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WORLD MARITIME UNIVERSITY

Malmö, Sweden

**COMPUTER BASED LABORATORY SIMULATION IN
MARITIME EDUCATION**

By

AIT-MOKHTAR RAMDANE

Algeria

A dissertation submitted to the World Maritime University in partial
fulfilment of the requirements for the award of the degree of

MASTER OF SCIENCE

in

**MARITIME EDUCATION AND TRAINING
Engineering**

1998

DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The content of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

..........

.....5 October 1998.....

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ABSTRACT

Title of Dissertation: Computer Based Laboratory Simulation

Degree: MSc.

The dissertation is the study of the introduction of computer simulation to perform laboratory practice of mariners. The skills developed by the traditional methods and required by international conventions are identified. The conception of the transmission of practical knowledge on computer-based simulation poses the problems of the essential need of laboratories, the role of teacher, and the control of process of learning. The development of the technology especially the interactive communication man-machine and the progress of artificial intelligence contribute widely to improve the function of the computer in training and education. The purpose is not to replace the laboratory or the teacher by the computer but to contribute for the improvement of the education by the stress of individual instruction. Every learning environment has an implied method of information presentation. The traditional notions of study skills are changing slowly comparatively to advances of technology and industry. A deep analysis of the ways in which ideas about learning strategies and laboratory practice can be introduced into classroom life is taken. Education must become more efficient. To this end curricula must be revised and simplified, textbooks and classroom techniques improved. The main method chosen to assist students to increase control over their learning was to provide each of them with adequate tools. The computer as object of instruction attracts the consideration of educators and could be a solution to follow the quick evolution of the science and technology. The computer's capacity to perform a large variety of activities added with possibilities of electronic communications represent a potential educational benefit for students and teachers. The latter can develop strategies to apply these relevant tools to their learning environment.

KEYWORDS : Simulation, Computer, Training, Education, Practice, Multimedia.

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List of abbreviations

AGP	: Accelerated Graphics Port
BASIC	: Beginner All purpose Symbolic Instruction Code
Bit	: Binary digit
CAD	: Computer Aided Design
CAL	: Computer Aided Learning
CBS	: Computer Based Simulation
CBT	: Computer Based Training
CD-ROM	: Compact Disk Read Only Memory
COBOL	: COmmon BUiness ORiented Language
CPU	: Central Processing Unit
DPI	: Dot Per Inch
DVD	: Digital Versatile Disk
EUNET	: EUropean NETwork
FDD	: Floppy Disk Drive
FORTRAN	: FORmula TRANslator
GMDSS	: Global Maritime Distress Safety System
GOC	: General Operator Certificate (radio communication)
HDD	: Hard Disk Drive
ICBT	: Intelligent Computer Based Training
KB	: Kilo Bytes
LAB	: LABoratory
LAN	: Local Area Network
MB	: Mega Bytes
MET	: Maritime Education and Training
MIDI	: Musical Instrument Digital Interface
MODEM	: MOdulator DEModulator
MS-DOS	: MicroSoft Disk Operating System

OS	: Operating System
PC	: Personal Computer
RAM	: Random Access Memory
ROC	: Restricted Operator Certificate (radio communication)
ROM	: Read Only Memory
STCW	: Standards of Training, Certification and Watchkeeping
SVGA	: Super Video Graphic Adaptor
VGA	: Video Graphic Adaptor
WWW	: World Wide Web

✓

1 Introduction

The world is changing, and changes are also occurring in education. Every learning environment has an implied method of information presentation. The traditional notions of study skills are changing slowly compared to the advances in technology and industry.

It is urgent to look at some of the ways in which ideas about learning strategies could be introduced into classroom life. To cope with international concern expressed in STCW95 convention, education must become more efficient. To this end, curricula must be revised and simplified, textbooks and classroom techniques improved. The main method chosen to assist students to increase control over their learning is to provide each student with adequate tools. The computer, as an object of instruction, attracts the consideration of educators and could be a solution to follow the quick evolution of the science.

The conception of the transmission of practical knowledge on computer-based simulation poses the problems of the essential need of laboratories, the role of teacher, and the control of the process of learning.

The development of technology, especially the interactive communication man-machine and the progress of artificial intelligence, contributes widely to improve the function of the computer in training and education. The purpose is not to replace the laboratory or the teacher by the computer but to contribute to the improvement of education by the stress on individual instruction. The role of the teacher in laboratory simulation will be sensitively different. He will not be a knowledge holder but a manager of knowledge. The overflow of information can create confusion on an immature mind, so the teacher has the duty to guide the students in their choice of activities, and recognise their limitations.

The teacher will be trained to have a global approach to problems, to analyse any new situation, to be receptive of discussion, to communicate, to distribute tasks, and to delegate part of the responsibilities. This is more a partnership than a competition. The educational systems using artificial intelligence combine a didactic knowledge required for the evaluation of knowledge and the possibilities of each student and therefore adapt individually a pedagogical strategy.

1.1 Practical in laboratory and simulators

The objectives of Maritime Education and Training are to establish appropriate and effective human competencies, to optimise the training, and to reach the level of recognised standards (STCW 95). The difficulty to ensure common standards by various maritime schools, especially in developing countries, is related to the economical aspects that they have to face.

In order to respond to the lack of qualified seafarers, the shipping has industry introduced full automation to carry out some stringent functions. These innovations have reduced the duties on board, and subsequently the crew, but increased the technology and the requirements to handle it. On the other hand, the technology has also changed the curriculum of the mariners and the skills that must be achieved. The lack of practical seagoing experience is seen as a major reason for casualties and a weak point of the training. Instead of sending the apprentice on board a ship, which is very expensive and difficult to manage if the school has no training vessel, the practice can be compensated by the use of simulators. This will prepare him for the environment and the function he is going to perform on board. Unfortunately laboratories, simulators, and training ships are very expensive to acquire, maintain, and operate. In order to prepare their students for their future careers, Maritime Education and Training institutions have to find the way to ensure academic knowledge and practical experience.

The introduction of computers in education has become of extreme strategic significance in the past two decade. Indications point to the increasing future

intensity and impact of this issue on the national educational policies. The cost of this innovation represents an increasingly heavy burden on the national economy.

1.2 Economical aspects

Even though the laboratory work is recognised as essential for the process of learning, many institutions are not doted with such resources or have a problem of equipment or logistics. The dilemma faced by the educational managers is to cope with requirements for effective education and the adverse financial situation of their budget. The questions are how to allocate the sizeable resources and for what uses, where to make the cuts. The choice is somehow difficult. Most countries, even the developed ones, have to face this critical problem. Developing countries are more seriously affected and try to deal with the world recession by the policy of austerity. Some budgets are frozen or shrunken. The implication of the slim resources on the quality of education is disastrous and the relevance of educational systems for the individual development is doubtful. This leads to a loss of public confidence and attractiveness of learning. The educational systems are inappropriate to respond to the needs of the society. The impact of technology on occupations, the tendency of employers to set higher educational requirements, and the need for employees with specialised training have made vocational preparation imperative. The challenge is to find ways to use the limited resources more efficiently and effectively.

1.3 The Computer Based laboratory Simulation (CBS)

One of the problems in the field of laboratory simulation is that the laboratories are multiple and expensive systems, which have limited application in the field of automation, electronics, engineering, . The purpose of this investigation is to prove the efficiency of the graphics, visual techniques and the methodologies of designing a PC-based laboratory simulator. The development of the PC-based

simulation covers a wide range of different learning types under different conditions. Also the investigation explores a set of suitable and flexible graphics software for various general maritime education and training use. There are a lot of programs which fulfil the above objectives and their performance and capabilities are tested and validated.

Areas for further research and development are presented including the application of graphics, visual techniques and design methods. Three-dimensional graphics and visual techniques are available on the market. Furthermore, the programme strives to provide users with the ability to train under realistic circumstances.

The arrival on the market of the microcomputer in the eighties was an important step in the growth of computer industry, which was supported by a decrease in the cost of material in such proportions never seen before. This decrease in the prices permitted veritably a massive entrance of computers in all domains of cultural and economical life. This fact makes it possible to built a multi purpose computer laboratory to simulate electronics, automation, and engine plant laboratories.

Therefore, the Computer Based laboratory Simulation (CBS) can be a solution to the problem posed by the cost, the logistics, and the maintenance of laboratories.

The CBS will also fulfil the pedagogical aspect of the training, and allows the student to carry out the practical. To convince those who are still hesitating to recognise the benefit of this tool in education, I shall try to demonstrate its pedagogical effectiveness. There is no doubt that the computer has the attraction of the students, and some teachers say that its usage stimulates, illustrates, facilitates acquisition of information, develops the sense of the communication, and self study. Appropriate preparation and genuine design of the programs enhances the didactic functions described above. The function of stimulation is very important and creates a double incentive: the need to go forward in the topic and the achievement of better

understanding.

Several surveys confirm that learning speed as well as long term retention is improved with interactive training compared to traditional classroom training. Students find it more exciting, more realistic and easier to learn complicated issues.

2 The laboratory in maritime education

2.1 Description of traditional education.

There is complete agreement that the assimilation of knowledge is the main goal of education. However this agreement is more apparent than real because there is a division about what constitutes knowledge.

The one, who consider that knowledge is information, have their pedagogical approach different from those who identify knowledge with the process of thinking. The former focus on the information that the learner has amassed and can reproduce at the end of his program, whereas the latter focus on the skills and the attitudes that the learner has adopted that enable him to learn more.

The first way known for knowledge to be communicated has been the apprenticeship. The one who does not know (the apprentice) watches the one who does (the master); he imitates the master until he knows what the master knows. This is not an effective method for stimulating the growth of new knowledge.

The method that is always in practice and was erected in institutions of formal schooling is telling. The one who knows (teacher) tells the one who does not know (student). The student listens, tries to remember and is usually required to reproduce his memorising at some stage so that the teacher can judge whether or not the knowledge has been transmitted.

Other methods try to remove the difficulties of human relationships from the act of communication by removing one party from the scene. The student can watch the master on film or videotape. Some promising advances have recently been made in the field of learning. Undoubtedly, various issues will surface in the school of

tomorrow because technology will provide students with access to information and the tools to produce substantial work.

2.2 Functions of the laboratory.

2.2.1 The purposes of the laboratory practical

A lecture provides theoretical information but a laboratory practical allows you:

- To experience first hand experiments or observations made,
- To experience rediscovery of the concepts or observations described in the lecture,
- To acquire a practical skill.

Students thus acquire knowledge and skill during the laboratory practical. The primary purposes of the laboratory practical are to:

- Develop skills of measurement;
- Allow the verification of concepts previously studied;
- Provide experience in experimental design, scientific method and operation of instruments;
- Provide an opportunity to observe living things in their natural habitats or natural phenomena in the field;
- Enable the student to acquire a certain level of skill required in his future career;
- Guide and stimulate interest and thinking;
- Link theoretical concepts and experimental observations.

Handling the laboratory practical goes through the following check-list to see where one may need to improve ones ability to appreciate fully the laboratory practical.

The working group is a very important practice. The pre-lab briefing is important since such sessions provide detailed instructions to certain activities to be done. The practical sessions usually complement lectures. So it is worth reading the schedules and lecture notes to understand what is to be achieved. It is important to understand the principle, the objective and the methodology of each experiment. In some cases, not understanding instructions or inattention can pose a danger.

Working independently provides students with the opportunity of testing their level of understanding of the topic learnt, and learning from their mistakes. An important aspect of education is the training of the mind to think creatively and to search for answers independently.

The skill of writing reports is a part of laboratory training. Each report should have sufficient experimental detail so that someone else reading the report can replicate the experiment exactly. The report of an experiment should consist of these sections: objective, materials and methods, results and observations, discussion and conclusion. The results and observations should be written lucidly and the discussion should be centred on whether the results and observations matched the theoretical expectations. Provide explanations if not. Do the results match or differ from those of others? If not, provide science-based suggestions as to why they differ. The only way to master a skill is through practice. So students should carry out the experiments or exercises as instructed and acquire a good standard of practical skill.

2.2.2 Skills required

The education of Science and Technology has always been supported by experiences in laboratory and workshops. Many educational academics think that practical work in the laboratory is essential for all the students, especially those involved in the engineering field. The objectives of the laboratory work are included in the curricula and lead to the achievement of the programmes. Benjamin Bloom

(1956) in *Taxonomy of Learning Objectives*, divides what can be learned into three broad categories:

- **Psychomotor Skills.**

- ❖ The "touch" approach involves the use of the muscles of the body, the control of the movements, and the eye-hand co-ordination.
- ❖ Psychomotor skills are very important in engineering and must be mastered by the students.

- **The Affective Domain.**

- ❖ Attitudes and feelings are acquired from experiences. The emotions we experience constitute a kernel of our life knowledge.
- ❖ The attitude we develop in a specific situation as a response to an event is determined by our past experiences.
- ❖ The experience of team working develops the communication skill and therefore is worth for professional life.

- **Cognitive Skills.**

- ❖ Better understanding of the relationship between the theory and the practice,
- ❖ Visualisation of the real plant,
- ❖ Illustration of the deficiency of the theory in modelling processes,
- ❖ Development of aptitude in experimental methods,
- ❖ Reinforce the learning and enhance the ability to think, to analyse, and to process information.

2.3 Teaching study skills

The traditional teaching styles are characterised by two dominant instructional strategies:

- Lecturing or demonstrating to the whole class

- Directing students to work alone at seat-work or homework, using their workbooks or lecture materials.

The teachers stick to follow the traditional way of learning and reproduce the same pedagogical scheme:

- Set curricula
- Standardised and tested programs
- Lectures for pre-set blocks of time

Despite enthusiasm for different approaches to classroom instruction there is high resistance to changing the teaching style and class organisation. Teachers find that it is very difficult to leave the model they know best and on which they rely. They think that it is reasonably efficient and effective.

2.4 Curriculum evaluation

Educational technology providing aids (tools) coping with needs of education concerns solve many problems that educators face each day (especially in developing countries). Educational technology as defined by the National Council for Educational Technology: “ The development, application, and evaluation of systems, techniques and aids to improve the process of human learning”. The role of education is to prepare the youth for the challenge of development, work and life.

Changes occur rapidly and the curriculum must follow them in order to fit the needs of society in mutation. Familiarisation of the new technology should be the first step towards the preparation of generations to face the future with more confidence.

Educational aids:

- Products, all sorts of materials and aids,
- Process or a technique for designing software for instructional materials,

- The relation between education and technology is obviously evident. The society is transformed by the technology and inevitably education undergo a similar transformation. This change affects educational reforms and teaching pedagogy and leads to fit the concerns of society:
- Experience of high development rate (demand for skilled labour force, democratisation of schools, need of high-tech. personnel to improve mathematics and science teaching),
- Competitive behaviour in order to respond to the independent concerns of nations,
- The recent development of satellite communication and networks involve the advent of Internet and permit its incredible success. The impact of Internet on societies is considered as sociological issue.

3 Computer Based Laboratory simulation (CBS)

3.1 Brief description of computer

A computer is an electronic device, which is mainly composed of four units. That is, input unit, central processing unit with internal memory, output unit, and storage memory.

The input units are all equipment whose function is to enter data into the central processing unit. The standard device for entering data is the keyboard. There are also many other input peripherals like the mouse which monitors the position of a pointer on the screen, the bar code readers, the optical scanners, graphic tablets, voices entry devices, telephone modem, etc.

The central processing unit is the heart of the computer system. All the operations are performed in this unit. All information, instructions and data are conveyed as a digital signals in binary form and flow through the microprocessor, and then stored in the internal memory.

The internal memory can be divided into two basic categories: Read Only Memory (ROM) which has constant and permanent contents, and Random Access Memory (RAM) which has volatile contents because it requires a constant source of power to maintain itself.

The output peripherals are all items whose function is to display information from the central unit through video, audio, print, or electronic means. The video screen is the standard output.

The external memory is an auxiliary storage for information. The different kinds of storage memory are magnetic, such as floppy disks and hard disks, or optical like CD-ROM.

An operating system is software (set of programs and commands) which controls and monitors all the electronics composing the computer, and allows the user to communicate and execute tasks. MS-DOS, WINDOWS, UNIX, SYSTEM 7, OS/2, etc., are the operating systems mainly used.

Specialised programs which perform specific tasks, such as word processing, database generators, spreadsheet, graphic tools, etc., are available and can be used in education to provide students with materials, drills, simulations, and tutorials.

3.2 Network

The network consists of computers that can communicate with each other. The aim purpose for this is to create an infrastructure of information, which can be shared by many users all over the world.

The Internet was set-up in the 1960's as a network of university centres, research institutes and defence installations in the USA. Just like the telephone network, the Internet does not depend on a single central exchange. Computers were able to link-up with each other using a variety of different routes. Actually, Internet is connected to many other networks such as European EUNET, which consist of twenty-eight national networks.

University students and staff are the classic users of Internet. They can put out any problem in their research on the network and many million of people can think about it with them. Electronic mail can be exchanged with any user connected. Internet offers many different services, thereby explain its explosive growth. Many educational networks provide teachers and students with materials and facilitate cultural and scientific exchanges. Electronic conferencing specifically designed for

use in schools is devoted to curriculum, language exchanges, classroom to classroom debates, etc.

The access to different types of databases, the hypertext and World Wide Web increase the possibilities of Internet and attract a large community of users.

3.3 Computer methodology

3.3.1 Approaches to Computer Assisted Learning (CAL)

Schools are gradually adapting the use of computers and related technology. The introduction of such tools has encouraged schools that have adopted them to experiment with their efficiency. The relevant remarks have been made from the observation of these experiences and involve some changes on ways to teach: small group instruction, coaching, learning at own rate, and integration of visual are admitted as main factors for improving the knowledge

The computer's capacity to perform a large variety of activities with the possibilities of electronic communications added, represent a potential educational benefit for students and teachers. The latter can develop strategies to apply these relevant tools to their learning programs.

The spectacular development of the science and technology, especially in electronics, telecommunications, and computer science, has innovated the method of learning, and posed the problem of adaptation for teachers and students to the introduction of new tools.

Further questions dealing with the future of education are asked, and discussed by people in control of education. The transformation has started but the changes are slow. Today's young teachers will lead education into the 21st century. Before trying to answer these important questions, let us imagine what the education in the future will be.

We are at the beginning of computer-based technology and the possibilities are incredibly promising. The increasing miniaturisation in the electronic industry will provide computers with new generations of microprocessors and memories with

high storage and small access time. The new architecture design for computers with multi-processors on the same motherboard working in parallel will allow a multi-programmation and will perform many tasks at the same time.

Several users in all parts of the world will share databases, which contain human knowledge. Special programs can select instantaneously for any teacher or student the materials they need for any specific topic from these databases.

Actually, the programming is sequential and linear. Multi-programmation and parallel programming will transform the possibilities of the computer, and very complex problems could be solved. This involves the development of telecommunications, and the perspectives offered by the optic fibre are promising. The flow of information exchanged between two sites will be increased considerably. The response time to any request will be reduced.

Images and sounds will be the natural way of communicating. Multimedia fulfils already these functions in a small scale.

The virtual reality is an incredibly promising field, which arouses the interest of searchers. Programs and special devices are combined to create a virtual space where experimentation is carried out, and the performances of the subject are registered and analysed.

Simulation is as near as possible to the real case. Events occurring in a three-dimension space involve an environment and ambience that create sensations. Special equipment, like a helmet with optical possibilities and flying suit with electrodes attached to the body at certain points, excite and provide sensations to the subject who is projected into an unreal world.

For example, the visit of a ship in virtual reality takes place as in the real case. One has the sensation that one is on a ship where one can move inside this space, forward, backward, open a door, see what is on left, right, speak with a virtual guide, or encounter persons, etc. The illusion is perfect.

In this surrealistic universe, education will become an initiating travel into the land of knowledge where the apprentice will discover, gradually, what a teacher has

programmed for him before. Progress will be adapted to the possibilities of the student. One explores more quickly than the other can. Learning is seen as a game from which the player moves only if he wins. This means he exits the stage if he acquires the knowledge.

3.4 Strategy for computer uses

The introduction of computers in education during the last three decades has led to the development of many learning techniques that can be supported by this medium. Some of the issues faced by all people involved in computing and in education are quite interesting. Sophisticated techniques like tutorials, drills and practices, simulations have been introduced. It is important to emphasise the fact that these techniques do not bring anything fundamentally new to the science of pedagogy. Teachers have always experienced these methods. What is new is the medium and the package (dedicated software for typical task). The knowledge is presented to the students in a way that interactions will stimulate their creativity.

3.4.1 Tutorial.

A tutorial is an effective way of communicating a knowledge using a combination of video, audio, text, and graphics. The relevant factors to the success of this method of teaching are:

- The layout: interface design in interactive style
- The control : the commands allowing the navigation in the package are simple and clearly indicated;
- The objectives are stated and the presentation should be attractive and stimulate the interest of the student.

Tutorials aim to satisfy the need of students to be guided through initial use of the information. They are good for presenting factual information, learning rules,

principals, and problem solving strategies. A scenario used in tutorials is generally built in three sections (figure 1):

- **Introductory section:** the student is informed on the purpose and the nature of the topic. Objectives of the lesson are clearly set.
- **Core section** where knowledge is structured and organised in items. Each item is presented and elaborated in steps allowing a progressive acquisition of the information.
- **Evaluation section:** before closing an item and to move to another, and in order to ascertain that the knowledge is acquired, an assessment is conducted. It can be a quiz, a questionnaire with multiple choice, or a problem to solve. A student must respond and the program judges the answer, and makes a decision what should be the next. If the student made a wrong answer, he is given feedback to enhance comprehension and future performance.

This process of learning is designed on iterative cycles. Each cycle is composed of an item, an assessment, and a feedback depending on evaluation.

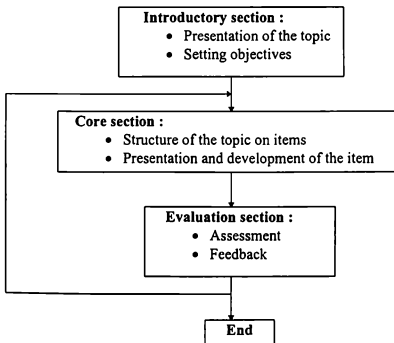


Figure 1: Tutorial's iterative cycle

A tutorial is a program designed to introduce information about a specific topic and lead toward an identified goal. The procedure used to reach to such goal is progressive, that is, information are presented in a sequential manner. The progression is punctuated by test to ensure student comprehension. Initial guidance is included in the form of prompts to encourage answering correctly and provides additional resources.

Tutorials help student to acquire a particular skill or concept and can provide interest and motivation. The teacher has to monitor the progress, and for this reason, tutorials must record student responses, and allow for the teacher analysis of all results. A good tutorial is thorough, enjoyable, interactive, and provide immediate and appropriate feedback.

3.4.2 Drills and practice.

The Drills and practice technique is used to reinforce knowledge by repetition in order to acquire skills and concepts. Students should have attended the appropriate lecture related to the topic for which the drill is used to provide practice. It can be compared to the workbook or the classroom exercise directed by the teacher. In combination with other methodologies, like tutorials, lectures, simulations, it complements the understanding and allows by intensive practice the fluency and retention sought. Drills are very important to fix the knowledge and develop the skills of problem solving. The drill software can be divided into three main parts (figure 2):

- Content section, which contains the list of all items developed in the program. A student has to choose an item. In some drill programs, the choice is done randomly.
- Development section, where the exercise is presented in such a way that the student goes through the objectives of the topic and gains the desired resulting skill or expertise.

- **Evaluation section.** When an exercise is answered correctly the program moves to the next until all the item is covered. However, if the answer is not correct, a feedback is delivered and another exercise related to the same item is presented to the student. The drill will continue to ask the same or similar question until the acquisition of the concept. Before moving to the next stage the student should perform successfully all the exercises of the item.

A library of exercises grouped by item and ordered by degrees of difficulty constitutes the main database of the program. The engine is the algorithm selecting the exercises in the items according to the answers of the student and leading satisfactorily to the purposes. A record of the performances of the student allows the program to proceed to the evolution within the topic. This record is also important for the teacher conducting the training. Drills are repetitions, so the motivation of the student is low. Effective software requires interaction based on deduction, inferences and recall.

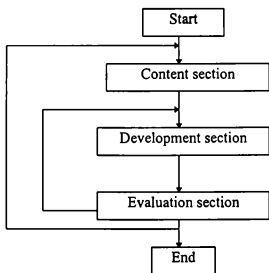


Figure 2: Program structure

3.4.3 Tests

Assessment is a fundamental step in the knowledge acquisition process. It is necessary before conducting a test to investigate all the elements influencing it. The

psychological aspect, the information delivery, the medium used to play a determinant role in the success of the process. The objective is to evaluate the effectiveness of the knowledge transmission and the quantity and the quality of the information gained by the student or the skill acquired. The ability to reproduce what is taught constitutes a valuable proof of the learning. There is also an important aspect to consider when conducting a test. The results can have a significant impact on the future of the student. For all these reasons the implementation of this technique in the computer should be carried out carefully. Using computers to generate, administer, and score the test presents some advantages which can attract the approbation of educators. Among these benefits are substantial time saved and the frequent improvement of the quality of testing.

The design of computerised tests:

The first step in any project is to set the objectives and the domain of its application. In the case of computerised tests, the objectives can be interpreted as a feedback of learning, or a method to rank order people. The first interpretation also called '*criterion referenced testing*' is valuable for the student who was given the opportunity to correct all misunderstanding and the teacher who can use the results to find out what the student does not know and adjust the learning.

The second form, called '*norm-referencing testing*', is designed for examination, to rank students or to issue them a certificate of competency.

Test programs are based on collection of exercises and questionnaires which are stored in the computer and represent a bank of information. These banks are also called databases and represent the principal asset of the program. The value of the test program is related to the size of its database and the relevance of its content. Good programs can generate an objective knowledge test based on the subject areas that the student has just studied. The advantages of such programs are in the development of the database which is permanently being improved: the number and the quality of the questions increasing continuously.

Scoring tests:

The weak point and the more discussed aspect of the computerised tests is the scoring.

Firstly, to be scored by a computer, a questionnaire should be restricted to a multiple choice, matching, or a short answer format. Nowadays, the computer logic working by comparison, it is very difficult to judge extended response. The pattern of the responses are defined and the student should conform to them.

Secondly, the student should be familiar with a computer, otherwise its performance will be dramatically affected and this will invalidate the test.

Finally, the test can be interpreted by the student in a wrong manner if the objectives that it covers are misunderstood. The system of scoring should be known and closely related to the purpose it serves.

3.5 Simulation

A simulation is a presentation of virtual reality, which allows students to interact with the environment where the experience occurred. The computer's program creates a realistic environment and presents material for student interaction. The responses of the student to different situations modify the environment and as a feedback to those responses the program presents new materials allowing the students to witness the results of their decisions. Simulation software can provide highly realistic practice at solving real problems. Simulation involves the learner by experiencing events or processes designed specially for educational purposes. The student learns about life vicariously through the simulation, constructing knowledge about the world from that experience. They put the student into an interactive discovery mode.

4.1 Principles of simulation.

The object of simulation is the design of models which should have the same behaviour that the systems they simulate. It is important that the model should give a high degree of realism, and react dynamically as closely as possible to reality.

It is based on mathematical models which consist of a set of equations governing the physical system studied. There is no doubt that it is a powerful tool for analysis and a natural setting for converting design into a form suitable for digital computer calculations. It can even be agreed that simulation methods are a major contributor to the rapid rate of advance of technology over the five last decades.

Modelling of process dynamics directly from physical laws rarely produces such equations. In contrast, the system model frequently takes the form of a set of ordinary differential equations, each obtained from modelling individual system components and their interconnections.

Phenomena are generally non linear models and multi variables, and very difficult to solve. The first step towards a solution is the linearisation of the equations of the model. The resulting model system is a linear approximation which requires a considerable computational effort depending on the number of variables and the nature of the problem. The objective to use a mathematical model of dynamical systems is to predict the performance of the system in a situation of interest.

For example, it may be useful to investigate the behaviour under fault conditions or to evaluate the nature of the system response to set point or input

changes. In general, an analytical solution is impossible and the engineer must resort to the generation of approximate solutions by analog or digital computer.

It should be clear that the presence of constraints in the model is a major source of difficulty in the calculation and can mean that the formal solution does not exist! It is generally true that the discrete version of the problem is simpler than the continuous one. The concepts will be so close to the continuous one.

The process of simulation can be divided into five steps:

- Problem definition
- Mathematical model
- Programming: implementation of the model in computer
- Experimentation: analysis of the model dynamics behaviour
- Validation of the model.

4.1.1 Problem definition.

Computer simulation is created and developed to respond to the needs of scientists to experiment with the behaviour of complicated systems. It is very difficult for economical or practical reasons to proceed with the real system. So, a dynamic model, which should be a valid representation of the system, is sought. The study of the real system should lead to a clarification of all interactions involved in the process. All the parameters characterising it should be identified and listed. The primary study is essential to have a comprehensive approach to the problem and to state thoroughly all the conditions under which the process occurs. So, the problem will be said to be well defined.

4.1.2 Mathematical model

It is important to find out the rules which describe the behaviour of the system. Generally, these rules are physics laws governing natural phenomena. When the system is complex, it may be necessary to break it down into sub-systems, which are easier to handle.

Consider now a real system (which is in general non-linear continuous system) for which it is necessary to sketch out the formal representation of the laws, describing its state and dynamic behaviour. The pressing question is now, what is the relevance of the above representation to the real system? More precisely, can we convert the real system into the theoretical concepts?

Computer models underlying the simulation can be classified into three types:

- Continuous model which is based on time. The mathematics is differential equations, and the way to find out the solution is numerical integration. Initial conditions and the increment time are crucial to the solvability and the feasibility of the performance of the problem.
- Discrete model. The mathematics is probability and statistics. The solution and program imply the perfect knowledge of the distribution representing the patterns of the events and the time required for their apparition.
- Logical model represented by a set of { If - Then } rules which imply decision making.

Once the model is stated, a mathematical machinery is spread out as a means of approaching the solution. The philosophy of the approach is that the design problem is formulated in such a manner that it is directly solvable by a digital computer.

The formulation of the problem is the translation of its elements into a mathematical framework. The essential elements of the model are:

- A dynamic system
- Specified objectives
- Set of admissible controllers
- A means of measuring performance to test the effectiveness of any given control strategy.

The analysis of the model is important in the sense that we have to take into account a number of constraints.

4.1.3 Programming.

The implementation of the model in a computer is a phase of the development which is time demanding. It is preceded by a deep study embracing functional and organic analysis of the problem. It consists of the production of the algorithm of the problem and its programming.

The algorithm is the logic description of all the steps leading to the solution. Most importantly, more emphasis should be placed at this level of the design because it represents the core and the essence of all the project.

The programming is the transcription of the algorithm in a collection of instructions understandable to the computer. Special programming languages are used to carry out this task and the computer easily interprets the code resulting from such operations. Many languages such Basic, Fortran, Pascal, C, etc. are well known in the programmers' community.

Programming languages are classified as they appear historically as low level and high level languages. At the beginning, the implementation of the program in the registers of the computer takes a long time and necessitates many operators. All the instructions are written in machine-code which is a succession of digit numbers 0 and 1. The assembly language is an improvement decreasing the burden of the programming by the introduction of pseudo-code. These languages are close to the hardware and involve the knowledge of the set of microprocessor instructions delivered by the manufacturer.

In the fifties the first high-level languages FORTRAN and COBOL (figure 3) became available on the market. High-level languages are relatively sophisticated sets of statements utilising words and syntax from English language. They are built like the human language with vocabulary, grammar, structure, syntax, and semantics. Many others have been introduced since the sixties. The latest is visual software programming tools (figure 4) like Macromedia, Java, etc. The characteristic of these languages is the fact that they are not directly understood by the machine, they have to be translated by a compiler or an interpreter in a machine language.

Actually, their advantage is the interfaces which are more visual and endowed with numerous tools to handle graphics, sounds, images, and codes. The programming is more procedural and object oriented. The emphasis is stressed on the design of the interface which should be more convivial and easy to handle.

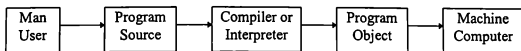


Figure 3: Synoptic scheme of computer programming

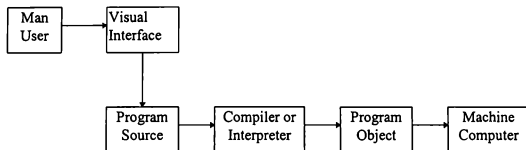


Figure 4: Synoptic scheme of Visual computer programming

4.1.4 Validation.

A simulation model is an abstract representation of the real system under investigation. It is a reflection of the modeller's understanding of the system components and its behaviour. The physical systems being continuous, it requires the aid of a great number of parameters to describe them adequately. This leads to complicated models which are very difficult to solve. So, a necessary simplification is introduced by lumping all the different possible models for the real system into one abstract with ideal characteristics. This simplification is important for the computerised solution of the system but poses the problem of the validity of such a simplified model. Tests and experimentation are the most used methods for the validation. However, the validation is very difficult when the system does not exist or its behaviour is not known. This can be the case with economical, and

astronomical models. Validation can occur during the realisation or after. The source information relevant to the validation is the data collected during the experimentation of the model and its comparison to the real behaviour of the system when it is possible. An activity cycle diagram and interactive graphical displays make the model more logical and transparent to the user who can easily detect bugs or misfits.

4.2 Graphics and interactivity

The success of computer games and simulation is to great extent the result of the improvement in the high-speed processor and computer graphics technology. The availability of this technology at a reasonable price makes it possible to expand the use of computer graphics as a presentation medium and computer generated animations are becoming common. The fact that a user can watch and interact with the dynamics of the model during its execution is the key point for the simulation concept and development. Visual interactive simulation is a method which uses high-resolution colour graphics terminals and three-dimensional design to render simulation more realistic and attractive.

The user observes the behaviour of the model under investigation and can use his knowledge in order to interact with it and tries different decision strategies. Numerous simulation software designed for educational purposes are doted with the visual interactive capabilities which give better insight into an experiment than all traditional reports.

4.2.1 Interaction methods.

Generally, education simulation packages are easy to install and the user has only to follow the set-up procedure. Once the simulator is installed, the user is impatient to get to grips with it. Running across the top of the window is a menu that gives the possibility to build a new project or to run an existing one. Under the menu, the navigation bar allows one to go to the different sections, all of which are relatively self-explanatory. This kind of presentation encourages the user to learn

and interact with the information. Interactive elements include pop-up menus; small windows containing help messages that appear on the screen when a user makes a mistake. Scroll bars, usually located on the side of the computer screen, enable the user to move to another portion of a large document or picture.

The integration of hyperlinks induces non-linear presentation and allows the connection of different elements in order to enhance understanding. This method uses coloured or underlined text or a small picture, called an icon, on which the user points the cursor and clicks on a mouse to get the complementary information. For example, students in engineering schools use interactive software of circuit design to learn the basics of electronics and to immediately implement, test, and manipulate the circuits they design on the computer. The mouse-click on each component opens a window containing the features of that component and some other explanations.

4.3 Simulation support environment

There are some basic facts that can be considered as grounds for the introduction of computer simulation in maritime education. One of them is STCW 95 which revises the traditional approach to competency certification, and introduces the use of simulators as an alternative to sea experience. The second is the technological environment, which has transformed the maritime industry by the introduction of more automation. The third reason is the amazing developments in communication. The technical and commercial management of the fleet is nowadays unthinkable without the aid of computers. So, the necessity of computers in education is an admitted fact, and the issue is to seek for effective methods, which can give expected outcomes.

4.4 Benefits of simulation training for education.

The essence of education and training is shortened to "Tell me, and I'll forget... Show me, and I may remember... Involve me, and I'll understand." (*Shipping World & Shipbuilders, Oct.1996*). The practical use of simulators for educational purposes is cost benefit for engineers. It allows better understanding of systems behaviour, and experiences practical operational techniques and abstracts.

4.4.1 Educational aspects

It is crucial to examine the relevance of the purpose of computer simulation to enhance laboratory practice within the curriculum. It is obvious that computer simulation cannot cover the full spectrum of laboratory activities. However, a current development of this science arouses an increasing interest of those involved in education. There is no limit to the positive learning experience to these tools when they are driven by a creative thinking and extended imagination. It is of great importance for the tutor to concentrate on the learning process rather than the means by which the objective is achieved. However, it is essential to notice that to study and explore a simulation package is time consuming, and affects also the teaching and learning strategies. The tools should be considered as a complementary aid at the disposal of the students and the tutor. When placed within their real context, such tools give better results than the traditional techniques.

4.4.2 Operational point of view

Using simulators can overcome the shortcomings and errors which are considerable as damage to equipments in the real life situation. Some experimentations in real situation presenting a danger are conducted safely for the operators and the equipment. They are time saving in achieving operational experience, and effective training. It is possible to monitor the level of skill and there is no limit on procedures. Experimentation can be repeated with the same or varying

conditions. So, the student can master new skills step-by-step at his own rhythm. The instructor can introduce challenges such as machinery breakdown or add parameters to the training scenario.

4.4.3 Economic point of view

The use of PC-based laboratory simulators provides different training situations, operational scenarios, and faults or an emergency program. There is no need to have laboratories, which are very costly. A large amount of running costs will be saved.

4.5 Artificial intelligence

The ambition of the intelligent computer based training (ICBT) is to place the student in a position as the principal actor in his own education. The computer becomes a medium of knowledge with interactive vocation and endowed with a number of pedagogical capacities. Such education is based on three aspects of knowledge:

- The concepts of computer based training (CBT),
- The concepts of artificial intelligence,
- The science of education, more precisely cognitive sciences.

The challenge is considerable. The project is to introduce for the benefit of education all the possibilities and improvements of computer technology. The main idea is to break the concept of the machine as a centre of control where everything is planned and the stiffness of its exchanges with the student. Introducing more flexibility, promoting individual progression, sanctioning and increasing the field of investigations of the machine.

Finally, the objective is to reconsider the role of the computer as a tutor taking into account the new technological and pedagogical means. The introduction of

technology in education leads to the transformation of society. The social change involves a new learning environment.

4.5.1 Pedagogical impact

The objectives of the pragmatic approach of cognitive psychology are to minimise wasting time, optimise sense alert, discovery, and the control over activities, to favour the development of personal solution rather than stereotypes.

The impact is also technologic with the appropriation of the advances in technology and communications. New environmental learning is necessary when new behaviour is desired. The will to adapt the progression of the knowledge to the learner is real. The purpose is to eliminate the traditional classroom and to replace it with a workstation where the apprentice will be alone in front of the screen. Working in groups, or classes is very stimulating and essential in the learning process; nobody contradicts this fact. Since Piaget (1947), it has been impossible to ignore the benefits of active pedagogy based on error, trial, and success. According to Piaget, the error is a source of learning and progression. The strategy is to locate and identify the errors, to foresee the weaknesses and develop a process in order to correct the faults by the introduction of subtle drills and practice. Naturally the progression at each step depends on the response of the apprentice.

4.5.2 Authoring

The big improvement in the authoring languages has made it possible to meet the exigences of this kind of software. The challenge is to recreate a scenario of traditional learning, and to put the apprentice in the situation of a real actor. To produce such packages requires a good analysis of the topic, its requirements, the possible errors and their management. The use of the computer induces the concept of self-training, which gives it an essential pedagogical role. It becomes a tool of discovery and creativity. The developers are put in charge of taking the knowledge and to transcript it in a form where it can be retrieved quickly, excite interest, and be

easily assimilated. The research of such performances requires the finding of a model where knowledge is a combined learning skill.

4.5.3 Knowledge based models

Balacheff (1991) distinguishes two models of knowledge:

- The first is behavioural and conveys the actions of the apprentice; for example trials, responses to questions, etc.
- The second, epistemic results from applied diagnosis to the previous model and describes the knowledge of the apprentice.

An example illustrating these concepts is electricity laboratory work. Here the universe of studies is composed of batteries, bulbs, wires, meters for voltage, intensity, resistors, etc. The pedagogical objective is find out how associations of causality are made up in the students' minds. Many consequences result from such an approach:

- It give a better understanding of the strategy of learning
- It allows the build up of a cognitive model, which can be used to interpret and predict the students' capabilities, to deliver appropriate explanations, and to provide corrective actions.

Artificial intelligence methods are another source of progress in learning pedagogy. They are used to solve problems, bring appropriate explanations, evaluate performance, and establish a genuine strategy of teaching. The advent of multimedia systems reinforces this tendency and allows diversification into the exchanges Man-Machine by the creation of ingenious interfaces. It is possible to classify the artificial intelligence fundamentals in three categories:

- Expert systems which are not dedicated to the education purposes; however they are used in training where they have an important impact. They simulate the

reasoning of expert. For example, they are found in medicine for medical diagnosis, in engineering for trouble shooting, etc.

- Specific problem solving softwares with a library of exercises or a generator of new situations. These kinds of programs interest those who want to become experts by an intensive application and expertise.
- Most interesting for education is what is called 'the intelligent tutors'. They are conceived for educational purposes and tailored for specific topics. Intelligent tutor knows the solution to the exercises, and the necessary explanations if they are needed. They vary the level of difficulty according to the answers given by the apprentice. They are able to explain the knowledge involved in the reasoning process. The simulators are well adapted to the training of mechanical processes: the real succession of facts are simulated and take place in real time. The trainee learns how to react efficiently to many new events, he acts and observes the effects of his actions on the process. Bridge and engine space simulators are examples of such programs.

4.5.4 Intelligent tutor

Depending on the goals assigned, the intelligent tutor is structured around four components, which are the expertise of the topic, the pedagogic expert, the student model, and the interfaces.

4.5.4.1 Topic expert

The quality of the knowledge is fundamental and requires encyclopedic expertise to collect facts and basic rules related to the followed goal. Accuracy and clarity are valuable assets. Induction and abduction hypothesis for reasoning are used. From the abduction method, the causes are deduced from the effects observed. Medical diagnosis, or 'fauna and flora' programs are a good illustration for this kind of reasoning where arguments are provided from the database of recorded facts.

The inductive reasoning method extends the properties valid in some cases to the general ones. Analogical and heuristic knowledge govern the way to conduct the reasoning. The core of all the process is derived from the database which can grow by the record of new situations. The information related to the progression of the student during the different practices is recorded and applied to determine the pedagogy which best suits the subject.

4.5.4.2 Pedagogic expert

This is based on didactic theory (the error theory, for example). Its role is to place the student in the best position for learning: choice of exercises, free or guided mode of learning, evaluation of the progression, indication of the errors and contradiction in the reasoning, and presentation of the explanation.

To conduct efficiently the learning process, the pedagogic expert axes its strategy on the student model information. The functions of this model are essential. The key point of all the process, it controls the understanding of the concepts presented, and the methodology for delivery.

4.5.4.3 Student model

The student model is a reflection of what is considered as a standard. It is a theoretical construction of the student profile based on an evaluation of the observed gap between desired and acquired knowledge. It also includes the analysis of errors, and the linguistic style which influences the mode of communication. It records all the experiences and learns from them. It evolves by increasing its database, which is built on the inheritance structure properties. It allows a hierarchy of concepts, and also a negative reasoning. Any reference to missing information is considered as false.

The objective is to establish a reliable profile of the student which reflects his intellectual capabilities and individual characteristics: interest, need for repetition, receptivity to advice, personal initiatives, learning by errors, and aptitude to abstract.

The student model is practically defined as a table where rows show the concepts of the field and the columns contain indicators related to the concept of knowledge. Indicators precise if the knowledge has been studied in the present or previous lessons, and if it is acquired or not The value of indicators are good, bad, or see it again.

5.1 Introduction

Nowadays computer automation is present in the engineering, manufacturing, and business environment from managerial to technical levels. The declining costs and increasing efficiency (power, speed, and safety of information) of hardware and software have brought the use of computers as a working standard, and the ability to use computers an essential skill, in almost every activity. Computer literacy is becoming more and more a condition of finding a job in the modern work-place. To fulfil this requirement of skilled computer users, education has the duty to review the curriculum and to take into account this new aspect of modern technology trend.

Maritime industry is also concerned by this evolution, and Maritime Education and Training institutions as stressed in STCW95, should focus on practical application and job-related skill. The objective is to satisfy the needs of the industry by the introduction of a comprehensive skills oriented tools capable of cultivating student enthusiasm and hopefulness to reach essential expertise. In addition to the acquisition of the knowledge related to the practice, the computer based laboratory simulation develop fundamental skills in many computer's areas such as:

- Operating systems,
- Software applications: word processing, databases, electronic spreadsheets,
- Programming languages,
- Simulation programs,
- Multimedia systems, etc.

5.2 Multimedia features

Multimedia systems using interactive CD-ROM access to images, and sound recordings make the use of computers more effective and more efficient. Multimedia is a combination of a number of devices to present information under the control of computer. Most multimedia applications include predefined associations, known as *hyperlinks*, that enable users to switch between media elements and topics. The power multimedia systems lies in their ability to network information resources, and to provide ready access to the learner. As a teaching tool, it might include the use of textual, graphic, audio and video materials to convey information to the user who would interact with it by reading, listening, and observing still and moving images. Multimedia is a logical extension of simulation with the characteristics of drills and practice tutorials and problem-solving approaches. Multimedia is not only a presentation tool, but it gives students control of powerful tools in the exploration, and creation of information.

5.3 New form of thinking

There are several different forms to communicate information and the technological means used should subsequently suit the planned objective to be efficient. The integrated way of multimedia using computer and various devices, combining text, video, graphics, animation, and sound attracts the favours of a large audience. This emerging way of communication gains its popularity from the ease-of-use level of its practicability. Events are moving so rapidly with respect to information technology that it is almost impossible to become integrated in a national policy of education without a comprehensive approach of the economic and cultural stakes. Large sums of money are already invested and there is a growing demand for people with knowledge and skills in the areas of multimedia information, systems, and technology. Universities are just beginning to help in this regard, and a

curriculum effort is necessary in order to provide guidance and support. In order to comply with the new technological environment it is urgent to review the way of teaching the traditional skills:

- Reading
- Writing
- Building models
- Experience the reality

Rethinking these skills to cope with the needs of industry, research, development, etc. can assist education on what should be concentrated upon.

5.4 Visual learning

To provide students with hands-on, practical experience using software can be worthwhile. However, to be efficient, the student should be familiar with computer communication and desktop publishing. Practice by means of simulation using multimedia products poses particularly difficult challenges for user interface designers. The academics and designers should address the typical interface challenges of software or hardware products and also face a multitude of other issues introduced by each media type. Some specific user interface considerations, such as functionality, structure navigation, and visual design should be taken into account. It is important to bear in mind that the objective of the software is not to handle the program, but to perform the skill for which it has been designed. Laboratory technicians do not have the knowledge necessary to design multimedia applications to simulate the laboratory practice, and similarly multimedia developers do not have experience in education and practice, are challenged to make their products accessible and interactive. Multimedia user interface design, for technical and educational purposes, is becoming its own discipline, gathering experts from education, industry, and media design.

The design language provides the developers with the powerful tools and enables them to express new forms of education and information. It will allow visual,

sound, and expert knowledge to take form and create mechanisms for the teaching style. To take advantage from this technology, educators must learn how to listen, to read, to watch, and to interpret the code behind each image and each sound. This will lead to a real transformation of the teacher behaviour when conducting a course using such medium. Audio, video, motion and synthetic animations enhance the conceptual understanding. Abstract representations and methods for structuring the knowledge can be built into a systematic foundation for understanding the interpretation of information in both the auditory and visual domains together. Audio and visual media are well integrated in a real world experience. So, the challenge is to transplant these modalities in the human-computer interface.

The multimedia system is at its beginning and the first applications already on the market are attempts to mimic the real world rather than to strive to give a natural representation. There are certainly new ways for the exploration of the possibility to express this emerging art; some research in voice recognition has been done and will lead to the replacement of the keyboard-touch by the voice.

5.5 Flexibility

The main advantage of multimedia software for educational purposes is its flexibility. It is generally structured in such a way that any user can perform any practical topic. The educator can run as many work-practices as there are available work-stations in the laboratory. Each part of the software is self-contained and may be covered in the order that best suits the needs of the course. Each student can go through the practice at his own pace and even if it is recommended to follow the sequences of the course, it is possible to choose a different order. At all the stages of the work-practice on-line help related to any particular point of what is going on is available.

5.6 Evaluation of multimedia applications.

Effective evaluation of multimedia applications for engineering simulation is quite hard, and necessitates the identification of all the objectives that the program should satisfy. It is also important to determine reasonable quality criteria, and which metrics are suitable for measuring them. The educator in charge of practice should define the procedure to be applied, and if standards already exist, how to implement them. All these issues should be discussed by all the staff involved in the institution. A better understanding of evaluation criteria is a key point in quality assessment, and a condition to find out methods for systematic testing.

When simulation software is selected, it is profitable to think of the ultimate goal of the concerned training. Depending on the needs which could be a reinforcement, or building of existing skills and performance levels. A training programme will tend to take students through four stages of learning:

- Knowledge: acquisition of background to a skill,
- Recognition: recognising at what extent we might apply the skills,
- Simulation: application of what was learned in a practical way,
- Action: final stage of knowledge and simulation in order to apply them in the real situations.

Multimedia training is very good for the delivery of the knowledge and recognition. It also assumes a limited role in simulation for behavioural training. In technical skills, the full simulation process tends to be focussed on virtual models to carry out actions from which result the understanding of the simulated system behaviour.

5.7 What is a multimedia system ?

Multimedia is the integration of different means of communication in very exciting way to stimulate the senses at any levels of comprehension. It includes high

quality sound, still and motion video, text, animation and graphics. This requires certain hardware equipments, and software programs to drive them.

At the beginning is the personal computer which should respond to the future utilisation. For this reason, it is important to bear in mind that the possibilities to expand or up-date any equipment depend on the "needs / wants" analysis realised before any purchase. The ideal is to buy computers that are fitted out with desired devices and also capable to run any program.

5.7.1 Hardware

The principal features to look for in hardware are:

Central Processing Unit (CPU):

The 32-bits processor (Intel Pentium I or II or equivalent) can perform any multimedia software activity. Obviously larger are the registers of the processor (more bits) faster is the processing, and more complex are the instructions it handles and bigger is its capacity to address the memory. Each processor works under the supervision of an internal clock which rhythms the progress of any program instructions. The first Intel 8086 (1981) ran with a clock of 4.5 MHz ; and the latest Pentium II has reached 400 MHz.

Memory:

All the instructions performed by the CPU transit via the central memory. To run under Microsoft Windows 98 (operating system) requires a minimum of 4 Mega-bytes (one byte represents one character, and 4Mb are equivalent to 1311 pages of text, each page has 40 lines and 80 characters per line). To operate efficiently multimedia programs, it is recommended to expand the memory to 32Mb because images and sound consume a lot of memory space.

Graphics controller:

Some multimedia programs use high definition images or sophisticated three dimensional graphics, and all graphic controllers do not have the ability to

display them. There are several standards of graphics cards on the market, and it is vital to choose one which fits the needs and is compatible with the monitor.

Monitor:

It constitute the fundamental output element of the system. To be sure that this important part of the computer system the wants and needs to run desired programs, some factors should be considered:

- Resolution is the number of dots or pixels (luminous points) that can appear in the screen. The higher is this number, the sharper are the graphics or images displayed. The common resolutions are 640 x 480 , 800 X 600 , 1024 x 728 pixels .
- Colour: VGA and SVGA (Super Video Graphics Adaptor) become 'de facto' standards of monitors. Colours enhance the presentation and some programs are written to run solely on 256 colours configuration or more.
- Screen width: the most common monitors are 14-inch screen. However larger ones have displays which are comfortable and easier to read for the user. Graphical stations for technical design or simulations require 17 or 21-inch screens to present a global view.

Special monitors called tactile screen are required by some programs which display controls enabled by a finger-user touch.

Disks controller:

Is the electronic card that links the main board and the storage units: floppy disks, hard disks, and CD-ROM. Hard disks, with their high capacity of storage allow all the data and programs to be available and ready for use. The software programs come on 3½ -inch diskettes used with floppy disks or more recently on CD-ROMs, which have a storage capacity of 650 Mbytes. Diskettes are also used to store data when CD-ROMs require a rewrite CD-ROM device to do so.

Sound controller:

There is a wide variety of standards stretching from a simple mono sound card to a high-fidelity stereo sound with 3D sound effects. Some are equipped with

chips enabling the multiple streaming of WAV files and digital mixing to 64-voice wavetable synthesis which is a studio quality instrument. A musical instrument digital interface (MIDI) links the computer to real instruments and controls them.

Communication controllers:

Are the input / output ports which allow communication. Two serial ports and one parallel for the printer are already available in all standard computers. However, to connect the computer to a telephone line for Fax or Internet services requires a special device called a MODEM (MODulator-DEModulator), which transforms analog signals to a digital signals and vice-versa. If the computer should be linked to a network, a network card is needed.

Keyboard:

The quality of a keyboard depends on its ergonomics, the feel of its keys, and its layout.

Pointing devices:

The mouse is the main element, however some software requires the use of a digital tablet and optical pen.

Printer:

Considered as the standard output, printers are indispensable to have hard copies of any work. Several types exist in the market varying from dot-matrix, letter-quality, ink-jet to laser. Some are slow and noisy, and others like lasers are high-performance. The qualities to seek in such devices are the speed and the resolution (DPI: number of dots per inch); colour is also an asset.

Plotter:

it is impossible to imagine engineering design without a plotter to draw hard copies of the graphics, engineering drawings, etc. Plotters are doted with a set of pens in different colours.

6.1 Features of simulation software

The development of simulation software necessitates a specific knowledge, particularly in engineering science, education and multimedia communication. It is designed to respond to the needs of industrial designers, or educational institutions concerned with laboratory practice. Its main characteristics are to be productive, interactive, flexible, and to save time whether used in a laboratory or at work. A good simulation program allows a simple and reliable progression during all the process. It provides the instructor with visual tools for creating the work-practice, and full control over all of it.

The simulation needs of maritime education and training can be divided into two categories:

- Laboratory: automation, electronics, languages, engineering drawing, etc.
- Practical training: radio-communication, navigation, cargo handling, ship stability, marine engineering, etc.

6.1.1 Laboratory simulators and practical training

Teaching general principles of technical science like electronics, automation, and engineering is quite different to cultivate skill in manipulating electronic devices, controlling ship operations, or monitoring ship propulsion from the engine room. Knowing solely the principles is not sufficient from a vocational stand-point. To be of value, the mastering of the job related techniques should be demonstrated in practice. In the shipping industry, the environmental concern and the safety issues have led to the revision of the STCW78 convention. The amendment stresses on the

Simulink module launch the user in the world of simulation. Many automation toolboxes are available, in particular control systems, signal processing, optimal control, identification, etc.

The user can build any system by dragging the necessary components from toolboxes, start the simulation and observe in real time the behaviour of the system.

Other software: *Easysym for digital circuits*, *Psie*

6.2.2 Electronics -Workbench EDA

(Interactive Image Technologies Ltd. 1996)

Application : Electronics lab

Description: This fits any curriculum, and complements any lecture, textbooks, and lab notes. Doted with a library of analog and digital components, it allows the building of any circuit and ensures that it works like the real thing. The user has at his disposal virtual electronic devices like oscilloscope, logic analyser, Bode plotter, and meters which give true real-world results. More information about this software are given in the case study at the end of this chapter.

Others software: There many others packages which fulfil the same task.

6.2.3 Autocad

Application: CAD (Computer Aided Design) for engineering drawings

Description: Autocad is fitted with all the simple primitives like line, arc, circle, spline, rectangle, ellipse, and tools for joining, breaking, snapping to grids and to other drawing entities. Tools are accessible from the menu bar or toolboxes. It displays a wide range of drawing attributes such as layers, line types, and text styles.

Powerful libraries in mechanics, pneumatics, electrical wiring schematics are available. Combined with an appropriate library, it generates pieces of equipment and sectional details all with a click of the mouse to the desired size.

Experts users are able to expand on what the program can offer by using the built-in list-processing language: AutoLisp.

Other software: The CAD family; *ALDA* Infologics Sweden

6.2.4 Maritime English

Application: Languages laboratories

Description: Many software companies have a project of maritime English packages. Some projects are underway : Seagull AS has planned to release *Maritime English* package at the end of 1998.

However English test packages are available: *Shipping agent, Marlines English Language Test*, is one of them

6.2.5 Machinery Space Simulator

(CBT Version 2.2 - Marine Soft Entwicklungs u. Logistikgesellschaft mbh 1992-97)

Application: Marine engineering

Description: this diesel engine simulator package recreates the machinery space environment, and allows normal operating modes. It includes the following systems: main engine, starting air, fuel oil, lubrication oil, cooling water, and steam circuit.

The instructor has the possibility to create exercises. Students should know how to start up a machinery space system, and also how to identify, localise, and remedy faults and malfunctions. There is always on the screen a menu-guidance and icons of dedicated keys to control and monitor all operations. Mimic diagrams of operating systems like fuel oil, lub-oil, fresh water, sea water, compressed air, are displayed with controls being operable by mouse clicks. Graphics plots, alpha-numeric displays of pressure, temperature levels, and machinery controls and indicators are reproduced on the screen.

More details about this software are given in the case study at the end of this chapter.

Other software: *CBT 2000 System* Kongsberg Norcontrol; *Turbo Diesel* PC Maritime Ltd. ; *Marine Propulsion Plant* Advanced Marine Enterprises Inc.

6.2.6 Mariner.

(Baron & Dunworth, Naval Architects & Marine Consultants).

Application: Ship loading and stability

Description: provides information relating to the reserves of stability and longitudinal strength for routine conditions of loading. The user is driven through a system of graphical screens for the assessment of statutory requirements for strength or intact and damage stability.

Once the vessel is chosen, its appropriate graphics are displayed. The input of data is in spreadsheet format and the analyses are immediately performed allowing a continuous updated view of the operations. It can be used on board for routine loading calculations.

Other software: *Cargo Secure* SSPA Maritime Consulting AB; *CBT-Stability for Ship Operations*, Innovative Training Systems; *Ship Loading Simulator*, Ocean Motions etc.

6.2.7 GMDSS

(Poseidon GMDSS Simulator (PGS) . Poseidon Simulation Systems AS , Norway)

Application: Radio-communication

Description: The software is designed to train maritime the communications procedures, GMDSS (Global Maritime Distress and Safety System). The ambitions of this interactive program are to satisfy two goals:

- Acquisition of the necessary knowledge to be able to pass successfully the GOC (General Operating Certificate) and ROC (Restricted Operating Certificate) exams.
- Refresh the knowledge to maintain the skill.

The package is divided into six books that the user can handle easily by a simple click on the mouse. The first two books GMDSS and Technology give an introduction to a GMDSS, the equipments required, and radio technology. With Operation and Procedures books, the user is invited in interactive way to work with

GMDSS equipments in different distress alert situations. Search and Rescue, how to avoid false alerts, and maritime terminology are also treated. The applications book ascertains the understanding by using different scenarios where the trainee is in a distress situation. Tests are conducted at the end to evaluate the understanding.

6.2.8 ANRIS 2000

(CBT - Marine Soft Entwicklungs und Logistikgesellschaft mbh 1992-97)

Application: Navigation and integrated bridge system

Description: this software is knowledge-based monitoring and control of nautical safety and risk alarm functions. The aim is to increase student instruction of approaching ships in order to avoid collision. Situations of danger are recognised in anticipation, analysed and evaluated in order to allow the ship management to make quick decision and take right actions.

6.2.9 3MS DeskSim.

(Danish Maritime Institute)

Application: Shiphandling, Harbour and Channel Design, Watchkeeping, Offshore Operations, Risk Analysis.

Description: this is a structured desktop training tools for marine officers. DeskSim is a modular Client/Server based application running under Windows NT. There are many modules dedicated to maritime training available (*MsEquip*: navigation lights and mechanical effects on own ship, *MsEnvir*: sea environment, *MsTship*: traffic ships, *MsRadar*: synthetic ARPA radar, *MsBridge*: real instrument and control interface, etc.). This modular feature allows the management of the training centres to build their laboratory practice with the modules they really need. The program provides a realistic vessel behaviour by a display of different bridge instruments on Client computer screens. This reproduces the whole bridge configuration.

6.9 Case study

6.9.1 Electronics Workbench

The education goal of this electronic package is to provide electrical engineering students the ability to explore the electronic design and experimentation. The integration of schematic editor (figure 5), SPICE simulator and on-screen waveforms makes scenarios easy and instant to design an experiment.

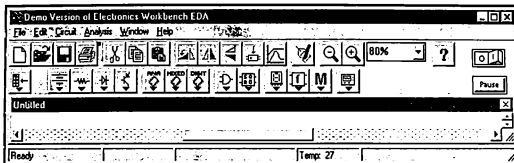


Figure 5: Main window

The SPICE engine options include:

- Digital simulation, which allows the simulation of analog, digital and mixed analog/digital circuits (figure 6) with feedback between the analog and digital sections.
- Monte Carlo analysis, which calculates the variations in a circuits performance allowing for component tolerances. This option performs statistical analysis
- Analog behavioural modelling, which allows the description of analog components (figure 8), or entire circuit blocks, using a formula or a look-up

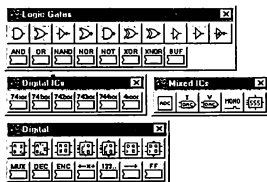


Figure 6: Digital and integrated circuits



Figure 7: Basic circuits and different power sources

table.

- The extensive model library, which makes available all needed devices.
- Import and export SPICE files, gives the capability to work with existing libraries of files or generate SPICE output for other analyses.

- The program supports unlimited number of passive, sequential, combinatorial, control, hybrid, indicator, gate, and IC components. parameter variation routines, including DC operating point, AC Frequency, Fourier.

- It allows up to 25 active components in each circuit, including diodes, transistors (BJT and FET), opamps, rectifiers, diacs, triacs, and lossy and lossless transmission lines.

In Electronics Workbench it is easy to use the drag-and-drop interface, and the fully-editable device models. Over 500 editable device models are included in the package. Analog, digital, or true mixed-mode simulations are possible.

After a circuit schematic is created, it remains only to turn on the power or click the simulate button to see the role of the simulator performing the solution of the circuit and generating the data, visible on instruments such as the oscilloscope. More specifically, the simulator is the part of Electronics Workbench that calculates a numerical solution to a mathematical representation of a created circuit.

For this calculation to occur, each component

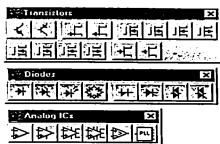


Figure 8: Analog components

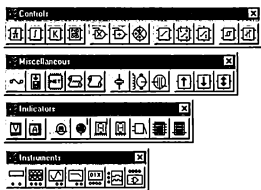


Figure 9: Control systems and display instruments

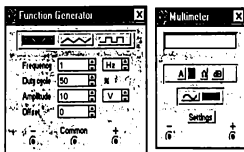


Figure 10: Function generator and multimeter

in a circuit is represented by a mathematical model. Mathematical models link the schematic in the circuit window with the mathematical representation for simulation. The accuracy of the component models determines the degree to which simulation results match real-world circuit performance.

The mathematical representation of a circuit is a set of simultaneous, nonlinear differential equations. The main task of the simulator is to solve these equations numerically.

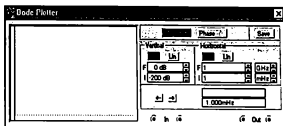


Figure 11: Bode plotter

A SPICE-based simulator transforms the nonlinear differential equations into a set of nonlinear algebraic equations. These equations are further linearised using the modified Newton-Raphson method. The resulting set of linear algebraic equations is efficiently solved using the sparse matrix processing LU factorisation method.

The simulator in Electronics Workbench, like other general-purpose simulators, has four main stages: input, set-up, analysis and output:

- At the input stage, after one has built a schematic, assigned values and chosen an analysis, the simulator reads information about the circuit.
- At the set-up stage, the simulator constructs and checks a set of data structures that contain a complete description of the circuit.
- At the analysis stage, the circuit analysis specified in the input stage is performed. This stage occupies most of CPU execution time and actually

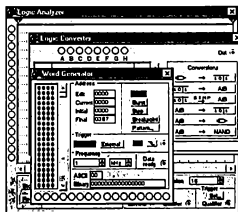


Figure 12: Logic tools

is the core of circuit simulation. The analysis stage formulates and solves circuit equations for the specified analyses and provides all the data for direct output or post-processing.

- At the output stage, the simulation results are viewed. One can view results on instruments such as Bode plotter (figure 11), oscilloscope, or on graphs that appear when an analysis from the Analysis menu is run or when Analysis/Display Graphs is chosen.

There is a full menu item of analyses (figure 13) which improves the productivity with insights into the behaviour and stability of the designs. A wide variety of circuits can be analysed using the simulator module PSPICE. There is a big number of specific tools for analysis (figure 12) ranging from precision instrumentation amps, microwave mixers, switching power supplies to digital control circuits.

Mixed analog and digital circuits may also be analysed.

In spite of its friendly and easy to use interface, it is apparent that the software cannot be handled

efficiently without a good understanding of electronics principles. The student should focus on the objective of the practice rather than losing his time on the discovery of the capabilities of the software. Here the role of the electronics professor is vital for the success of the practice. The goals of the laboratory session should be clearly defined and as closely as possible related to the purpose they serve.

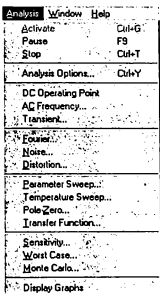


Figure 13: Analysis menu

Example :

This circuit in figure 14 oscillates at approximately 2 MHz. The oscillating frequency can be varied by adjusting the inductance value L. The simulation is started by clicking on the switch in the top right corner of the main window.

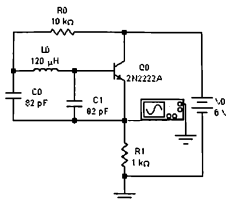


Figure 14: Oscillator diagram

A double click on the instrument icon (figure 14) enlarges it and an oscilloscope appears (figure 15)

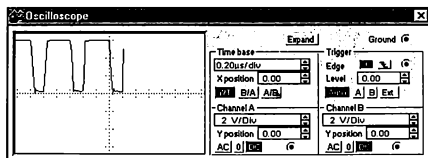


Figure 15: Simulation output on oscilloscope.

An understanding of the role of simulation has done much to explain the specific properties of the mechanical and electrical systems. Just as the dynamics system behaves and responds to changes in force, intensity, and other environmental stimuli, so the simulation gives an accurate and reliable response to the system behaviour. Of course, some people are thinking about the content side of simulation in education. There is little consensus, save for one point: that the salient issue of the simulation will be the need to reduce the cost of the practice.

6-3-2 Machinery Space Simulator.

The simulator runs an RTAxx Sulzer engine. All useful display and control functions are featured on the screen (figure 16). They are constantly available, and the operator without training or memory effort can access any information or perform any control task. Information is displayed in analog or digital form.

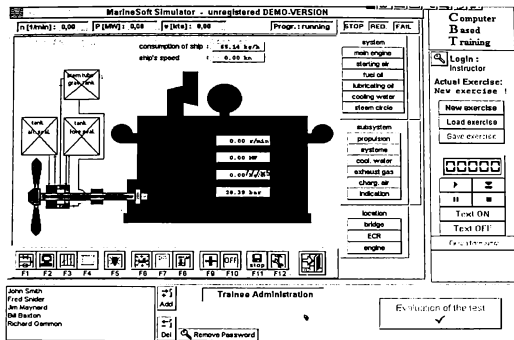


Figure 16: Bridge Control Unit

The display is divided into three areas: the main area presents the process activated, the second a menu system that calls up the desired system or subsystem, and the last the commands from which the operators login or the instructor can load or sketch exercises. There is also a tools bar in the bottom of the window which contains icons

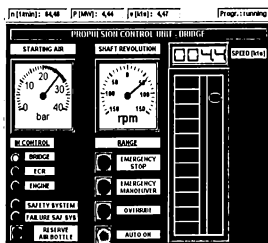


Figure 17: Bridge control unit

triggered by a mouse click or key functions (F1 to F12).

The engine can be started from the bridge, the engine control room or the engine itself as it is in the real ship (figure 17). Starting air, shaft revolutions, ship speed and output power parameters are displayed in analog or digital forms. The start up can be manual or automatic.

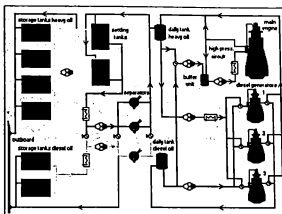


Figure 18: Fuel oil system

As the operating program is a mathematical model of the real engine, it handles all the parameters governing the whole system and displays the useful ones inside the mimic diagrams in front of the component of each sub-system. Therefore the operator can follow the running conditions of that element and can remedy any abnormal situation.

Mimic diagram control.

Generally the mimic diagram represents the whole or a part of the process. State and parameters changing are clearly visible and feedback on the entire process is displayed.

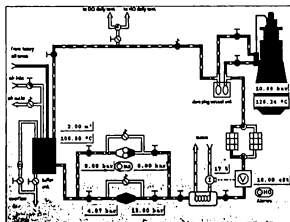


Figure 19: Main engine fuel oil system

There are 20 mimic diagrams with many important variables displayed. The mimics describe the different systems behaviour: fuel oil system (figure 18), main engine fuel oil system (figure 19), fuel oil separators (figure 20), HT-circuit main engine

The selected mimic diagram is displayed as soon as its key (F1 to F12) is depressed.

In each mimic diagram analog display elements are represented and may be controlled by a simple mouse click. For example, the operator opens or closes fuel valves, activates system elements like heater, heavy oil or diesel oil separators.

the addition of computing power, speed, and extended capabilities enable the operator to have an overview and to handle the operations of the whole process.

Figure 21: HT-circuit main engine cooling water

performed in the real plant have to be executed in the same order. The difficulty is to recognize in the mimics the appropriate device and to set it correctly.

On the down side there are two problems. The first is the absence of context sensitive help. The second is the documentation: a student expects to get information about the engine and the model used for the simulation.

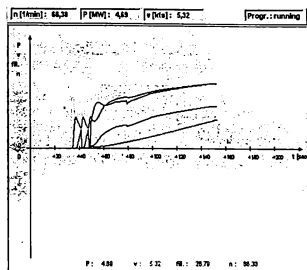


Figure 22: Propulsion parameters diagram

Recording historical display

Through the recording historical function, analog variables are recorded and memorised during the running time and may be displayed on demand as trend curves. Figure 22 plots five measured variables (shaft revolution, speed, power, n-soll, fill.) in the same graph.

Alarm management


Alarm - Journal									
		urg.	measure point	value	upper limit	lower limit	appear time	receipt time	ackn
1	2		p_FO_ME	0.00	12.00	10.00	14:22:52		
end of list									

Figure 23: Alarm journal

The whole process is monitored as in reality. Alarm states are visible on supervisory and mimic diagram displays. The active alarms are displayed in the alarm journal (figure 23) in order of occurrence. When an alarm occurs a small red lamp begins to flash in front of the associated system or sub system until it is acknowledged and fixed. The alarm overview is accessed by depressing the dedicated key.

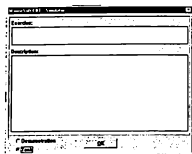


Figure 25: Loading exercise dialogue box

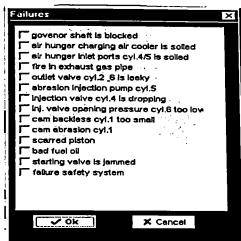


Figure 24: Failures list

Setting exercise.

The instructor has access to the module which allows him to define and set the performance to be experimented in an exercise (figure 25). The student should follow the predetermined procedures on that experiment and tests his understanding of the related topic by an effective dialogue with the simulator

Analysis.

The machinery space simulator is an easy and fast to use program for the education and training of marine engineers. The main tools needed for general technical purpose are all in place and functions such as the different procedures to prepare and start the engine are available and straightforward to use. It covers the engineer curriculum and is an excellent support for the knowledge gained during the lectures. Its friendly to use interface makes it easy to run. However, it is impossible to run properly and efficiently without a good knowledge of the engine and the auxiliary machinery. The success or the difficulties to conduct the experiment sessions depend on its knowledge requirement. Rightly it is an important support for the practice and reinforces the classwork in such a way that all the basic concepts will be mastered.

The interactive mimic diagrams describe accurately how the different system and sub-system work and give the possibility to the student to interact with the process. The complete and useful picture in the screen is a virtual representation of the real process. It is a concept and is perceived by the student as a concept rather than the expression of the reality. There is a danger for the student to lose the sense of the reality if there is confusion engendered by the identification of this image to the real plant. There is some evidence that replacing engine practice by computer simulator is not realistic, and can lead to misunderstanding of the real thing. Even if it contributes to a deeper understanding of the scientific process, it is essential to bear in mind that the student can perceive it as a game, and to avoid this unwanted situation.

Laboratory educators forget to teach science as a process rather than a body of knowledge. The credit of this kind of program is to show the necessity to know the rational process behind the procedures before their application. The learning engendered by this pedagogy tends to give a good feedback of what the student has assimilated, and the way he applies it.

7 Multi-purpose computer laboratory design.

7.1 Why a computer laboratory?

Many educational institutions already have a computer laboratory, or have planned its purchase because it has become an important item of the curricula. The proposal is to use it as multi-purpose laboratory especially in the institutions where there is a lack of laboratories. Gracefully, to the growth of software development and the universality of the computer as a tool, it is possible to respond effectively and with a lower cost to the unavoidable need of practice.

The basic principle is to utilize a highly flexible approach that maximises applicability and performance to fulfil any laboratory process requirement. The computer laboratory offers students and teaching staff centralised information, data, and knowledge that is informative, and easy to understand or manipulate. It takes maximum advantage of state-of-the-art microprocessor technology. Therefore, with the use of this task distributed and modular architecture, computer based simulation avoids unnecessary dependency on products and spare parts used in laboratories for their normal running and maintenance.

7.2 Laboratory project

The purpose of this part is to project and propose the design, planning and implementation of an advanced computer laboratory, based on the analyses and trends discussed in the previous chapters. The emphasis is stressed on functionality. Educators are more interested in simple systems which fulfil the curricula

requirements rather than sophisticated technology. However, they welcome any technology which lightens their daily burden and improves the educational process.

7.2.1 Computer laboratory features.

Being able to execute the most sophisticated algorithms, the computer system is suitable for the simulation of any process in all industrial fields. In all industries, it contributes to manufactured product quality improvement and production cost reduction, by optimising the raw material, and increasing the production rate. The use of simulation for design and research is generalised and recognised as a source of saving time and money.

- **Flexible and adaptive architecture :** The computer is designed in such a way that it is possible to buy additional circuit boards to support add-ons. Controller cards for communication (Ethernet, Fax-Modem), sound and video are examples of add-ons of this open architecture. Besides separate system elements like printer, plotter, projection devices can be added when it is needed. The system configuration can be autonomous desktops or a local area network (LAN). The system can work with just monitors. The software constitutes an important feature of the flexibility of the use of computers. Indeed it is possible to migrate at any moment to better operating system, and to extend the capability of the laboratory by acquisition of new simulation packages.
- **Software and curriculum independent:** All desired sophisticated programs, such as word processing, databases, spreadsheets, programming languages, and simulators can be handled by the base cards. Utilizing various libraries of tools, complicated work may be done in a pleasant manner. The diversity and the strength of the software combined with the power of multimedia systems, offer all useful display and control functions. Any display can be reproduced on paper by the hardcopy unit, or recorded on the storage unit.
- **Multifunction:** the laboratory can be used as:

- ✓ Computer laboratory to teach any topic related to computer science. This will serve students, faculty and staff with a wide variety of computing and printing facilities.
- ✓ Simulated laboratories in automation, electronics, engineering design,
- ✓ Computer based training: engine room simulator, stability, GMDSS, bridge simulation, loading and discharging
- ✓ Lecture and presentation room
- ✓ Video conference room
- ✓ Distance learning room
- ✓ Enhanced language laboratory thanks to multimedia capabilities. Working as a language laboratory, the lab should fulfil all the related requirements: training oral comprehension, pronunciation, reading, spontaneous expression, conversation, and doing structured exercises. It is important to notice the fact that students have to work at their own speed.
- Interactive: all kinds of communication and interaction between teacher and student workstations are desirable. Capability to share software, data, video, graphics from anyone to anyone, or in sub-group.
- Capture and storage of learning sessions: the system can record the lecture as well as student presentations and performances.
- Teacher faculty training program
- Distance learning:

7.3 Equipment list

7.3.1 Teacher workstation

Intel Pentium II Processor 400MHz

128 MB 100 MHz SDRAM, expandable to 768 MB

Intel 440 BX AGP set

512 Kbytes LB Cache
10 GB 8.5ms Ultra ATA Hard Drive
SuperDisk LS-120 MB Floppy Disk Drive
Toshiba DVD-ROM II Drive and STB DVD Decoder Card
128 Bit AGP 3D Graphics Accelerator 8 MB SGDRAM
3D PCI 64 wavetable stereo sound card
ATX full size Tower Case
Microphone and head set
Interface cards:

- Ethernet
- RS232
- PC-TV with telex and video capture

Keyboard
Mouse
Miniature video camera link to student stations
Monitor : 21" SVGA colour

7.3.2 Student workstation

Intel Pentium II Processor 400MHz
64 MB 100 MHz SDRAM
Intel 440 BX AGP set
512 Kbytes LB Cache
3.2 GB 8.5ms Ultra ATA Hard Drive
128 Bit AGP 3D Graphics Accelerator 8 MB SGDRAM
3D PCI 64 wavetable stereo sound card
ATX full size Tower Case
Microphone and head set
Interface cards:

- Ethernet

- RS232
- PC-TV with telex and video capture

Keyboard

Mouse

Miniature video camera link to student stations

Monitor : 17" SVGA colour

7.3.3 ComWEB equipment.

ComWEB is a modular hardware-based 'web' which provides a multimedia information delivery system. Its infrastructure for communication suits the educational needs. A VideoWEB controls the functions of all monitors, keyboards, mice, and sound. A real dialogue can be established between the teacher and the students, or a group of students, or between two students. The teacher can take over control of all the student system in order to focus their attention on a particular point or to direct a presentation. The capability to scan their monitors unobtrusively lets him provide individual help when it is needed.

If computers in the lab are not linked on network topology, the VideoWEB offers some functions of a conventional network like sharing software resources. Compatible with any existing network, it adds its functionality to the power of the network.

To create a multimedia VideoWEB, the following components should be added:

1. Control console

- 1 x MCC-300 main hub
- 1 x ComWEB type audio-visual / video distribution control panel to 20 stations
- Video, Sound, Speech intercommunication links to student workstations
- Programmable RS232 interface
- Video output device
- Projector port for direct connection to overhead projector

- On screen pointer and line drawing tool ('digital chalk')
- 1 video presentation stand (Sony VP100) linked to overhead SVGA projector via video distributor
- PA amplifier
- VCR player
- Desktop console

2. Audio-visual / video downlink units

- 20 x COMWEB MCC-190 type controller units
- COMWEB cable and connectors

7.3.4 Others

1. Printer:

1 off HP laser-jet printer

2. Overhead projector:

1 off SVGA fixed colour projector with good resolution

3. Video teaching and conferencing links:

1 off Electronic whiteboard

1 off remote control zoom Tele-Video camera for video conferencing

7.3.5 Laboratory outfit

- Electrical

The laboratory should be fitted with sufficient power point outlets (50) and wired in a way to secure all the equipments plugged in.

- Furniture

21 x chairs with height adjustment control

20 x computer desks

1 x console desk for the instructor

7.4 Budget estimates

Table 1 shows the distribution of costs according to the information delivered by COMWEB company and PCs Magazine at the date where this proposal is written. This approaches the real cost, however the exact amount will vary somewhat for each trimester. The operating system and software are not included in the provisions.

Instructor		Price \$ US
PC workstation with 21" monitor		3500
Comweb MCC300 Hub		3000
Comweb control panel (20 stations)		1000
Programmable RS232 interface		500
Pointer & line drawing tool		300
Sony VP 100 video presentation stand		4000
Video distributor output device		700
PA amplifier		300
VCR player		350
Digital voice messenger (Sanyo)		400
Microphone control headset		50
Room speaker (2)		150
Connecting links and accessories		500
Student workstations		
20 PCs with 17" colour monitor	20 * 1500	37500
20 headset microphones	20 * 50	1000
20 Comweb MCC-190	20 * 400	8000
Fiber-optic / UTP cabling and connectors		500
21 x miniature desktop video camera	21 * 50	1050
Laboratory		
1 x HR overhead mounted SVGA colour projector		7000
1 x HP laser-jet 5M printer		1250
1 x mounted zoom PCI video camera & fittings		500
Electronic whiteboard		9000
Total		80550

Table 1: Cost estimation of computer lab.

7.4 Project realisation

The essential improvement of all factors that have an impact on operational effectiveness of the computer laboratory realisation should have the decisive influence on the financial aspects. The most important of those factors are:

- Time reduction ,
- Incorporation of teaching staff for the development of the project,
- Creation of team which can maintain the laboratory,
- Optimum needs required.

Schedule of the project

A project schedule includes a list of the tasks or activities necessary for the realisation of the computer laboratory, and the length of time or duration each task will take. Table 2 and figure 20 are made with Microsoft Project software. Tasks, durations, and other information, such as dates and deadlines, are used to build a schedule of the project.

To create a workable schedule, tasks should be linked to reflect or model the way the project will really work. Any changes in the start, finish, and duration of a task affect other tasks to which that task is related.

It is most efficient to analyze the schedule and make changes early in the planning process, ideally before the project is in progress. However, after the project is under way, the schedule can be checked and adjusted when it necessary to meet the defined goals.

The arrows diagram (figure 27) shows the critical path using project management method of calculating the total duration of a project based on individual task durations and their interdependencies.

7.4.1 Project schedule

Activity Name		Duration	Precedence	ES	EF	LS	LF
1	Project Initiation	3	B	0	3	0	3
2	Review of existing laboratory system	2	A	3	5	3	5
3	Review of the curricula	2	A	3	5	3	5
4	Identify user requirements	2	B	3	5	3	5
5	Identify performance requirements	1	C	5	6	5	6
6	Prepare Software specifications	1	C	5	6	5	6
7	Equipment and configuration	3	C	6	9	6	9
8	Identify network system	1	C	9	10	9	10
9	Identify network topology	5	C	10	15	10	15
10	Identify type and number of computers	1	C	10	11	14	15
11	Identify type and number of printers	1	C	10	11	14	15
12	Identify type of plotter	3	C + D	10	13	12	15
13	Projection system	5	E	15	20	15	20
14	Soundings	5	E	15	20	15	20
15	Prepare Cost estimation	5	E	15	20	15	20
16	Laboratory Setup	10	D	20	30	20	30
17	Electrical installation required	10	D	20	30	20	30
18	Ventilation	5	D	20	25	30	35
19	Computer network wiring	5	D + C	20	25	30	35
20	Specific furniture	5	D	20	25	30	35
21	Installation	10	D	30	40	30	40
22	Install Equipment	5	D + C	30	35	30	35

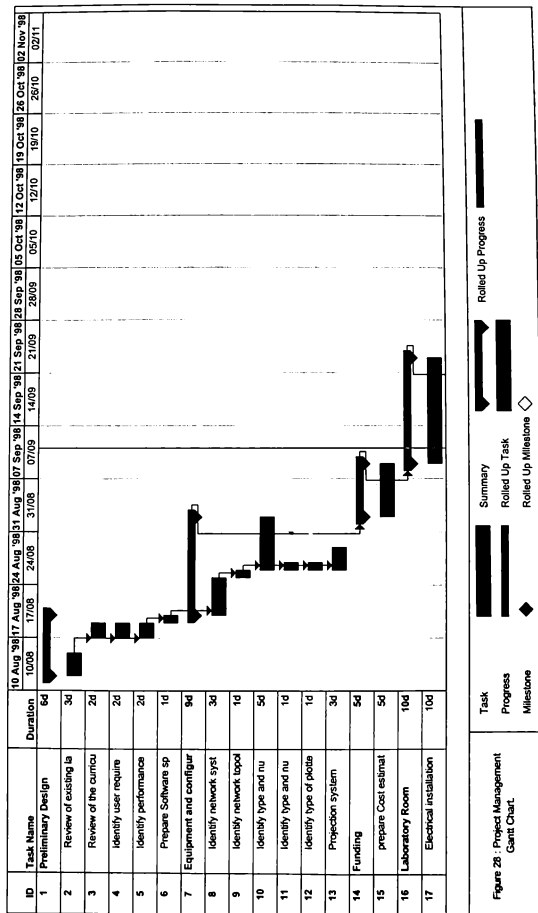
23	Identify System operators (Hardware)	2	C	30	32	33	35	3
24	Document operating instructions	3	C	30	33	32	35	2
25	Install Software system	5	C	35	40	35	40	0
26	System Test	10		40	50	40	50	0
27	Prepare expected results	2	C	40	42	40	42	0
28	Derive test cases	3	C	42	45	42	45	0
29	Conduct system tests	5	C	45	50	45	50	0
30	Training	10		50	60	50	60	0
31	Design operator training	5	C	50	55	50	55	0
32	Conduct operator training	3	C	55	58	55	58	0
33	Design staff training for each laboratory simulated	5	C + B	50	55	53	58	3
34	Conduct staff training for each laboratory simulated	3	C	58	61	58	61	0

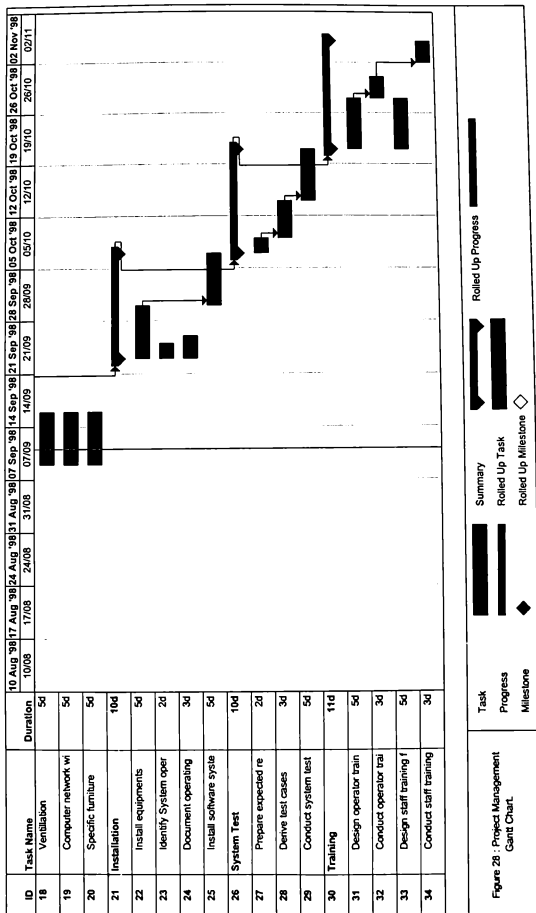
Table 2: Computer project frame table

Legende

- A : Pedagogical (Prof involved) team
- B : Laboratory (Prof and Technician involved) team
- C : Computer (Prof and Computer Engineer) team
- D : Maintenance responsables
- E : Computer engineer and financial responsables
- ES : Earlier Start LS : Last Start
- EF : Earlier Finish LF : Last Finish
- FLOAT : Gap allowed to begin the task

7.4.2 Time scaled logic diagram





7.4.3 Arrows diagram

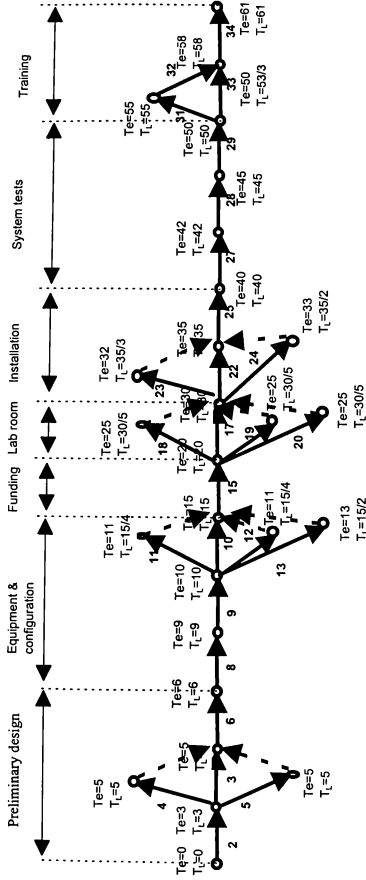


Figure 27 : Arrow diagram of computer lab project

Legend:

T_e : earlier end of the task T_L : last end of the task n : number of floating days
The bold numbers represent the identifiers of the tasks.

7.4.4 Laboratory design

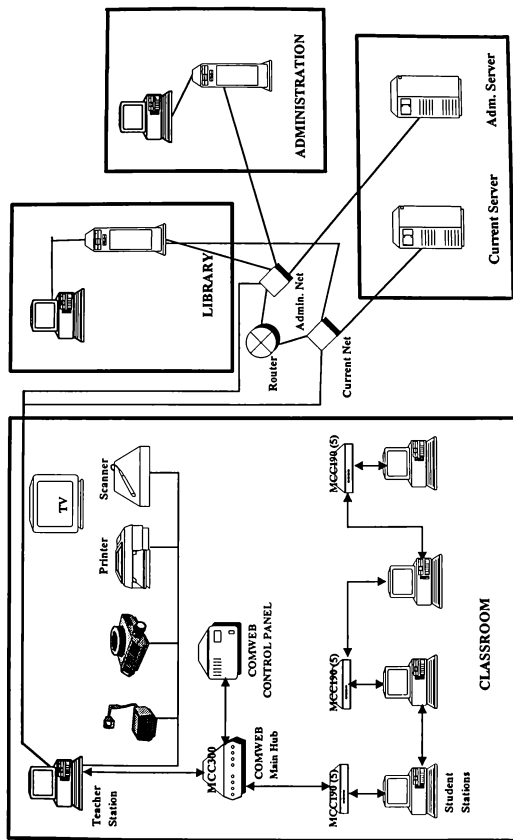


Figure 26: Computer laboratory system design

8 Conclusion and recommendations.

The technological advances have transformed all the economic sector, and introduced the problem of adaptation of education systems to this new environment. Social, economical, and cultural changes are occurring quickly and influencing daily life. The advent of satellites has launched a dynamic development of communication such as some people consider the planet as a global village. Since the first personal computers at the end of seventies, where they were seen as a family toys for entertainment, a big step has been achieved. The increasing development of microelectronics has reduced drastically the size and the price of computers.

Nowadays computers are involved in all human activities in such a way that the millenium bug has become an enormous concern, which may paralyse many economical sectors: banks, hospitals, transportation, industries, etc. Internet has changed the way to conceive the fundamentals in communication, education, business, and entertainment. Underway is a genuine mutation of human relationships. It is the beginning of the Information Age and the computer is its universal tool; the key to access what is called the information super highway.

In education, surfing the Internet opens valuable sources of documentation: text, video, and multimedia materials. The connection to universities, colleges, or conferences allows students and teaching staff to exchange ideas, and updates their knowledge. Integrated electronic capabilities included in some basic systems like electronic mail, telephone registration, information storage and retrieval are necessary for any educational institution. When the extension of such systems is done, it allows for computer conferencing, access to library holdings and services, management and communication between students and faculty. Such systems plug any institution into national and international networks and open new avenues for

marketing, distance learning, and information sharing. Distance education and virtual universities are emerging forms of education, which result from the new capabilities of technology and also the need to reduce costs.

All the aforesaid statements are reasons for any educational institution to budget for a computer laboratory. As was demonstrated in the previous chapters it may fit the functions of many laboratories, and therefore be a smart investment. With all its capabilities, it costs less than a top-quality language or automation laboratory.

During all the development of this work, the pedagogical value of the software simulation and its impact on the training has been the driving goal to achieve. The focus on the methodology approach of learning to use such programs has been to address with reference both the traditional concept of practice and the promises of the simulation. The underlining problem in the traditional system faced by some countries is in the lack of laboratories or the fact that they are obsolete. The practice when it is botched hinders the blossoming of careers and is designated as an important impediment that brings inefficiency to educational programmes. The whole process is incapacitated. So it is vital to review the curricula and restructuring of all the system with a clear focus on bringing good intentions to reality. Doting institution with computer laboratories allows integration of the new technology in education in order to respond to training requirements and to cope with the need of the industry. This evolution will bring about a new way of thinking and the efforts of teaching staff will be rewarded. The benefits cannot be measured in economic terms only but the improvement of overall educational effect will be apparent. The laboratory concept has been identified followed by the fact of taking into consideration their impact on skills acquisition. Other factors are also involved.

The philosophy is to replace the job experience by its simulation in a laboratory in order to compress the duration of training. The outcome is obviously the development of the skill behaviour required to perform adequately a given task. Marine simulators as training tools are empowered with great potential. They enable students to process a set of alternative experiments on critical conditions of running.

This unusual experimentations will allow them to investigate situations which are impossible to reproduce in real life with total safety. They can also be used for the assessment and the student has the opportunity to demonstrate his ability to perform the job as stipulated in STCW95 convention. Their benefits are the attainment of skills, knowledge and attitudes. The world of simulation is growing and extending its influence to many sectors of human activities. Even if an existing software program does not fit exactly the needs of maritime education curricula, things are evolving so quickly that big improvements are made each day.

The stand-point of simulation is the emphasis placed on process as opposed to content. In addition, the activities performed with such packages provide hands-on experience for the students which allow them to acquire an appreciation of the importance of experimentation in technical science. The chief priority is to build a process in which students pass by degrees to a more advanced or mature stage of comprehension, ability and skill.

The role of the teacher has been highlighted. Depending on his involvement the training may be very exciting and fruitful or boring and without any interest. Major issues related to the software development and its impact on training have been investigated. In order to extend the pedagogical capabilities of the software, and to tailor instructions to perceived student needs, artificial intelligence methods are being used. They combine the pedagogic expertise, a domain specific knowledge to a student model that forms the core element of the learning system.

A general review of multimedia systems and their relevance for the educational environment is presented followed by detailed discussion of multimedia devices. Some suggestions about multimedia standards are given. There is a list of maritime software with a brief description of their capabilities.

Even if educators welcome the realisation and the apparition on the market of any simulator, to recognise its benefits and put more trust on it is the big step of its validation. However, the use of some of them (ARPA, GMDSS) are already mandatory and there is encouragement for others.

The multipurpose computer laboratory is a potential solution to the complex problem faced by institutions in developing countries. The fuller use of this valuable asset will go a long way into the future strengthening the credibility of the educational mission. As expressed by Rowntree D. (1988) : "The more reasons you can find for doing what you have to do, the more energy you are likely to put into it - and the more you are likely to get out of it."

The human element in the shipping industry is designated as the main source of casualties. With just cause the international community has pushed IMO to set standards of training and to establish international regulation. The STCW95 convention plays a vital role in the contribution towards the safety and the success of operations.

The aim of the conventions is to foster a concern for education among institutions by actively involving them in the international dynamic process of the maritime industry and its impact on the environment and safety.

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