huge amounts of data and can only be performed for very short video sequences). The decompression system (hardware or software) is needed on every delivery workstation. Compression techniques and standards are the key to quality images and video digitising.

Video sequences can come from any video source: cameras, camcorders, videotapes, videodisks, TV, CD-ROMs. Some digital cameras which are now on the market, directly record video sequences in digital mode, avoiding the digitising work.

It is also possible to buy a series of images or sound files from specialised companies like MEDIASOURCE or COREL, which produce copyright-free CD-ROMs with such files. One has to check whether the images and sound formats are adequate for the software used to develop an application.

Appendix F
Telecommunications and training

Television has played an important role in training for many years. The way Open Universities work is the best example of it, on top of educational programmes offered to schools by public and private TV channels. In the first case, learners work alone and are offered to regularly meet with tutors; they receive written material and homework by mail; they are sometimes using computer E-mail to correspond with teachers and other learners. In the second case, the TV educational programme is used in the classroom by the teacher as a support for his or her course.

PC networks (LANs or WANs) offer interactive possibilities, to different extents: access to centralized courseware, to centralized information (dictionaries, encyclopaedias) or virtual classrooms using different types of lines according to the infrastructure existing in the countries, with different one- or two-way audio and/or video transmission.

PC teleconferencing is another interesting tool for training: still frames and audio may be sent in both directions on rather slow lines, or motion video and audio can be sent via faster lines (ISDN, optical fibres). When compressed video is used on both sides of the system, the user can see his or her correspondent and both can see and discuss the same document on their respective screens. Nowadays the market offers different hardware and software packages for this application. PC teleconferencing can be very interesting for remote learners who wish to correspond with other learners, teachers and tutors; questions and answers, opinions, contradictions, etc. can be expressed and solved very quickly using this system.

Different transmission systems can be used:

- ISDN (Integrated Switched Digital Network);
- PSDN (Packet Switched Digital Network);
- PSTN (Public Switched Telephone Network).

Electronic mail (E-mail) has a similar function, but it is more oriented to the one-to-one communication, while in a PC teleconferencing system everyone can read everyone else's input, and anybody can answer or join the discussion.

Last but not least, the **Fax (or Fac-simile)** is a very simple and cheap means of transferring educational material, homework, questions and answers, etc. at low cost. In some circumstances, it may be the only available tool!

Appendix G
More technologies for training

There are a few more technologies that have not yet been mentioned and may be of interest for training:

The touchscreen

In applications where the keyboard and/or the mouse utilization is not easy or appropriate, a touchscreen may be used. This will for example be the case in a public area, where keyboard and mouse could be damaged or stolen.

Touchscreens are built on several technologies. The more touch sensitive, the more expensive is the display. But intermediate solutions also exist: panels can be installed by the user in front of a normal screen, thus transforming it into a touchscreen. Most of the applications need no change at all in order to be used with a touchscreen instead of a keyboard or a mouse. For training, touchscreens will among others be very useful in simulation exercises, where the learner will physically "touch" the button or object as he or she would do so in real life.

The voice recognition/command

Considerable progress has been made in this area during recent years. The fast increasing power and speed of PC microprocessors have helped, because these applications consume a large amount of computing power. Learning languages is the first area where one can see a very profitable utilization of voice recognition.

Computer assisted translation

The translation of educational material from one language to another may require a long time and involve a high cost. Automatic translation has not been implemented yet, except for very quick and approximate translation of scientific documents or newspapers. The result of these translations only gives an approximate an idea of what the document contains, to decide whether it is useful to translate it properly.

What has been successfully implemented, and is being constantly updated, is a set of translation help tools. With the fast improvement of spelling check and grammar verification in the best-known text processors, these tools will came into general use and allow translations to be made more quickly and less expensively.

Appendix H
Training the disabled

The millions of disabled persons in the world can benefit from a certain number of technologies for their training either to find a new job or to keep the one they have; a substantial percentage of disabled people were indeed not born so, but became disabled after an illness or an accident; so, they had a job before which may be lost if they are not helped by some technology.

Here are but a few examples of what technology can do for them:

1. various systems make the use of the **keyboard, mouse and screen** easier:
   - touchscreens are used for some applications for disabled persons for whom touching a rather big area on the screen may be much easier than pressing a single key on the keyboard, or even clicking on the mouse button;
   - software shows every character on the screen in a zoomed mode, for those who can not read the usual character size;
   - limited keyboards with big keys are used when people have difficulties controlling their hand movements;
   - software allows key combinations (e.g. ALT-Ctl-Del) to be replaced;
   - the keyboard touch may be replaced by an infrared beam controlled by the head around which the beam generator is attached.
2. **voice command** systems replace the use of the keyboard for simple commands: e.g. DOS commands, spreadsheet commands (left, right, up, down, etc.).
3. **blind people** can use the PC for their E-mail, text processing, spreadsheet calculations, etc. thanks to the use of voice

synthesizers which "read aloud" for them what comes on the screen; they can also "read" their newspaper every morning in countries where news are sent by radio waves during the night to the PC of blind persons equipped with a receiver and a voice synthesizer.

4. **therapists** can also use PCs and technology to:

   - help deaf people, mainly children, to learn how to produce a certain number of sounds by a visual comparison of sound waves of the learner and of the therapist;

   - help mentally impaired persons (e.g. after a car accident), to recover memory.

Glossary[23]

ADPCM (Adaptive Differential Pulse Code Modulation):
a standard encoding format for storing audio information in a digital compressed format.

Analogue:
refers to any operation in which data are represented by a continuous physical flow; as opposed to digital.

ANSI (American National Standards Institute):
responsible for the setting of computer standards.

Architecture:
in computing, refers to the philosophy of computer hardware design; open architecture indicates systems which allow for the addition of peripherals and internal enhancement cards from third-party manufacturers; closed architecture systems are advertised as "all-in-one-box" solutions, discouraging users from adding memory, etc.

ASCII (American Standard Code for Information Interchange):
the standardized 8-bit data character code used internationally to code alphabetic, numerical and other symbols into the binary values.

23 This glossary is mainly an extract from that published in "An Introduction to IBM Multimedia Solutions" - November 1991; some definitions have also been taken from "Le nouveau dictionnaire Marabout de la micro-informatique" - Marabout Informatique - 1990.

Authoring language:

specialized high-level computer language which permits non-programmers to develop courseware; program logic and content are combined; offers fewer capabilities or options than an authoring system.

Authoring system:

specialized computer software which helps users to design interactive courseware without computer programming; instructional logic and content are separate; allows greater flexibility than an authoring language.

Bandwidth:

the range of signal frequencies that a piece of audio or video equipment can encode and decode; video uses higher frequency than audio, thus requiring a wider bandwidth.

BETAMAX:

consumer videotape format developed by SONY (1/2" tape).

BETACAM:

a 1/2" video recording format developed by SONY that offers near 1" quality tape on a portable system.

Bitmap:

graphic image made of a certain number of points per inch; bitmap files are rather large but may be condensed.

Broadcast quality:

in the USA a standard of 525 lines of video picture information at a rate of 60 Hz; in Europe, 625 lines at a rate of 50 Hz.

Bus:

a circuit or group of circuits which provides an electronic pathway between two or more CPUs or I/O devices; popular computing buses include IBM PC bus, ISA bus, EISA, MACINTOSH Nubus.

Cache:

temporary storage for data requiring quick access.

Camcorder:

a lightweight hand-held videotape camera/recorder.

CAV (Constant Angular Velocity):

a mode of videodisk playback in which a disk rotates at a constant speed, regardless of the position of the reading head; each frame is separately addressable; CAV disks rotate at 1800 revolutions per minute (NTSC) or 1500 rpm (PAL), one revolution per frame.

CCITT (Consultative Committee for Telephony and Telegraphy):

an international standards organization dedicated to creating communications protocols.

CD-A (Compact Disk Audio):

optical disk (12 cm) that contains musical information encoded digitally; 74 minutes of high-quality digital sound; standard developed by PHILIPS and SONY, known as the "*Red Book*".

CD-I (Compact Disk Interactive):

a digital compact disk recording interactive applications made of text, audio, images, animation and compressed video; a standard developed by PHILIPS and SONY, known as the "*Green Book*".

CD-ROM (Compact Disk Read-Only Memory):

an optical memory storage (12 cm) in the CLV format; can hold about 600 Mb: a standard developed by PHILIPS and SONY is known as the "*Yellow Book*".

CD-ROM XA (Compact Disk Read-Only Memory Extended Architecture):

an extension of the CD-ROM, a step between CD-ROM and CD-I, promoted by PHILIPS and MICROSOFT; the extensions add ADPCM audio and permit the interlacing of sound and video data for animation and sound synchronization.

CISC (Complex Instruction Set Computer):

most computers on the market use this system, as opposed to those which use the **RISC (Reduced Instruction Set Computer**).

CLV (Constant Linear Velocity):

an alternative format for laser videodisks which allows twice as much playtime per side, but does not offer many of the user-controlled capabilities; it can be read in linear play only; the revolution speed varies with the location of the pickup to ensure a constant data rate; the speed for a NTSC disk varies from 1,800 rpm at the inner track to 600 rpm at the outer edge.

Compatible:

used to describe different hardware devices that can use software or play programs without modification.

Component video:

the separation of chrominance (colour) and luminance parts of the video signal; these two signals are recorded separately which helps to maintain better picture quality over more generations.

Composite video:

a colour video signal that contains all of the colour information in one signal; the complete visual wave form of the colour video signal composed of chromatic and luminance picture information.

Compress:

to reduce certain parameters of a signal while preserving the basic information content; compressing usually reduces a parameter such as amplitude or duration of the signal to improve overall transmission efficiency.

Compressed video:

a video image or segment that has been digitally processed using a variety of computer algorithms and other techniques to reduce the amount of data required to accurately represent the content and thus the space required to store it.

Compression:

the translation of data to a more compact form for storage or transmission.

CBT (Computer-Based Training):

the use of computer to deliver instruction or training.

Computer graphics:

visual images generated by a computer; graphics standards include CGA, MCGA, EGA, HERCULES, VGA, SVGA, XGA, etc.

Courseware:

instruction software including all disks, tapes, books, charts and computer programs necessary to deliver a complete instructional module or course.

Device driver:

software that tells the computer how to talk to a peripheral device, such as a videodisk or a printer.

DDE (Dynamic Data Exchange):

a form of interprocess communication supported in Microsoft Windows and IBM OS/2; when two or more programs that support DDE are running simultaneously, they can exchange information and commands.

Digital:

a method of signal representation by a set of discrete numerical values, as opposed to a continuously fluctuating current or voltage (i.e. analogue).

Digital audio:

audio tones represented by machine-readable binary numbers rather than analogue recording techniques; analogue audio is converted to digital using sampling techniques whereby a "snapshot" is taken of the audio signal, its amplitude is measured and described numerically, and the resulting number is stored; more frequent sampling results in a more accurate digital representation of the signal.

Digital video:

a video signal represented by computer-readable binary numbers that describe a finite set of colours and luminance levels.

Digitize:

to register a visual image or real object in a format that can be processed by a computer; to convert analogue data to digital data.

DYUV(delta-YUV):

an efficient colour coding scheme for natural pictures used in CD-I; the human eye is less sensitive to colour variations than to intensity variations; so, DYUV encodes luminance (Y) information at full bandwidth and chrominance (UV) information at half bandwidth or less, storing only the differences (deltas) between each value and the one following it.

EISA (Extended Industry Standard Architecture):

internal 32-bit bus, an enhancement of 8/16 bit ISA (IBM PC/AT) architecture, developed by several computer manufacturers in 1988 as a response to IBM's MCA (Micro Channel Architecture) bus; offers full compatibility with ISA bus and boards.

Fax (or facsimile):

to electronically scan and copy a replica image of a document for transmission via telephone lines or other means.

Fibre optics:

the technology in which audio/visual signal/information is transmitted through a glass fibre strand capable of transmitting light.

Frame:

a single, complete picture in a video or film recording; a video frame consists of two interlaced fields of either 525 lines (NTSC) or 625 lines (PAL/SECAM) running at 30 frames per second (NTSC) or 25 frames per second (PAL/SECAM): a film runs at 24 frames per second.

Frame grabber:

a device that stores one complete video frame.

Frame rate:

the speed at which video frames are scanned or displayed; 30 frames per second for NTSC; 25 for PAL/SECAM.

Freeze-frame:

a single frame from a segment of motion video held motionless on the screen; unlike a still frame, a freeze-frame is not a picture intended to appear motionless, but is one frame taken from a longer motion sequence.

Generic courseware:

educational courses that are not specific to one organization and thus appeal to a broader market; as opposed to custom courseware, which primarily meets the needs of one specific client or audience.

Giga-:

prefix meaning "one billion" ; as in Gb (one million bytes).

GUI (Graphics User Interface):

a visual metaphor that uses icons representing actual desktop objects that the user can access and manipulate with a pointing device.

Graphic file formats:

- EPS (Encapsulated Postscript):

designed by ALDUS to provide a way to display Postscript images; EPS stores a Postscript description along with a bit-mapped equivalent of the image that can be displayed on the screen;

- PICS:

a MACINTOSH specific multimedia format for exchanging animation sequences; assembles several PICT files (frames) and combines them into one file;

- PICT (Picture Format):

developed by APPLE in 1984 as the standard format for storing and exchanging black-and-white graphics files; PICT2 (1987) supports 8-bit colour and grey scale;

- RIFF (Raster Image File Format):

an extension of TIFF devised by graphics developer LETRASET;

- TIFF (Tag Image File Format):

a format for storing and exchanging scanned images (developed in 1986 by ALDUS with MICROSOFT and others) which is compatible with several personal computing platforms, including IBM and MACINTOSH.

Hertz (Hz):

the standard unit of measuring frequency; one Hz is equal to one cycle (or vibration) per second.

Hi8 video:

the high-quality extension of the Video8 (or 8 mm) format which features higher luminance resolution.

Hypermedia:

an extension of hypertext that incorporates a variety of other media in addition to simple text.

Hypertext:

the concept of non-sequential writing which allows writers to link information together through a variety of paths or connections; hypertext allows users to seek greater depths of information by moving between related documents along thematic lines or accessing definitions and bibliographic references without losing the context of the original inquiry.

Instructional design:

the methodology and approach used to deliver information in a manner that achieves learning.

Interactive:

involving the active participation of the user in directing the flow of the computer or video program; a system which exchanges information with the viewer, processing the viewer's input in order to generate the appropriate response within the context of the program; as opposed to linear.

Interleaving:

a method of storing information sequences in an alternating series of frames .

ISA (Industry Standard Architecture):

standard name for IBM PC/AT computer bus architecture.

ISDN (Integrated Services Digital Network):

an international digital telecommunications standard developed to enable transmission of simultaneous high-bandwidth data, video, and voice signals (all digital).

ISO (International Standards Organization).

JPEG (Joint Photographic Experts Group):

a working committee of the ISO defining a proposed universal standard for the digital compression and decompression of still images for use in computer systems.

Keypad:

a small keyboard or section of a keyboard containing a smaller number of keys.

Kilobyte (K or Kb):

a term indicating 1024 bytes of data storage capacity.

LAN (Local Area Network):

a system which connects two or more microcomputers to allow shared resources and communication.

LASER (Light Amplification by Stimulated Emission of Radiation):

an amplifier and generator of coherent energy in the optical, or light region of the spectrum.

Laser disk:

common name for reflective optical videodisk; a laser is used to read the micropits on the disk which contain the picture and sound information.

Linear:

a motion sequence designed to be played from beginning to end without stops or branching, like a film; as opposed to interactive.

Luminance:

brightness; one of the three image characteristics coded in composite television, represented by the letter Y; may be measured in lux or foot-candles.

Magnetic storage:

any medium (generally tape or disk) upon which information is encoded as variations in magnetic polarity.

Magneto-optics:

an information storage medium that is magnetically sensitive only at high temperatures, while stable at normal temperatures; a laser is used to heat a small spot on the medium, allowing a normal magnet to change its polarity; the ability to tightly focus the laser greatly increases the data density over standard magnetic media.

Mega-:

prefix meaning "one million"; as a Mb (one million bytes) or a MHz (one million hertz).

MCA (Micro Channel Architecture):

revised bus of PC architecture introduced by IBM in some PS/2s; incompatible with original PC/AT (ISA) architecture.

MIDI (Musical Instrument Digital Interface):

an industry standard connection for computer control of musical instruments and devices.

Modem:

contraction of MOdulator/ DEmodulator; digital device that converts data from a computer into signals that can be transmitted over ordinary telephone lines, and vice-versa.

Modulation:

a process whereby information is converted to some code, and the code is made part of a transmitted signal; the opposite process is demodulation.

MPEG (Motion Picture Experts Group):

a working committee of the ISO defining standards for the digital compression and decompression of motion video/audio for use in computer systems.

Multimedia:

refers to the delivery of information, usually via personal computers, that combines different formats (text, graphics, audio, still images, animation, motion video) and/or storage media (magnetic disk, optical disk, video/audio tape, RAM).

Nano-second:

one-billionth of a second.

NTSC(National Television Systems Committee) of the EIA (Electronics Industries Association):

a colour television format having 525 scan lines; a field frequency of 60 Hz; a broadcast bandwidth of 4 MHz; a frame frequency of 1/30 of a second; a colour sub frequency of 3.58 MHz.

Nubus:

architecture used in MACINTOSH II series of APPLE computers.

OLE (Object Linking and Embedding):

open specification that will enable developers to more easily integrate information created by different applications by making simple extensions to existing graphic applications which run under WINDOWS, OS/2 PM and APPLE MACINTOSH System 7.0.

OOP (Object-Oriented Programming):

a programming methodology in which every element in a program is self-contained.

Optical memory:

a generic term for technology that deals with information storage devices that use light (usually laser-based) to record, read or decode data.

Overlay:

the facility to superimpose computer generated text and/or graphics onto motion or still video.

Packet switching:

the transfer of data by means of addressed packets (or blocks) of information, whereby a channel is occupied only for the duration of transmission of the packet; in contrast with circuit switching, the data network determines the routing during (rather than prior to) the transfer of a packet.

PAL (Phase Alternation Line):

the European standard colour system, except for France, Russia and Eastern European countries.

PC Card:

also called Credit Card Adapter; a credit card-like PC adapter for portable PCs; exists in different thicknesses (3.3, 5.0, 10.5 mm), typically used for memory or other input/output functions (e.g. modems, harddisk); any PC Card can be installed and functions in any system supporting the PCMCIA specified interface.

PCM (Pulse Code Modulation):

a standard means of encoding audio information in a digital format by sampling the amplitude of the audio wave-form at regular intervals and representing that sample as a digital numeric value.

PCMCIA (Personal Computer Memory Card International Association):

a non-profit association of more than 300 members which is setting standards for PC Cards.

Pit:

the microscopic physical indentation or hole found in the information layer of a videodisk.

Pixel:

an abbreviation of picture element, the minimum raster display element represented as a point with a specified colour or intensity level; one way of measuring picture resolution is by the number of pixels used to create images.

Pulse code or **pulse:**

a signal which, when recorded on every frame of a videotape, facilitates editing and access by making individual frames easier to identify.

Quantize:

a step in the process of converting an analogue signal into a digital signal; measures a sample to determine a representative numerical value that is then encoded; the three steps of converting analogue to digital are: sampling, quantizing and encoding.

Raster:

the area illuminated by a scanning beam of a TV system; a raster display device stores and displays data as horizontal rows of uniform grid or pictures and sound from a videotape to a monitor.

Remediation:

corrective teaching.

Resolution:

number of pixels per unit of area; a display with a finer grid contains more pixels and thus has a higher resolution, capable of reproducing more detail in an image.

RGB (Red-Green-Blue):

a type of computer colour display output signal comprised of separately controllable red, green and blue signals, as opposed to composite video in which signals are combined prior to output; RGB monitors typically offer higher resolution than composite.

RS-232:

a standard serial interface between a computer and its peripherals.

RTOS (Real-Time Operating System):

CD-I operating system, developed by MICROWARE.

Sampling:

the process of taking measurable slices of an analogue signal at periodic intervals; a step in converting an analogue signal into a digital signal.

Sampling rate:

rate at which slices are taken from analogue signals when converting to digital; frequency at which points are recorded in digitizing an image; sampling errors can cause aliasing effects.

Saturated colours:

strong, bright colours (reds and oranges) which do not reproduce well on video, but tend to saturate the screen with colour or bleed around the edges producing an unclear image.

SCSI (Small Computer Standard Interface):

a device-independent interface used for a wide variety of computer peripherals.

SECAM (SEquentiel Couleur A Memoire = sequential colour with memory):

the French colour TV system also adopted in Russia, Eastern Europe and ex-French Africa; the basis of operation is the sequential recording of primary colours in alternate lines.

Shell:

an outer layer of a program that provides the user interface or the user's way of commanding the computer.

Speech synthesizer:

a device that produces human speech sounds from input in another form.

Still frame:

a single film or video frame presented as a single, static image; refers to information recorded on a frame or track of a videodisk that is intended to be retrieved and displayed as a single, motionless image.

S-VHS (Super-VHS):

a higher-quality extension of the VHS home videotape format, featuring higher luminance and the ability to produce better copies.

S-video:

type of video signal used in the Hi8 and S-VHS videotape formats; it transmits luminance and colour portions separately, using multiple wires, thus avoiding the NTSC encoding process and its inevitable loss of picture quality; (see also: **Y/C video**).

Sync-locked:

the precise coincidence of two pulses or signals, as in the sync pulses of a videotape recorder locked in with the sync pulses of a camera.

Teleconference:

a general term for a meeting not held in person; usually refers to a multi-party telephone call set up by the phone company or private source, which enables more than two callers to participate in a conversation; the growing use of video allows participants at remote locations to see, hear and participate in proceedings, or share visual data (see also: **video conference**).

Teletext:

computer information inserted into the normal broadcast signal; a one-way information system.

VCR (Videocassette Recorder):

generic term for home videotape device.

Vector graphics:

line drawing; a vector display device stores and displays data as line segments identified by the x/y co-ordinates of their end points.

VHS (Video Home System):

consumer videotape format developed by Matsushita and JVC.

Videoconference:

a teleconference (see also **teleconference**) with bi-directional images transmission, using high-definition TV cameras; it allows participants to see each other as well as any object which is in the room; terrestrial and/or satellite communications can be used.

Video 8 or 8mm video:

video format based on the 8 mm videotapes popularized camcorders.

Videotape formats:

generally classified by the width of the magnetic tape:

- 1" used for professional or "broadcast" quality video recording and editing;
- 3/4" U-MATIC (SONY) used by most industrial video;
- 1/2" primarily used consumer format (VHS and BETA) and their high-quality formats (S-VHS, SUPER BETA);
- 8 mm popularly used in hand-held camcorders; provides high quality recording in tiny tape format.

Videotext:

a collective name for systems which use the domestic TV receiver to display data from a central computer transmitted to the set via coaxial cable or telephone link; a special set of fairly low-resolution text and graphic characters that can be displayed via specific decoders.

Virtual reality:

a computer-generated "reality" into which users may enter by virtue of bodily peripherals such as data gloves and head-mounted computer graphic displays.

Voice recognition:

a computer input technology in which a human utterance is recognized within the computer terminal and then converted into machine-usable binary code.

WAN (Wide Area Network):

the integration of geographically distant or technology incompatible LANs.

WORM (Write Once/Read Many):

a type of permanent optical storage that allows the user to record original information on a blank disk, but does not allow erasure or change of that information once it is recorded.

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