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A study of the role of CBT [computer based training] and [the] use of CBT in enhancing marine engineering education and training standards

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WORLD MARITIME UNIVERSITY
Malmö, Sweden

A Study of the role of CBT and Use of CBT to Enhancing Marine Engine

By

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

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in

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ABSTRACT

Title of Dissertation: **A Study of the role of CBT and Use of CBT to Enhancing Marine Engineering Education and Training Standards**

Degree: **MSc.**

The dissertation is the study of role of CBT in enhancing marine engineering education and training (MEET). The technological advances, which have occurred in recent years, have encouraged maritime institutions to search for more advanced and efficient teaching methods. Marine engineering courses are focus on the training in practical problem solving and hands - on ability. Several strategies are used in marine engineering education and training. All of these methods have to be supported by large and systematic facilities. The main problem faced marine engineering training is how to meet the increasing requirements of engineers with the difficult financial budget. A systematic training system including CBT seems to be an adoptive solution. CBT has used as simulator, tutor, skill practice and assessment in marine engineering training. There is also a tendency to replace some engineering experimental exercises by computer based simulators, in order to provide more chances for students improving understanding of some concepts. As a tutorial learning and individual assessment tool, CBT is considered to be one of the best methods for on board training. The internet provides more opportunities for student to play a more active role in the acquisition of knowledge. More and more CBT software has been developed in marine engineering field. It is important for instructors and trainers to learn the features of CBT in education and training. However, the role of CBT in MEET is related to the characteristics of marine engineering education and training. The facts of CBT application is far from the expectation in the early days. There are some advantages and limitations of utilisation of CBT in marine engineering training. The author try to explain that both attitudes of ignoring the effectiveness of CBT and exaggerating its function in engineering training are not scientific way. We should realise that no single technology is best for all engineering training situation. CBT is only the most potential training technology and still need to develop in current time.

KEYWORDS: CBT, Marine Engineering Education and Training

TABLE OF CONTENTS

List of tables

List of Figures

List of abbreviations

CAI : Computer Assisted Instruction
CAL : Computer Assisted Learning
CBA : Computer Based Assessment
CBE : Computer Based Education
CBI : Computer Based Instruction
CBS : Computer Based Simulation
CBT : Computer Based Training
CD - ROM : Compact Disk Read Only Memory
IT : Information Technology
IV : Interactive Video
MEET : Marine Engineering Education and Training
MET : Maritime Education and Training
OBT : On Board Training
PBL : Problem Based Learning
SCL : Student Centered Learning
STCW 95 : Revised Standards of Training, Certification and Watchkeeping Convention
TCL : Teacher Centered Learning
WBL : Web Based Learning
LSU :
USMA :
SIPWA :
MATLAB :

CHAPTER ONE Introduction

The main aim of this dissertation is to show that CBT has a great potential in marine engineering education and training, but no single technology is best for all engineering training situations. Hence, trainers must be aware of the various alternatives and be able to apply each when appropriate.

The development of technology has dramatically improved productivity in shipping industry. We have seen many advanced equipment and technology continually equipped on vessels. However, the field of Maritime Education and Training (MET) has been slow to adopt technology to improve productivity. Only in the past three decades has a sustained effort been made to apply technology to full range of teaching and learning activities. “The impact of working and living in an information processing age has many social, economic and political aspects impinging upon traditional way of conducting education and training or of operating ship. This factors also need to be taken into account in planing for the future use of computer technology in maritime community.” (P.Muirhead, 1998)

Engineering is at the heart of transforming scientific advancements into technological realities. As in any endeavour of this sort, education and training are the key in developing the human capability to carry out the effort continually and to utilise the outcomes fruitfully. Any shipping company neglects the enhancement of knowledge and skills of its technical workforce risks wasting its resources and seeing its progress diminish and eventually deteriorate.

The technological advances, which have occurred in recent years, have encouraged marine engineering institutions to search for more advanced and efficient teaching methods. More undergraduate curricula now include the use of computers in teaching programs. The availability of computer hardware as stimulated educators to consider alternative methods of information dissemination and more advanced approaches and technical to teaching students.

Marine engineering course is focus on the training in practical problem - solving and hands - on ability. This training is a process of behaviour modelling learning. Several strategies used in marine engineering education and training are discussed in the Chapter 4. Among them, practical enhanced training, problem solving learning and student centred learning are mostly considered. However, all of these methods have to be supported by large and systematic practical facilities including laboratory, training boat and large scale simulator. These expensive hardware show that marine engineering education and training is a high cost process. Individual learning is another fact in marine engineering education and training. Various of advanced machinery and equipment appear on board and push marine engineers continually update their knowledge and skills.

The features of several training technologies are discussed in the paper, which are used in engineering training. Some of them are identified to be the effective training technical. The main problem faced marine engineering training is how to meet the increasing requirements with the difficult financial budget. A systematic training system including CBT seems to be a adoptive solution.

Trainers and ship owners have searched for more ways in technology based training in order to enhance the efficiency and productivity. Computer based training is one kind of advanced training technical and has used as simulator, tutorial, skill practice and assessment in marine engineering. CBT did not apply to marine engineering

training widely until computers and computer - based - control system are available on board. Because CBT can possess the same interface with that of real marine software system. Especially, some equipment manufacturers produce their CBT software, which come from the real equipment control system. Many CBTs have been used in practical training to replace some contents of laboratory. As tutorial learning and individual assessment, CBT considerate to be the best method for on board training. This is dealt with in detail later.

In the recent years in marine engineering laboratory, there have existed the tendency to replace some experimental exercises by their computer based simulations, especially in the electrical and automation equipment laboratory. These replacement just be partly, and laboratory simulation can only be utilised as exercise and practical aids, and improve student's understanding of some concepts. Main and key period of practical training still should occur in laboratory or on board. The relation between laboratory training and CBT is discussed in Chapter four.

With increasing access for students to the WWW course materials maybe made available via the internet. This technology provides opportunities for student to play a more active role in the acquisition of knowledge, and also enhance the function of CBT. The potential of the on - line experiment has open another window for CBT, and student will be able to do a real engineering experiment on computer through internet, not on simulator.

The utilisation of CBT on board enable seafarers to comply with general and specific competence requirements. Various of CBT software are available including thermodynamic, marine boiler and diesel engine operations. The courseware provides both a performance profile and an ability profile of user. The intention is to focus on practical solutions and a number of demonstrator projects. Many equipment manufacturers have also delivered CBT training system for their products.

The advanced research and utilization of CBT on board has done by Norwagian shipping industry. There are three work packages namely training system improvements, vessel special training systems, and assessment tools. "The work has been a collaborative effort with several Norwegian ship companies. Key elements of the new system are CBT modules placed on board and in shore office, crewing agencies and support training centres." (P. Muirhead, 1998). CBT is considerated to be the best way of assessment on board. Individual seafarer can be assessed by a CBT program collaborated with distance education technology. Satellite technology can provide answers to many of problems in CBT on board by taking different approach. Links can be established to institutions for access to material by student at sea. CD - ROM and interactive video have provide wider possibility to CBT on board.

It is important that instructor and trainer learn the features of CBT in marine engineering. There are some advantages and limitations of utilisation of CBT in marine engineering. Although CBT has great effective on engineering training, CBT can not replace the training of hands - on and workshop, and can only employed as a extraordinary supporting technical in engineering training. The role and function of CBT is discussed in the chapter four.

CHAPTER TWO CBT and Its Development

2.1 The development of CBT

It has been about forty years since educators and computer scientists began using computers for instructional purposes. In that early time, computers used for education and training existed only at large universities and was largely restricted to reading and typing text. Within the invention of microcomputer near the end of 1970's, we have seen the rapid spread of computing in business, schools, and homes. Microcomputers have evolved from machines dependent on typing and text printout, to machines that allow interactive via text, graphics, voice, and pointing. The most recent developments in microcomputer technology provide even greater power and ease of use through advanced multimedia devices. They also permit networking of many microcomputers to share information and resources.

The early days of instructional computing saw much excitement for its potential and many prophecies of great educational improvement through computer based instruction. However, while there have been great strides in technology and availability, actual improvement of instruction is less dramatic. The current state of instructional computing is a confusing mixture of many types of computers. This and the accompanying problems in software and hardware incompatibility, is a major factor hindering the success of computer based instruction for improving education. Other factors hindering its success are a shortage of people skilled in developing

quality courseware, and disagreement with in the field on how computers should be used in education.

Educational computing began with a few, large, government-founded project on main frame, and mini-computers. Up to the late 1960s, more than a thousand programmes for computer-based learning were developed in the United States. In Europe the programmed learning at the contemporary level commenced in the mid-1960s. A great amount of investigation was carried out to formalise, a description of the learning process and to define information characteristics of trainees mental activities. Beginning in 1972 the mitre coration's TICCIT project introduced computer- based instinct on mini computer design theory.

In 1978, the first widely available micro computers were released. Apple II micro computer succeeded in becoming the most common micro computer for use in universities and schools. The most early coursware was designed for the Apple II.

The release of the IBM personal computer in 1981 resulted in a sudden expansion of the micro computer market into business and industry. The IBM-PC has become the more popular micro computer for higher education.

The 1984 release of Apple's Macintosh computer instigated many changes in the field of micro computing, and this computer provided far better integration of text and graphics, better voice and music capacity, and permitted not only typing for user input, but the mouse for pointing at and drawing on the screen.

In 1989, the Next computer was released. It combines the graphical user interface with higher speed, storage, networking potential multi-tasking, and flexibility. The quality of computer-based instruction is going to a new step.

With the development of technology, multimedia technology has applied to the computer , with greater speed and storage. The high expression ability of multimedia has led CBT into one of the most favourite education and training method. The release of multimedia authoring software, makes the CBT more popular and easy to develop. More and more professional people on varies field comment to joining the design develop and evaluate the CBT courseware. A great amount of CBT courseware were produced and this learning approach is widely used in universities, schools on job training and individual study.

Instructional and educational computer programs have many names. Some of them are: CAI, CBE, CAL, IAC, CBI, CBT. This paper uses the term computer - based - training (CBT) because this paper's emphasis is on training rather than instruction.

2.2 Definition of CBT

Computer-Based Training (CBT) refers to the use of the computer as a tool to facilitate and improve training and instruction. A CBT is also a software programme, which is developed for individual training of personnel on personal computers (PC) and group training in the classroom. CBT programs use tutorials, drill and practice, simulation, and problem solving approaches to present topics, and they test the student's understanding. These programs let students progress at their own pace, assisting them in leaning the material. So CBT is also suitable to seafarers' on - board training and on - shore training. It is made available to employees on the company's in-house network system. Most of the CBTs include written information, photos, multimedia, video and animation. The subject matter taught through CBT can range from basic math facts to more complex concepts in science, engineering studies, and practical skills. Computer Based Training enables education and training of personnel within a given topic by means of data - technology.

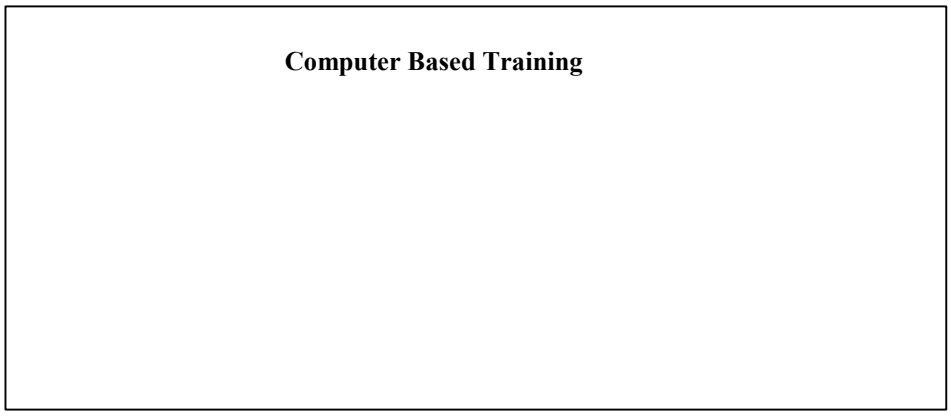

Figure 1 CBT and its branches

There are different types of CBT programs: tutorial, simulation, drill and practice, and problem solving.

A tutorial's job is to tutor by interactive means, in the other words, by having a dialogue with the student. The tutorial presents information, asks questions, and makes decisions based on the student's responses. Like a good teacher, the computer decides whether to move on to new material, review past information, or provide remedy. The computer tutorial is very efficient, because it gives the student who needs it individual attention. In addition the student can progress at his or her own pace. Furthermore, a good tutorial is interesting, easy to follow, and enhances learning with sound and graphics.

In simulation programs, students take risks as if they were confronted with real-life situations without having to suffer the consequences of failure. Students can experiment with dangerous chemicals on the computer screen, for example, and not be in danger from the actual chemicals. Students can repeat experiments easily as often as they wish. In machinery simulators, there is no expensive machinery that is

easy to damage by wrong operation and students do not have to wait a long period time for the effects of experimental conditions before they can observe the results. Simulations save time and money, reduce risks, and work well in decision - making simulations. Many educators feel that a well - designed simulation software affords students the opportunity to apply classroom knowledge in more realistic situations than can other wise be set up in a classroom, which enhances students' learning.

The drill and practice programs differs from tutorial software in a key way: It helps students remember and utilise skills they have previously been taught, whereas a tutorial teaches new material. Students must be familiar with certain concepts prior to working drill and practice programs in order to understand the contents. The typical drill and practice program design like this: The computer screen display a problem, the student responded, and the computer provided immediate feedback. The learner stayed with the problems until reaching a certain level of proficiency and then moved on to a more difficult level. This software frees the students and the teachers to do more creative work in the classroom. Many of these programs serve as diagnostic tools, giving the supervisor relevant data on how well the students are doing and on what work they need. They also provide immediate feedback for students, allowing them to progress at their own speed and motivating them to continue.

Problem solving skills are necessary in a complex engineering world, and a good way to develop these skills is to practice solving problems. The critical thinking needed for problem solving can be practised in any content area. Problem solving programs emphases co-operation and are suitable for small groups or individual students. Teachers like this type of software because it helps students with hypothesis testing and taking notes. Similar to simulation, problem solving programs easily can be used with only one computer and as many as thirty students. The whole class can be involved in critical thinking and making inferences. This type of software gives students more freedom to explore than drill and practice software.

2.3 The Benefits of Using a CBT

User friendliness

The term "Computer Based Training" may sound frightening to many people who believe that such training only addresses personnel well experienced with personal computers. The fact is, however, we have seen quite the opposite. A well designed, user-friendly CBT requires limited PC- knowledge and the threshold value for being able to use it is lower than most people expect. Thus, the CBT technology has been found attractive, not only by "data freaks", but most certainly by the more practical categories of personnel as well.

Training may take place when it suits the trainee

Experience shows that to arrange a training course for a number of people is a very difficult puzzle to solve, especially for on job training. The reason of course being that the daily works takes up most of the available time. The basic idea behind a CBT is to make the training flexible and available at all times. One way of solving this problem might therefore be to distribute a CBT to all personnel. The personnel may be granted a timeframe for completing the training programme. Also, it is possible to check that the learning objectives are understood by including an assessment test as a part of the CBT.

Interactive

Nothing is more boring than reading page upon page of text from a computer screen. The training can be made much more interesting by including advanced data technology: it is a fundamental property of a CBT to be interactive, meaning that the trainee must carry out a lot of actions and exercises on his way through the

programme. The trainee will be forced to perform a lot of tasks such as; Moving objects from one position to another, answering questions and selecting and starting videos. In this way the training is made more interesting for the trainee. Also, an instant feedback on the exercises included in the various sections can be given.

Focus on needs

A CBT can be structured to focus on the needs, requirements and topics that the company find most important for the crew to learn about. By implementing a training programme it is possible to bring all trainees up to a certain level of competence within the defined area of the subjects. However, a CBT can easily be structured to be concise and of course give exactly the same information to everybody. Thus, everybody going through it receive exactly the same kind of information, presented in exactly the same way and without leaving out any vital information. For training responsible persons this can be quite a challenge, if they have to give several courses for different crews.

Access

Once the CBT has been developed, it is always there. It is not necessary to wait for a training course to be arranged or for the superior to have sufficient time available to go through the training. The only thing needed is the computer.

Distribution

Normally, a CBT is copied on to a CD - ROM. This makes it easy to distribute either by mail or to bring the CBT along when giving presentations outside ones own premises. It is also possible to save the CBT onto the institution's or company's in-house net-work. Everybody connected to the network may be given access to the CBT.

2.4 The limitations of using CBT

Most education and training programmes have their strong points, but also some weak points. This is also the case for a CBT. The limitations of CBT are focus on facilities available and the disagreement from the instructors and trainers. There are mainly following factors influencing the utilisation of CBT.

- The utilisation of CBT depends upon the computer. The price, position and quality of computer will influence the utilisation of CBT. CBT can only occur where the qualified computer is available. The cost of computer is still a problem for some trainees. Some computers equipped on ship are not qualified enough to carry out the CBT. This problem will be decreased by the development of computer technology and popularity.
- The result of CBT utilisation depends upon the design of CBT software. The trainee receive the knowledge and skills himself when he carries out a CBT individually. The computer will replace of the tutor and assessor, and provide all course materials. So the methods of explanation, demonstration and question asking will decide the deep and category of learning. Usually, the CBT courseware are developed by machinery manufacturers, computer programmers, some instructors or some engineers. Some critics question the value of CBT, claiming the it is all form and little substance. It is excellent at the style of demonstration in video, animation and audio, but poor at the content of course knowledge. Because of the lack of the depths in engineering training design.
- The CBT will overburdened instructor's responsibility and works. It is difficult for instructor to find the time to master multimedia CBT and devise CBT presentation. It is not very clear for implications of random learning, possible when students determine their own programs. The

organisation of CBT becomes more difficult when CBT in class. The instructors has to manage switch the attention of students between computer and himself. Sometimes these processes of changing attention make both instructor and students busy and tired. When CBT individual, the instructors also have difficulties to organise the learning program of different individuals.

- CBT has a trend to weak some traditional academic skills, which is still very useful in current time. The demonstration of principle and structure of machinery by CBT make easy understand to students. However, it has decreased the ability of imagination in mechanical space and structure. For example, the Drawing and Drawing Read are the basic skills of an engineer. They need improve these skills by practice the drawing read and by establish the feeling of space imagination. Too much CBT in engineering will "give" trainee too many "easier work" in machinery structure reading. So the future engineers could be lack of the ability of reading drawings, which is the most common skill occurring in their job.
- CBT can not replace of the hands-on training in MEET. CBT in hands-on field is only limited in the training of operation procedures and analysis of troubles. The most hands-on training always accepted in workshops or in engine rooms. These training must be carried out by "hands" and "brain" of the trainees. Obviously CBT can not do all these training. So called "hands on" CBT is only the part of hands-on work training. However, this CBT process can be very helpful to real hands-on training programs.

2.5 CBT and Multimedia Technology

Multimedia

Multimedia is a topic of high interest even in the academic world. It concerns a collection of media like written texts, photos, tables, diagrams, sound, music, television, video, etc. Multimedia is a technology and not a product. The generally accepted definition is stated as: "multimedia is every combination of text, pictures, sound, animation and video."

Multimedia also refers to communication from more than one media source that uses text, audio, graphics, animated graphics, and full-motion video. For years, teachers have made presentations using different kinds of media. Traditionally, they have used slides, movies, cassette players, and overhead projectors to enrich lessons. Now, however, teachers may employ a personal computer and hard disk storage to combine these different media sources in their teaching. A computer-based method of presenting information, multimedia emphasises interactivity. Computers offer input and output devices such as laser discs, CD-ROM, and stereo sound. For most teachers, however the expensive input and output devices are not available, so in practice multimedia refers to a computer with a sound board, video board and a CD-ROM drive.

Multimedia Authoring System

A multimedia authoring system supplies a frame to a project. To this frame the different elements like audio, video, text, images or animation are linked. The authoring system supplies communication links and working together of the media in different applications. The possibility to program the interactions between computer and user is also offered. Authoring systems deliver the environment to connect the

contents and function of project. They usually contain the program parts with specific ability to manipulate the different media.

Every medium has to be framed in order to be consistent with the other media. A good authoring system should have as many editing tools as possible to handle each used medium. This prevents the user from buying extra specialised software and omits communication problems from authoring system to the extra specialised software when integrating the software.

An authoring system makes it possible to keep an overview of the program structure while programming contributes to simple subtasks. There are two different ways of programming a visual programming with keywords and icons, using a program language specific of the authoring system mentioned at the one hand, or classical programming at the other hand. The first method is the most direct one . With this method, it is possible to stress the contents rather than the way of programming.

Almost all recent courseware programs are multimedia, and there is a definite trend toward surrealistic adventures. As evidenced by the software catalogues, developers are rapidly producing software that incorporates multimedia into all areas of the curriculum. These current software can be divided into many different categories, including tutorial, simulaiton and assessment.

Hypermedia

Hypermedia is a closely related word to multimedia in professional. Hypermedia uses the computer to input manipulate and output graphics, sound, text, and video in the presentation of ideas and information. When a teacher uses hypermedia, the computer directs the action of devices such as a videocamera, video disc player, CD -

Figure 2 Hypermedia workstation

ROM player, tape recorder, VCR tape deck, scanner, video digitizer, audio digitizer, or musical keyboard. Figure 2 shows an example of a hypermedia workstation.

2.6 Cognitive Psychology and Computer Based Training

The major methodologies and the designs of CBT are primarily guided by several issues in cognitive psychology. The areas of cognitive theory we believe are most important to CBT design are those relating to perception and attention, memory, comprehension, active learning, motivation, locus of control, transfer of learning , and individual differences.

1. Perception and Attention

All human learning is dependent on presentations designed for easy and accurate perception. Perception may be facilitated by many presentation design factors: detail and realism, the use of sound versus visual, color, characteristics of text such as its size and font, animation, and position of screen elements are but a few.

For perception of proper lesson elements to occur, the attention of the students must not only be initially attracted but maintained throughout the lesson. In addition to the factors just mentioned, attention is affected by many additional considerations including level of student involvement, personal interests and prior knowledge of the student, lesson difficult, novelty and familiarity, pacing, and variety.

2. Memory

Much of what we perceive we must store and be able to retrieve later. While the information storage and retrieval capacity of human intelligence is immense, assuring that the important things are not only perceived but properly stored is not trivial. Especially when faced with new and large bodies of information.

Two principles underline almost all methods of enhancing memory -- the principle of organisation and the principle of repetition. (Fleming & Levie, 1978) . In general, organisation is easier and more powerful. Showing the trainee the organisation of new information or imposing organisation upon it aids recall. When the use of

organisation is inappropriate or impossible, the use of repetition is often used. This is the case when there is a large amount of information, when the information has no inherent organisation, or for psychomotor skills.

3. Comprehension

What we perceive must be interpreted and integrated into our current knowledge of the world (R.Anderson, 1977). We must not only store and retrieve information but be able to classify it, apply it, evaluate it , manipulate it, and so on. Principles of concept acquisition and rule application, for example, guide much CBT design.

4. Active Learning

We not only learn by observing but by doing. Interaction not only mainteains attention but creates and stores new knowledge and skill. One of the essential features of CBT in contrast to some other media is its capacity to require and act upon student interactions. Although everyone stresses this important aspect of CBT, it is the characteristic on which much commercial courseware falls short. Designing interactions which are frequent, relevant, and increase learning is harder than even experienced developers believe.

5. Motivation

Proper motivation is essential to learning. Several theories of motivation suggest CBT techniques that will enhance motivation. Some unique aspects of CBT, which permit methodologies like simulation and problem solving, are very valuable for motivation enhancement. Motivation theories particularly relevant to CBT are those of Lepper, and Keller. Lepper maintains that motivations should be used which are intrinsic to the instruction rather than externally applied. Malone hypothesises that four elements which foster motivation are challenge, curiosity, control, and fantasy. Keller also suggests four factors are essential to motivation: maintenance of attention, relevance of the material, student confidence, and student satisfaction.

Additionally, they point out that techniques for maintaining motivation should be considered at both the macro and micro level. The macro level refers to the instructional strategy level, such as their suggestion to use gaming techniques. The micro level refers to specific elements of a lesson, such as the use of graphics and animation. Lastly, they emphasise that motivation techniques must be individualised, because different students find different things interesting.

Another set of suggestions for increasing student motivation comes from the work of Keller (Keller & Suzuki, 1988). Keller's general point of view is that the instructional designer must be proficient at motivation design as well as that the instructional strategy and content design. Keller indicates four design considerations relevant to creating motivating instruction: Attention, Relevance, Confidence, and Satisfaction, hence the ARCS model.

Intrinsic versus Extrinsic Motivation

Lepper has argued that motivations may be either intrinsic or extrinsic. Extrinsic motivations are those which are independent of the instruction, such as paying or otherwise rewarding the student with things they consider desirable. Lepper's research has provided evidence that when extrinsic motivations are used, student interest in learning is diminished because the student's goal becomes the reward rather than learning.

Intrinsic motivations, in contrast, are things inherent in the instruction that motivate the student. Put in common terms, instruction is intrinsically motivating if students consider it to be "fun". Lepper and his associates make several suggestions which they claim will generally enhance intrinsic motivation:

- Use game techniques.
- Embellishments should increase student intensity of work and attention and should encourage deeper cognitive processing.

- Use exploratory environments.
- Give the student personal control.
- Challenge the student.
- Arouse the student's curiosity.
- Give encouragement, even when errors are made.

6. Transfer of Learning

Learning in a CBT lessons is usually just a precursor applying or using that knowledge in the real world. Transfer refers to the extent to which improved performance in the lesson is reflected in the real world as well. Transfer is affected by type, amount, and variety of interaction, by realism of the instruction, and by the methodologies used. In training situations, transfer is ultimately the most important instructional outcome.

7. Individual Differences

Students do not all learn alike or at the same rate. Some instructional methods are better for some students. Another often praised advantage of CBT is its capability to individualise. But just like interactivity, this supposed advantage is not often taken advantage of. Most commercial software works about the same for all students. Good software will adapt to the learner, capitalising upon his or her talents, giving extra help where the student is weak, and providing motivations each student responds to. Because not every lesson will work for every student, matching students up with appropriate lessons and methodologies is important. That in turn depends on continual assessment of individual differences so that proper matching and other decision making can take place.

2.7 CBT and the requirement of STCW 95

STCW 95 has not give detail requirements in Computer Based Training. However, STCW 95 has made a minimum requirement for Maritime Education and Training. At same time, the increasing electronic technology and equipment requires the personnel on board possessing more knowledge and skills in ship's safe operation and maintenance. These factors have pressed the companies and institutes to enhance the training in the seafarers in a shorter period of time. Training is the systematic development of the skill behaviour pattern required by an individual in order to perform adequately a given task or job (Stammers, 1975). So the high efficient education and training technology is necessary in current Maritime Education and Training (MET). No doubt Computer Based Training (CBT) is one of the highest efficient training technologies and will play a more important role in Maritime Education and Training. Furthermore, the utilisation of CBT possesses some advantages in Marine Engineering Training, because CBT itself is one kind of Computer based equipment that is required in STCW 95.

STCW 95 now places greater emphasis through Part A of the Code on assessing the ability to perform tasks or functions for competency purposes. CBT can also provide a advanced platform for the assessing competency (P.Muirhead, 1998).

STCW 95 states that a simulator must be capable of simulating the operating capabilities of shipboard equipment concerned, to a level of physical realism appropriate to training objective, and include the capabilities, limitations and possible errors of such equipment. As a main type of CBT, simulators are widely used in marine engineering training. Manufacturers of marine training simulators are looking to provide trainee with more realistic training environment. There is a trend that computer based "on screen" simulators increase their application because their flexibility and cost effectiveness.

CHAPTER THREE The Technology and Marine Engineering Education and Training

3.1 The requirements of a marine engineer

To work on board as a marine engineer, he/she needs multi-discipline knowledge, both technical and non-technical. The duty of a marine engineer is to operate, maintain and repair the marine machinery in a safety, economical and environment friendly way (Nakazawa, 1998). The industry is full of specialists in each of their particular field - process, structural, instrumentation / mechanical, naval architecture and marine engineering, but they all have to be adaptable to, and aware of, each others disciplines. Addition all there are the non-technical demands such as legal, financial, contractual and commercial. It is believed that the ideal engineer should be adaptable, flexible and capable of working in any environment. He should fully understands the basic disciplines of engineering.

A marine engineer needs the present basics in applied mechanics, applied mechanics, applied heat, mathematics, engineering drawing, naval architecture and electro-technology as well as engineering knowledge for those aspiring to senior ranks. But they also require training in management, quality management, budget preparation and control, and much better standards than presently exist in control engineering, electronics, instrumentation, diagnostics and condition monitoring as well as computer literacy.

We also believe there should be a place for the good, practical engineer who is competent in the more junior positions on board. The need for ongoing training and qualification in some of these new skills and knowledge is addressed in a partner ship between training establishments and individual shipping companies, so that training will be tailored to suit particular needs in addition to statutory requirement.

3.2 The Strategies for Designing Engineering Courses

In order to meet the requirement to marine engineers, some strategies for designing MEET courses are adopted. They are enhancing the practical skill training, Learning outside classroom, student centered learning and problem solving learning. It is easy to find that these strategies have closed relation with the CBT methedology, that mentioned in last Chapter, and they should guide the design and utilisation of CBT in MEET.

3.2.1 Enhancing the practical skill training

After the initial presentation and guidance has already occurred, practices are applicable to all types of learning. Skill need a lot of practice. Skill is the capacity for carry out complex, well-organised patterns of behaviour smoothly and adaptively, so as to achieve a goal or out come. This covers verbal and social skills as well as physical tasks, when people become more skilled. They will consider having three wilder attributes: effectiveness, flexibility, and anticipation. Skill has to be acquired by practice in perceptual or mental exercises. Sometimes, practice exercises is the process of transfer theory to practices.

The marine engineering is a very practical and tough major which includes widely theoretical engineering knowledge and miscellaneous maintenance technical. The practical skills of a marine engineer include not only the ability of hands-on operation

and maintenance but also the technical of trouble shooting and diagnosing of the machinery. So the quality of marine engineering education and training is largely depend upon the outcomes of students' practical skill training. However, marine engineering practical skill training is a high - cost process. This process need three main conditions: a corresponding curriculum, qualified faculty and facilities.

There are corresponding problems of implement practical skill training. In order to enhance the practical skill training, three processes have to carry out. Firstly, to increasing class time for these training in curriculum. Usually the total time for education and training is limited, the increasing of practical training hours means the decreasing of theoretical class hours. It is not a easy program in the case of the education is strengthen by administration of institute, academic, committee. Secondly, practical skill training faculty is required to posses not only the teaching experience but also the practical ability. They are capable of dealing and explaining the possible problems in the operation and maintenance of machinery. At least, they have the certificate of competence of seafarer. However, qualified practical skill training instructors is still the weak point of most maritime institute. Finally, MEET needs many expensive equipment and installations, they usually include engine room multifunction laboratory, engine room simulator, automation lab., and training ship. Because of the economical limitation aspects, most institutes have to face the financial problem. The questions are how to allocate the limited resources and use it more efficiently and effectively.

3.2.2 Learning Outside the Classroom

Some principles that have guided the development of engineering course in the past are identified and applied to the development of strategies for contemporary circumstances. Implications of current changes in constraints are explored for class meetings and for student work outside class.

The realisation that two-thirds of a typical institutes academic course, and most of the learning, occurs outside the class meeting times compels careful focus by faculty on the design of interactive learning experiences to help students learn proficiently outside the classroom. Designing courses of study in which the learning activities outside, as well as inside , the class room form a coherent and effective whole can improve courses dramatically.

Teachers expect college students to accept the responsibility for learning most of what they need to learn outside normal class meeting times. This approach requires college students to spend less time in class. In college, the teacher spends much of the class time explaining to students what they should learn. Then the students leave class and learn the material, usually with the help of other students and perhaps with the help of the teacher or an assistant, study groups and , perhaps, interactive computer tools (CBT). This approach leads to the often - stated rule of thumb that college students should spend approximately 2 hours outside class studying and learning the course material for each hour spent in class. This time outside class should be a prime target for collaborative learning and interactive learning environment, which focus on the learner.

What is the purpose to ask the students to meet together at classroom? The fundamental purpose of the class meeting is to prepare students to learn efficiently after they leave the class meeting. From this viewpoint, nothing is fundamentally wrong with the often - criticised lecture method. Until recent times, the lecture method arguably has been one of the most time - efficient means available to teachers for communicating to students, within limited time, what they are to learn. Much of the criticism directed toward the lecture method apparently stems from belief that the primary purpose of class meetings is to provide a time for students to learn rather than a time to prepare them tolerant outside the classroom. From another perspective,

much of the criticism of the lecture method seems based on confusion between the supervised learning strategy practised by teachers in high school with the strategy, used by teachers in college, of helping students to become unsupervised learners.

student responsibilities in a course of study, simpler to describe than to accomplish, are three - fold:

- find out what is to be learned during the course of study,
- assume responsibility for doing whatever is necessary to learn it , and
- learn it

Teacher responsibilities are more complicated to describe and perhaps, to accomplish. The main obvious responsibility of the teacher is to introduce students what is to be learned; to evaluate the achievements of students; to explain and discuss the material to the students; to answer questions. The most important single responsibility of the teacher is to plan, actually to design, the course of instruction for the class. Although the most obvious part of this responsibility is planning the class meetings, the most critical, most demanding , and most often neglected part is designing that portion of the course of instruction that involves the students when they are not in class meetings, but learning on their own. Unfortunately, most experienced teachers have the distressing impression that the time students spend outside class is singularly unproductive. Thus, a key responsibility of the teacher is to design learning activities that help students make the best use of their efforts outside the classroom instead of wasting precious time. Indeed, the design of that part of a course that occurs outside the classroom is potentially the most productive single opportunity that is available to contemporary teachers for improving learning by students.

The recent widespread availability to teachers and students of inexpensive and easy to use software and of desktop and laptop computers permits placing material to be learned in files on disks or on networks (especially the WWW) and, thereby,

distributing more detailed, accurate and timely information than could possibly be accomplished through the traditional chalk/blackboard use of the lecture method. The traditional lecture method's days as the predominant teaching mode, therefore, are threatened not so much by its lack of interactively in comparison with collaborative learning and other student- centred approaches to learning, but by its recent relative inefficiency and inconvenience in presenting the material to be learned in comparison with techniques that exploit information technologies. Nowadays, it is exceedingly difficult to justify the use of class time for the teacher to transcribe notes onto the board as the students transcribe them into their notes.

It is important to note that a judicious combination of the lecture method and the distribution of information electronically can permit the teacher to devote much more time during the class meeting to motivating students, discussing key issues and answering questions than does the traditional lecture method alone. The class meeting time saved also can permit the teacher to introduce some student-centred learning approaches during the class meeting time. The objective in doing so, however, is not to make it unnecessary for students to use these approaches outside the class meeting time, but to improve the efficiency with which students use them outside the classroom.

What students need to improve their efficiency in learning outside the classroom are highly interactive learning environments in which they receive feedback about their work immediately, while their interest is high. How can such environments be achieved in practice? Formal and informal problem sessions have been conducted by engineering educators or their surrogates for years as a means of providing interactive learning environments in which students can ask for, and receive, immediate response to more questions than the teacher can entertain during the class meeting. In contrast to an apparently widespread notion that laboratory activities are mainly a means of inculcating practical skills in students, the main purpose of laboratories is

to provide a highly interactive learning environment in which the students receive immediate feedback about their work directly from experimental apparatus. In recent years, engineering educators have begun to encourage formation of study groups among students of a class. Such groups provide a potentially highly interactive, and effective, learning environment at little cost to the institution. One on one learning sessions between the teacher, or a hired tutor, and a student can be quite effective in providing a highly interactive learning environment, but as, unfortunately, a high cost. Few of these approaches offer more promise for improving the learning environment outside the classroom than Computer Based Training. On open - ended problems, students can realise intense interactively by comparing their work with results from computer simulation. In the process of evaluating the outcomes from two different approaches to a problem, students not only receive immediate feedback about complex open-ended problems with little direct effort by the teacher and learn the useful ability to evaluate their own work, they also learn to utilise results from unsuccessful attempts at solution to modify their approach to the problems.

3.2.3 Student - Centred Learning

A student - centred engineering education and training is also must effective when compel with academic depth and experience in the subject matter. In a "student - centred" approach to education and training, the student is at the centre of attention while in the more traditional or "teacher - centred" model, the teacher is the focus. Active learning is more likely to occur in the student - centred model while passive learning is more likely to result in a teacher - centred model. Shifting the centre of attention of classroom activities from the teacher to the student metaphorically seems to us to be a significant paradigm shift in education.

According to cognitive psychologists and educators, instruction is most effective when students are encouraged and even expected to become actively involved in their

own learning, thereby shifting the forms from what the teacher does to what the students do.

What are a professor's roles in student - centred education and training. George D. Catalano suggested following roles for a professor who wishes to explore a transformation from teacher - centred to student - centred engineering education.

- *Model thinking and processing skills*

One of the most important actions a teacher can take is to think out loud or externally process. A student - centred teacher may model brain storming or problem solving.

- *Know the actual and the desired cognitive levels of activities and of students*

Simply for engineering education's use, George. D.Catalano suggest that teacher routinely engage students in identifying the modes of thinking required in the different activities and possible reasons for difficulties they may have had.

- *Develop questions that facilitate student exploration and growth*

Questioning techniques and their importance in shifting the focus to students are one part of student - centred education. Students are asked to generate their own questions both in class and as home work assignments.

- *Use visual tools to establish connections and nurture the development of these tools in students*

The teacher - centred model of education essentially ignores one half of the student's mortal capacity. A visual tool we have found useful in tapping into that neglected portion of brain is mindmapping. Mindmap construction forces students to sort through new information and cluster the data into categories that indicate the extinct or lack of connections. An example of a mindmap used during the first meeting of fluid mechanics is provided (Figure 3)

Figure 3 An example of introduction mindmap for fluid mechanics

- *Provide group learning settings*

Two particularly effective group learning activities for use in the marine engineering training include: a) construction of teams of two to three students to work out solutions to well - defined and open - ended problems and then present their group results to the rest of the class for renew and, b) establishment of student - run recitation period wherein students ask other students for suggestions and guidance with the instructor serving as an interacted observer and facilitator. Group learning is good for them to establish the spirit of teamwork, which is very important for an engineering job.

Figure 4 Comparison of TCL and SCL in Thermodynamics Figure 5 Comparison of TCL and SCL in Fluid Mechanics

According to the tests hold in the course Fluid Mechanics and Thermodynamics in LSU and USMA, the performance of training in student - centred model is dependent upon the preparation of instruction and the content of the course (Figure 4 and 5). Three main conclusions were reached in this study. First, the students in the student - centred section did consistently better throughout the semester on the hourly exams and the final exam. Second, fewer students dropped the student - centred course. Third, the teacher who utilised a student - centred technique was judged much more favourably by the students in his class than he had been rated by students previously. The professor George D. Catalano said: "student centred roles and activities seem most effective when coupled with technical depth, not as a substitute for such expertise".

From above items, we can find that most of learning activities occur in the students' self - studies. An interactive learning media is very important in this process. Computer Based Training (CBT) is one of the most effective approach for this program.

3.2.4 Problem - Based Learning

The basic premise underlying the use of peer assessment and a problem-based learning (PBL) approach in engineering courses is that our students are being exposed to something closely approximating real life as a professional engineer. Students are given the opportunity to learn and practise knowledge and skills, as well as to develop and be assessed on their performance of professional behaviours, attitudes and values.

Further, engineering educators have the opportunity of developing and evaluating learning experiences that cover a whole range of the learning objectives frequently included in course descriptions, but mostly neglected in the traditional educational

setting, geared as it is, to the evaluation of academic performance on knowledge and skill based examinations. In effect, a PBL approach which incorporates some component of peer assessment, is an elaborate simulation of real life performance in a professional situation.

The important emphases in PBL is on learning. It represents a total approach to developing professional and life skills as well as supporting effective, self-directed adult learning.

PBL is concerned with:

- integrating new knowledge and skills with that already possessed by the learner, and the development of new knowledge and skills through the stimulus of a real problem. The learning starts from where the learner is, and focuses on the development of processes for seeking, fending collating, evaluating, interpreting, processing, applying, synthesising and presenting information in meaningful and appropriate ways.
- seeking out sources of information and expertise not possessed by the learner and then asking the right questions that will enable an investigation to proceed, in effect learning how to learn.
- helping the individual learn to recognise and accept skill and knowledge deficiencies; that they cannot be totally self-sufficient in solving complex problems; that they will need to trust, value and rely on the skill and expertise of others; and that they will need to cooperage and collaborate with others to achieve a solution to the problem.

There are many important concepts and educational values enshrined in these three points. The PBL approach is markedly different to the traditional lecture/tutorial/lab based engineering program and demands different roles from the course leader. PBL implies a much more sensitive collaborator, fellow traveller, mentor, colleague,

guardian role and a very tricky hands-off leadership role for the course leader. this role is both real and crucial to the success of the approach because it requires enormous effort and planning to ensure creation of an appropriate learning environment.

Achievement of this type of learning environment depends very much on arranging learning experiences which promote the development of a set of generalisable competencies such as those shown in Table 1.

Tables 1: Generalised competencies developed in Problem Based Learning.

- developing an adequate and appropriate date base of knowledge and skills from which to operate
- developing skills and strategies of data acquisition including finding, accessing and deriving information
- developing information processing and handling skills
- adapting to and participating in change
- dealing with problems, making reasoned decision in unfamiliar or novel situations
- reasoning critically and creatively
- adopting a more universal or holistic approach
- practising empathy, appreciating and valuing the other person's point of view, knowledge and skills (particularly if the person comes from another discipline)
- collaborating productively in groups or teams
- identifying one's own strengths and weaknesses, and undertaking appropriate remedy through continuing self-directed learning
- identifying the strengths and weaknesses of other team members and organising the team effort to accommodate the distribution of combined expertise.

These competencies not only enhance learning during a particular course of study, but are also important for continued development throughout their professional life. The key educational issues to emerge here are that:

- learning should take place within a context that is relevant and meaningful to the learner.
- learning is transferable.
- the learning approach should be appropriate to the situation.
- we should not make assumptions about what students know and can do.

3.3 The Current Problems in Marine Engineering Education and Training

"Engineering department students lack of practical experience at factories." Engineering education was criticised by the industry, the engineering circle, government, and even the schools themselves. The reason was being enable to cope with the actual needs of every sectors. The curricula of the engineering education starting from the freshman year to the senior year or even to graduate school focus on theoretical knowledge so much as that the graduates can not cope with the ever-changing industry.

The current problems faced MEET are different from country to country because of the factors of economic, political and traditional system. In general, these problems are related to organisation, financing support, quality of faculty, quality of students, the training facilities, effective assessment, and teaching materials and methodologies.

The problems related to organisation structure and financing support usually can only be solved or decreased by administration and government. Next to structural and financial reasons the problems in MEET system are due to the teaching faculty, students, laboratory equipment, curricula and syllabuses.

Problems related to the teaching faculty:

- lack of regular changes in the assistant professor , professor, and staff interested in wide range researches.
- referring of academic degrees is in fact a process of mere promotion and occurs in different subjects of study, not in scientific branches.
- lack of experienced instructors who have both high academic degree and practical working ability.
- lack of knowledge updating in marine engineering and IT.

Problems related to students:

- a relative low number of candidates.
- low preparation level of the candidate.
- insufficient motivation for entering marine engineering career.

Problems related to training facilities:

Problems related training facilities consist of fitted-up classroom,, equipment, libraries, laboratories, computer centres and training ship. Problems are usually caused by the laboratory equipment, training ship and simulator. More and more expensive facilities like laboratory, machinery and training boat are required. Usually few of the university or college have the capacity of holding so much advanced facilities.

- Laboratory equipment.

High quality engineering education is unthinkable without a solid quantity and quality of lab equipment. Difficulties with its updating due to short financing are the main problems. For example, the automation and electrical laboratory have some difficult experiments that usually take long time and need more skills. The simulator also is very expensive facilities in a common institute. A diesel engine workshop need a lot of auxiliary system to support it and its running usually take some

expenditure from the institute. All of problems like this should be considered in the MEET.

- Library

The library are of fundamental significance for the self education and learning. Usually there is a library in each institute or a school, it provides not only the text books but also the scientific and engineering magazines. The efficiency of student centred learning and learning outside classroom largely depend on the quality of the library. However, the trainees in industry have not such a good condition. They can neither carry many books with them during their changing working places, nor find a library on their ship or office. So on job training is difficult implemented if a library is not available. CBT has been considered to be one of the solution of the problem. Norwegian Seagull company has developed a CBT software package in the area of "library on board", which provides a wide knowledge and material in navigation, marine engineering, maritime safety, convention and codes and environment protection. This trend has provided a satisfied condition for on board training.

Some CBT solutions to the problems in MEET

Controller design is one of the most challenging issues in control engineering education and training. One should think that main problem is process identification, but looking into the books of basic control engineering one find that even for relatively simple plants with known parameters the design of a controller is a procedure of trial and error. So what we need ate direct methods of controller design, these are methods with a direct relation between the process parameters and controller parameters.

Thermodynamic is a major course on the marine engineering and training. The course is considered, from students' perspective, to be one of the most difficult courses in the whole educational program. This is probably caused by the combination of the applied mathematics that is involved and physical and chemical phenomena to which

it's applied in the course. A majority of the students are quite unfamiliar with these kinds of practical applications of mathematical models for physical processes and their dynamic behaviour. A general problem, not unique for this course, is how to get the students to participate more actively in the lectures and exercises, in order that they might go more deeply into the material, and find greater coherence in it. In a traditional course, the lectures are intended to give an overall introduction to the current topic whereas the aim of the exercise classes is to teach the students problem-solving methodology in order to enhance their problem-solving skill. However, during such lectures and exercise classes, it is observed that the majority of the students are inactive, in the sense that they do not engage in a dialogue with the teacher. Mostly, there is only a transference of written material from the blackboard to the students' notebooks without any critical analysis on their part. In my opinion, a two-way communication is necessary to gain a higher level of learning. This lack of communication might be due to the fact that the students, especially at the beginning of the course, do not have enough knowledge for a profound understanding of all the elements of the problem currently be tackled. During the exercise classes, there is usually no time for a comprehensive repetition of the theory previously treated in the lectures, and the time for independent study is limited.

Students find it extremely hard to comprehend the physical phenomena which occur in *electromechanical devices and systems*. Educators, too, find them difficult to deal with. The situation is further complicated when it comes to dealing with the basic concepts and principles of energy conversion which involves a thorough understanding of electric and magnetic field.

To be able to consider and skilfully investigate the behaviour of such devices and systems, one has to demonstrate not only the knowledge of physical phenomena, but also the ability to perform sometimes extremely complex mathematical operation and calculations.

A new experimental sit up and has been found that this particular construction is extremely useful when it comes. An experimental procedure was devised and implemented in which students are exposed to a variety of basic concepts, ideas and physical phenomena and their application in such devices and systems.

A *logic gates and basic digital systems* simulation has been recently designed and developed. The designed digital simulation system makes extensive use of computer graphics to simulate digital logic gates and fundamental digital systems and is written in an object oriented form. The product of the program is a colour graphical display which shows the circuit components, connection and text information. There are two standard screen layouts used in the simulator. The standardisation of the screen layout eases the student training exercise so that the student does not need to be reintroduced to each exercise after he or she has completed the previous one.

The system is designed to provide the student with an interactive simulation of real digital circuits and systems, thereby providing contact with the real world, without the necessity of using laboratory equipment. The practice with the simulation process on a colour graphic screen largely enhances the visualisation process, thus increasing the level of transfer of information.

Both the lecturer and student often experience difficulties during the teaching / learning process when the physics of *semiconductor devices*, and indeed the behaviour of such devices, are being dealt with. The theory of semiconductors is hard to comprehend by students due to the complexity of physical phenomena taking place in such devices and sophisticated mathematical expressions used to describe their behaviour.

The lecturer, on the other hand, is frequently not prepared to teach such a difficult subject. Moreover, he or she is not equipped with necessary tools required to illustrate the principles of operation of such electronic devices. This is where computer-based training programs can be of assistance.

3.4 Utilisation of Technologies in Marine Engineering Education and Training

3.4.1 Evolution of Hard Training Technology

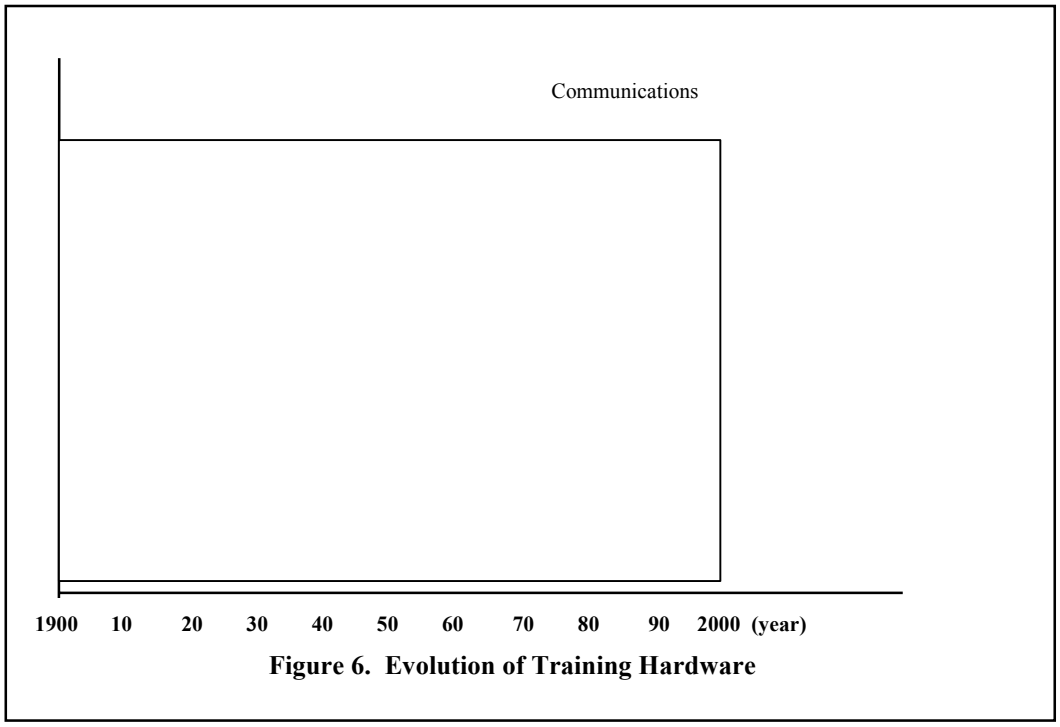

Figure 6. Evolution of Training Hardware

Training technology of marine Engineering has changed together with the development of technical and science . In early days, engineering training was the process that experienced engineer on instruction delivered the knowledge and skills by showing the drawing and modelling the skills, together with the using of blackboard and workshop. Later, the appearance of the using of transparency, slides, audio, film and video has improved the training a lot, especially the video has improved the education and engineering training. Till now, more and more

information technical (IT) has been applied to the education and training of engineering . we find the method can greatly improve it. Video and computer have been showed the most effective training technology in engineering education and training.

There are some hard technologies that are widely used in MEET. They include two main groups: passive learning tools and active learning tools. The subdivisions are shown in figure 7. The typical technology are Audiovisuals, videos, CBTs and Telecommunications.

3.4.2 The current hard technologies in MEET

In addition to the classroom and whiteboards / blackboards, there should be following common technologies in MEET.

Transparencies

Overhead transparency equipment was widely used for classroom instruction. The equipment itself has improved significantly, become more and more compact, quieter and more reliable. The popularity of overhead transparencies can probably be attributed to the ease of operation of the projector and case of making transparencies. It has a obvious advantage and flexibility in everything training, because it can make complicated engineering drawing and structure picture. ease to demonstrated in classroom, without any drawing work. So most of engineering instructor enjoy the demonstration of structure of machinery by overhead transparencies.

The major benefits of using transparencies in training are planning and time saving in delivery. The time saving has been shown to be in the order of 20 to 40 % over a conventional lecture.

Slides

Slide programs represent an unusual training technology in that they are equally suitable for both group presentations and self study use. The current generation of equipment includes units that feature fully synchronised slide, both review and forward projection. Development of slide materials is relatively inexpensive and quick.

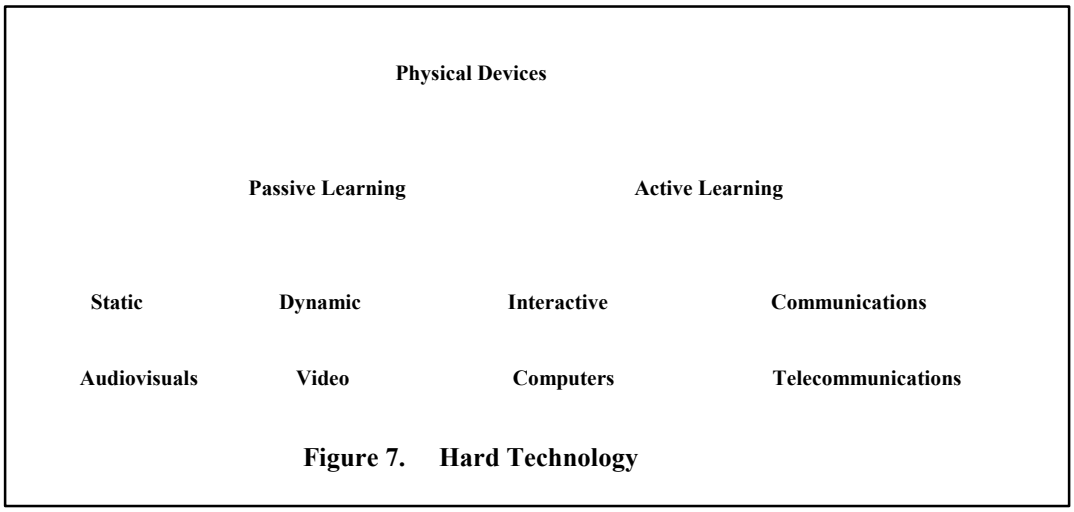

Figure 7. Hard Technology

Slide programs are especially well suited to training that have inherent requirements for visual presentation, such as the machinery repair, new equipment familiarisation or service procedure.

Powerpoint is a slide software for presentation. It allows slides to be created very quickly, and also makes revision and corrections much easier, since the slide images are stored in files. Usually, a computer projector should work together with the computer.

The major limitations of transparency or slides are those inherent in static and passive media, these media can only deliver information, they can not actively engage the student in learning by providing feedback and reinforcement.

Videos

In the field of MEET, perhaps the most challenge training technical to CBT is the video training. Video has been widely used for marine engineering training and it is also the most favourite technology in on-board training and distance-learning. It is suitable for both group learning and self-study. Video can present dynamic sequences of events and has the potential to be more attention technical than static media.

In video training, videos are not a stand alone product and are provided with manuals including notes fro trainers and trainees. The training process generally incorporates three stages, the video viewing, a practice drill and an assessment afterwards. The chairman of Videotel Len Holder said, "The trainer needs to be properly prepared and must find time to assess aferwards. It is very important to be prepared for things that might go wrong and go into a safety procedure so as to avoid disaster rather than being in it."

Hundreds of engineering training video tapes are available. They include maintenance and operation skills, management, safety training and wide range of technical subjects. Most of shipping company and colleges develop their own video tapes for training purpose , and establish video - library. Major corporations and colleges usually have their own video facilities and production stuff. Today, it is possible to produce high-quality videos with relatively little equipment, A great deal of progress has been made during the past decade in the development of compact and relatively inexpensive video production equipment, making video quite affordable and cost- effective for training purposes. Three other aspects of current equipment developments are significant to the use of video in training. The first is the widespread adoption of video cassette players that make video technology easy to use. The second development is the appearance of projection screens allowing video to be presents to small and large groups without the need of the multiple monitors.

The third development is the emergency of easily portable recording equipment. The availability of such compact equipment makes on-site shooting easier and had encouraged the wider use if video. This is particularly true for the use of video to record and playback on individual's performance during field or on-the job training to provide employee with visual feedback on their learning progress. An employee learning how to operate equipment or supervise other employees is video taped during practice exercises and then critiques the playback in terms of strengths and weaknesses.

With the development of technology, video training also has been improved a lot. The digital recording and storage of video results in improved sound quality and much greater storage density than the analogue techniques. So the computer generated graphic, animation, or sound can be easily integrated with video information. Video will play an even greater role in future MEET applications than it does at present.

CBT

The use of computers in training introduces a very important instructional capability: interactivity. Interactively derives from active responding and explicit feedback, with computer-based instruction, the student overtly responds to question, and feedback on the correctness of these responses can be provided.

The interactivity of computer-based instruction also makes individualisation and detailed progress tracking possible.

Computer - based - training is not the only way of achieving interactive training video disc is an inherently interactive medium, although it is most interactive under micro-computer control.

Unlike passive media, computer displays depend on what the user does. One major problem that students experience in using CBT relative to other media is disorientation about where they are in a lesson or course, what they already have seen, where they can go next, etc. To overcome this problem, it is necessary to provide students with a clear description of the structure of the maternal in terms of outlines, course maps, or flow - charts. In addition, it is helpful to put lesson names and numbers on each screen to allow students to locate themselves. The use of CBT systems for training is the most glamorous application of computers, although not necessarily the most cost - effective. The three common forms of instruction are drills, tutorials, and simulations.

Simulators

Simulators are devices used to train how to operate or maintain machinery. Almost all engine room simulator have been computer-controlled. The computer is used to generate displays, sense that the correct operation has been performed, and produce a trace of the student's actions for the instructor to review. The prime motivation for the use of simulators is reduced training costs. Most simulators cost considerably less than the actual equipment they simulate. Another important reason for using simulators is that they are safer than training on actual equipment. A third factor is availability. Simulators can be located wherever needed and in sufficient number to meet student loads. The design and implementation of engine room simulator derives primarily from the field of human factor continue debates in the simulator area is exactly how much fidelity (realism) a simulator must have relative to the actual equipment.

In recent years, however, there has been a trend using simplified three-dimensional panels and computer graphics displays of equipment rather than physically similar devices. This trend is supported by research showing that large scale realistic equipment is not necessary for an effectiveraining.

CHAPTER FOUR The Effectiveness and Efficiency Improvement of CBT in MEET

4.1 CBT and On - Board Training

STCW 95 requires that the ship owner has the responsibility to organising training his crew on board in order to fit the ship's operation. The crew need to update their knowledge about environment protection and safety operation on board. The trainers will need to consider all the resources and training aids available, including the expertise of other senior staff and computer based training. Ship owners have found the computer based training is one of the most suitable method for on board training.

More and more ships are equipped with computers, and in some new ships every person is equipped with a computer in his / her cabin. These computers provide an excellent condition and hardware for Computer Based Training on board (CBT on board).

With the development of technology, new electronic equipment, hydraulic and pneumatic control instrument, as well as the new operation requirements are introduced to the ships and operators. On board personnel will frequently meet these new equipment and technologies, and the technologies require the support of specialised training programme. Although shore based training still carry out most content of marine engineering education and training, "technology today provides an opportunity to transfer training on board." (Muirhead, 1995). Computer Based Training is an effective method of acquiring understanding, knowledge and skills.

Many practical training programmes previously carried out ashore now be transferred to ship. Companies and operators can assure themselves that their crews are receiving training with new equipment facilities and procedures on the ship through the introduction of interactive process. (Muirhead, 1995)

There are various of CBT packages which are multimedia application using CD - ROM and they can provide the basic training for marine engineers on board. One of the more recent developments in CBT is the production by Seagull of a suite of CD - ROM based interactive training programmes, the main feature of which is to cover the functional areas of the STCW 95 Code. They are linked to the above projects and through the "Onboard Library" concept the collection will ultimately provide more than 80 programmes when completed in 2000 (P. Muirhead,1998). Now most marine machinery manufacturers also deliver their products together with a training material including CD - ROM used for Computer Based Training. "Perhaps the most attractive use of new technology (including CBT) is in upgrading and refreshing the knowledge and skills of personnel on board, particularly where new equipment or operational procedures have been introduced." professor Muirhead said.

In 1993, Sulzer began equipped their low speed diesel engine with SIPWA which is an advanced diesel engine diagnosing system. The learning and training in operating the new system seems not easy to engineers by using the handbooks (specifications). Main problem is lack of connection between feelings in handbooks and the show on screen. Sulzer recognised and understood this situation immediately. They developed a CD - ROM which used in on board training and provided together with the SIPWA systems. The direct connection and demonstration of the operation procedures have greatly improved the effective and understanding of the new system.

There are more and more control systems which are monitored and showed by computer systems. The increasing skills in operation and adjustment in computers

require marine engineers familiar with all interfaces which appear during operation. No better method than Computer Based Training are there to suitable to training in such kind of system.

Computer based engine room simulation programs will play an important role in CBT on board. These simulators have sufficient behavioural realism to allow a trainee to acquire and exhibit the skills appropriate to the training objectives. Because simulators are not true replacement for seatime experience, they need to recreate the necessary rapidity and vigilance which are demanded on a vessel in operation. Therefore, on board PC - based simulation training will benefit from both the simulation exercises and the practical experience in a real engine room at the same time.

Transas Marine (UK) Ltd ERS2000 (Figure 8) is a PC-based simulator with on - screen controls only. It can be used as a stand - alone simulator or can be net worked in order to form a training class. This simulator is designed to instruct engine room watch keeping personnel in the correct operation of ship's diesel propulsion plant and its electrical power plant. Trainees are taught how to control plant during manoeuvring, to monitor the operation of machinery in line with present alarm parameters, and also how to shoot trouble within the system. Norcontrol also says that a large library of exercise areas and the same ship models that are used in its large simulators are available with the new PC - based simulator. The new simulators have, claims the company, the same fidelity as the larger units, but at the less cost of a PC system. The PC - based simulator can be upgraded to include any of the functions of the larger engine room simulator.

CBT also provides the assessment technology for individual's competence to perform the necessary skills on board. Assessment program usually follow the tutor program. The trainee on board does the test himself according the requirement of CBT.

Computer will automatically calculate the grades, give the mark and show the correct answer to him. So the trainee can know which level he is and which level he is heading next. Some Norwegian shipowners use these objective assessment programmes (CES2000) to screen the knowledge levels of seafarers.

All these technical improvement have offered a ripe time for the application of CBT on board.

The problems existed in CBT on board are the difficulties of monitoring and supervising trainee's programs. Without tutor or director standing in side, the learner has to look for the further programs himself and maybe confuse the processes and huge contents in the program. Usually, he will lost interests and confident when he fed up the program. That is also the factor affecting the effectiveness and outcome of CBT on board. One of the solution of this problem is the utilisation of distance learning. Distance learning technical which developed recently can provide student interaction, feedback and evaluation, and direct tutor contact. A typical distance learning unit may consist of a unit guide, a study guide supplemented by a reading or telecommunication. It may corporate with text book, CBT, or video or audio tape. So CBT will be more effective when it is supported by corresponding communication and interact units. These units are structured to provide the student with the sense of communicating and interacting with the educational or training institution and the designated tutor. Ashore, access to a tutor is normally provided by fax, telephone, teleconferencing. (Usually, the feedback to the student can be haphazard and take months). Satellite communication provides a unique link between student at sea and the tutor ashore. Assignments can be transmit, marked and returned within a very short period of time.

The new technology has introduced into maritime industry to raise the skill levels of personnel on board and, consequently, improve safety standards without adding

significantly to overall operating costs. And the transfer of many aspects of practical training from shore institutions to the work place is a desirable objective since on - job - training and verification of skill acquisition is best carried out by those at the work place.

However, the final problem of on board training is that the attractive training programmes will change the living pattern of personnel on board, and influence the normal working regular which ensure the safe operation. There is a potential trend of increasing study load in seafarers' off - watch time, that is against the original purpose of STCW95. So on board training should not enlarge too much and be careful to the study load limitation, and give enough rest time to seafarers.

4.2 The relation between CBT and laboratory training

The main courses on marine engineering consist of lectures, theoretical exercises and laboratory sessions. Often students study very profoundly their abstract textbooks on some chapters, but still have some difficulties to visualise important phenomena and ideas. The laboratory sessions may clarify a lot, but they also have some short comings.

The shortcomings of traditional laboratory sessions

First of all, the laboratory sessions are normally done just once per student group. Secondly, the sessions take place in groups of three or four students per experimental test set-up. Therefore it is not always enlightening for each student individually. Last, the sessions in laboratory do not have the aim to recapitulate the theory of the textbook, they are there to teach some of the practice. It will be demonstrated how multimedia techniques can assist to overcome the mentioned problems.

Computers and training programs should aid laboratory exercises to a maximum, when it is necessary (because of the cost of the experiment). CBT can support the experiment and hands - on exercises so as to enhance the efficiency and effect of practical skill training. CBT laboratory training usually occur in the preparation period of experiment and in the review period of experiment. So students can concentrate on the laboratory experiment more.

There are five basic cognitive processes in engineering practical skills: seeing, listening, feeling, doing and analysis. Usually, these skills training is carried out in laboratory workshop and in engine room. CBT mainly provide the training in "analysis". It has been showed that Computer Based Simulator can provide some training in seeing, listening, doing and analysis. Computer Based Simulation Training could be more effective if it introduced into laboratory.

Some typical CBT laboratory software

It is possible to the laboratory session a more profound way by exploring the multimedia application. In recent years in the electrical laboratory there have existed the tendency to replace some experimental exercises by their Computer Based Training (CBT) .

At Catholic University Leuven, according to A.Malfait, by using a CBT application, it is possible to confront the students in an alternative way with some difficult and basic topics of the course of Electrical Machines and Drives. Initially, it was intended to concentrate merely on the induction motor and more specifically on the behaviour of the rotating field when changing some machine design parameters. Later on, the program was extended and developed application consists of three parts:

- visualisation of the rotating field.
- mechanical construction of the induction machine.
- laboratory session.

In the part concerning the visualisation of the rotating field, it is possible to see the behaviour of the rotating field in two different cases. The student can interact with the program by choosing all the important machine parameters like the number of pole pairs, and the number of slots per pole and per phase. Each choice of parameters gives a different representation. The animation are generated by using too software and are imported into the multimedia program.

Figure 8 An example of circular presentation of the animation of the rotating field

Other possible interactions by the students are the answers to multiple choice questions where the student has to answer correctly before he can proceed with the CBT session. At end, to make the rotating field even more comprehensive, a part of a digitised video is implemented. The analogy between the physical principle of the rotating field and visualisation with up and down going bars is demonstrated very clearly. The same approach could be used to study the influence of the time harmonics in voltage and current supplied by a frequency inventor.

In the part dealing with the mechanical construction of the induction machine, the student gets an overall view of the squirrel cage induction motor. Clicking on the different parts of the machine , the students gets the name and more detailed picture.

The third part of the CBT deals with the laboratory sessions. By working with this part of the application the student can prepare himself for the practical laboratories. All the experiments and calculations the student has to perform during he sessions, are explained, and all the required measuring equipment and their connections are also shown in detail.

According to P. Jankowski, Computer simulation should be introduced into laboratory and could be more effective. The electrical laboratories in Maritime Academy in Gdynia have been divided into three groups.

- More important experimental exercises in electrical engineering aided by programs. In this group of exercises, students simulate electrical circuits on the computers. In parallel, they carry out the same experiments on real physical circuit. Results obtained from computer and physical circuit are compared and appropriate conclusions down.

- Computer simulations of more complicated exercises in electrical engineering. The purpose of them is to show the largest possible number of classical cases in electrical engineering that is difficult with practical exercises because of their time-consuming.

- Mathematical modelling-circuit and field models. The purpose of this group is to introduce the students to mathematical modelling technical through the skills to formulate circuit and field equations for some physical objects.

Some experiments, like in fourier techniques in liner network analysis, second order networks - Analytic simulation, circular quasi- stationary model, have been effectively carried out in the above CBT simulations.

Controller adjustment is one of the most challenging issue in high level engineering education and training. H.M.Schaedel has presented an universal method of direct controller design and adjustment by CBT. Using the parameters of the plant the parameters of the process controller (PI, PID) may be calculated by a set of formulas for proportional plants of arbitrary lag order and dead time. The method is being taught in the course of marine automation and control equipment, and supported by CBT for simulation of control circuits in frequency and time domain and controller adjustment.

These are the examples of using CBT in exercises which practical carrying out is too expensive and time-consuming. It is the better way to training students in some typical marine engineering problems by using CBT simulation.

However, the CBT can not totally replace the hands on training, especially in the training of mechanical maintenance skills. The cadets of marine engineering, who will be future exploitation engineer on board, should have direct contact with physical machinery.

4.3 CBT and Interactive Video

Interactive Video (IV) in the context of computer based training occurs when a student interacts with a computer that uses video as one of its output devices. Most of educators and trainers believe that interactive video is an extension of computer-based training, that is augmented by a video peripheral for high quality visual and aural presentations.

The primary advantages of video are lifelike images and sound. However, video is usually linear and not under the users' control. The advantages of computer technology have been discussed extensively, interactively, data storage, and

processing, and so on. However, the visual and auditory quality of most computers is still below that of ordinary video. The use of interactive video, which combines the technologies of video (television) and computers, provides the advantages of both.

The video disc has replaced the video tape in the interactive video technical because of its high speed searching, more durable, cheaper and easily controlled by computer. Usually, the most common form of interactive video consists of a micro-computer connected to a video disc player, and sometime, a television.

The video disc, stores video, stereo sound, and auxiliary control information, is played on a video disc player which has the components diagrammed in Figure12. The laser pick up, a laser beam, reads information off the video disc as it spins, The inputs allow for direct control by an operator or from an external computer. The outputs send information to a connected video monitor and to an external computer.

The microprocessor inside the video disc player controls everything, receiving and interpreting inputs, controlling the video disc and laser pick up, and sending data to the appropriate outputs.

There are two constraints of IV

- higher cost. The trainee should not only have the necessary computer equipment, but also the equally expensive videodisc players and interfaces.
- compatibility. There are many types of videodiscs, videodisc players, and computer videodisc combinations. Videodiscs themselves vary in size, capacity, and format of the stored in formation. So many possible combination choices face to the developer of an interactive video program. The problem of hardware and software compatibility is by far the greatest impediment to the advancement of IV.

Interactive Video is suitable to the engineering training because of a lot of operation, maintenance and trouble shooting included in training program. It is very effective and lively to explain and describe these processes with the Interactive Video. For example, an engineer cadet must learn to diagnose some rare troubles. But because they are rare, the cadet does not have much opportunity to encounter them in a limited period of time. The cadet sits at a computer with a interactive video device. The cadet see “live” motion video presentations of the trouble shooting and machinery repairing. The text and audio explain what is being done in each examination. The cadet must periodically answer questions that require careful observation of examination. After the instruction, the cadet goes through a simulated case study.

The availability of digital video devices is expected to significantly increase the power of interactive video training. This technical provides more function in video image editing, and also provides standardisation in the field of interactive video. So that users and developers would be able to buy one set of equipment that works with all programs. The further of interactive video depends on tools enabling us to use the technologies, and on our knowledge of how to use them facilitate learning.

4.4 CBT and Simulation

A simulation is a powerful technique that teaches about some aspect of the world by imitating or replicating it. Students are not only motivated by simulations, but learn by interacting with them in a manner similar to the way they would react in real situations. The purpose of simulation is to help the student build a useful mental model of part of the world and to provide an opportunity to test it safely and efficiently. In a simulation the student learns by actually performing the activities to be learned in a context that is similar to the real world.

There are two groups of simulations, physical simulation that teach about something and procedural simulation that teach how to do something. Physical simulations differ from procedural simulations in that they are not as interactive. Both of them are used in Marine Engineering Education and Training. Most simulations do not neatly into just one of these categories, but rather are a combination or synthesis of more than one type.

In a computer based physical simulation, a physical object or phenomenon is represented on the screen, giving the student an opportunity to learn about it. Typical examples are electrical circuit experiment simulation and controller design experiment simulation.

Figure 9 The simulation output on oscilloscope

The purpose of most procedural simulations is to teach a sequence of actions that constitute a procedure. An important type of procedural simulation is the "diagnosis" simulation. The student is presented with a problem to solve and must follow a set of procedures to determine the solution. Common examples are operating a hand- on process. The typical examples are engine room simulation, steam system simulation and fuel oil purifier system, which including trouble shooting and operation.

In all these procedural simulations, whenever the student acts, the computer program reacts, providing in formation or feedback about the effects the action would have on the real world. Based on this new information, student takes successive actions and each time obtain more information. A primary characteristic of procedural simulations is that there are more correct or preferred sequences of steps which the student should

learn to perform. However, there may be many different ways of reaching the same conclusions, not all of which are equally efficient, A procedural simulation provides the opportunity to explore these different paths and their associated effects.

There are two kinds of engine room simulator, large scale engine room simulator and PC-based Machinery space simulator. The large simulation has been considering the importance of realism in training environment and full missions. It usually be equipped with many real panels, monitors and controllers as well as audio devices handle, it is expensive and takes large space.

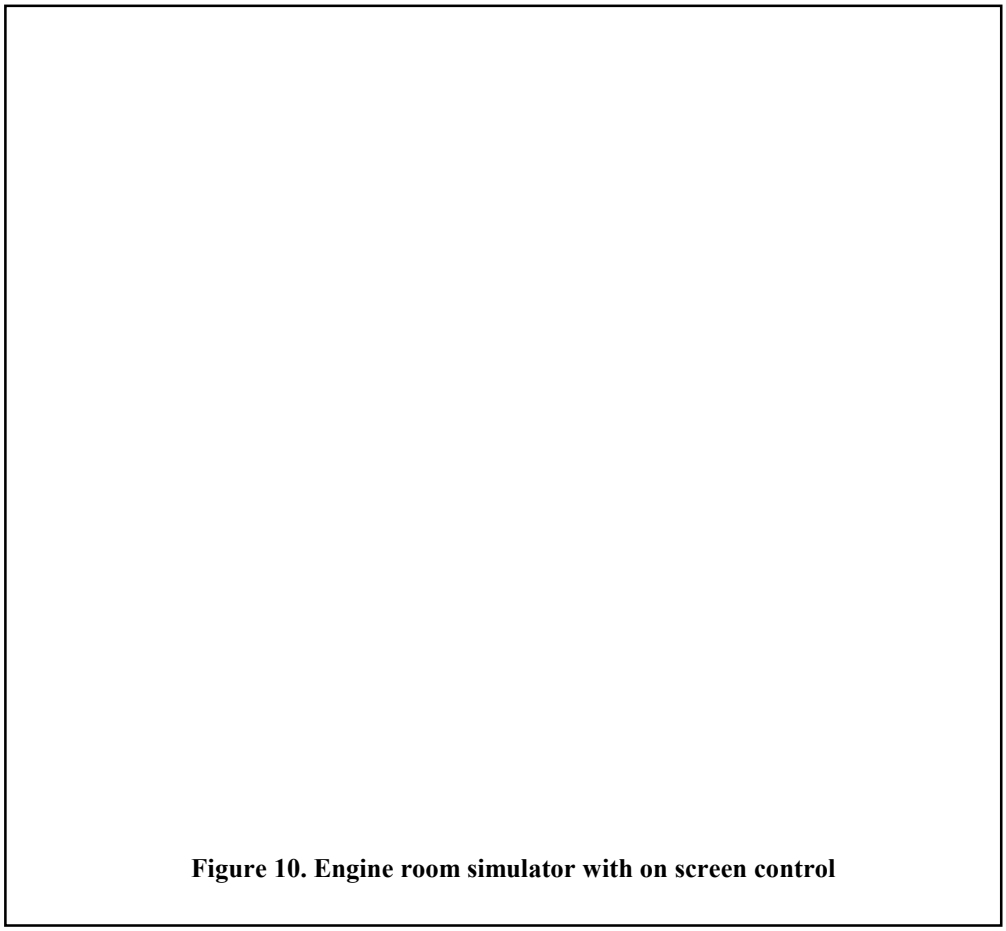

Figure 10. Engine room simulator with on screen control

PC- based simulator with “on screen control only” usually included in CBT catalogue. It can be used as a stand-alone simulator or can be net-worked in order to form a training class. It usually use commercial computer as work station and at less cost. It is called that the PC- based simulation can be upgraded to include any of the

functions of the larger engine room simulator. Norcontrol has develop the concept for improved training which combines interactive computer-based training with PC simulation. The simulations allow users to switch between the simulation of different models of engine, such as Mak, Sulzer and MAN B & W. This trend provides a wider application for CBT individual training or on-based training.

The simulators, providing training for a wide cross section of mariners from cadets to watch keepers and chief engineers, come in a variety of sizes and are able to replicate all pump and pope readings modelled to take account or fluid, gas currents and viscosity. In essence, the system provides full thermodynamic process representation, in contrast to the table-driven models usually adopted for engine simulators.

Both the large and medium systems come in modular formats allowing a progression from a small graphical version to a full mission engine simulator. The smaller Multi - task Graphics model is a work station- based machine suitable for simulation of main engine and sub-system functions. The new series makes full use of commercially available computers and standard software tools for a graphic user interface.

Computer based simulation has provided great amount of opportunities to practice or carry out problem solving learning.

4.5 Computer Based Assessment

There are two major ways to incorporate computers in the testing process: using the computer as an aid to construct the test; and using the computer to administer the test. Computerised test construction utilises the computer to generate, print, and score tests that students write on paper. Additionally, with the proliferation of microcomputers and mainframe computers with networks of terminals, it is now feasible to administer tests directly to students right at the computer or terminal. Both

techniques offer advantages and both have limitations. Wisely used, however, both can save a substantial amount of time without sacrificing quality, and can frequently improve the quality of testing.

For many years, computers have been used to help construct and score tests. Such help takes a variety of forms. For example, storing test questions in pools. They can be accessed whenever tests are needed. There are three main ways to assemble questions into test form: the questions could appear in the same order as stored in the computer, or questions could be ordered randomly, so that each answers the same questions but printed in different orders, or to construct the test by selecting questions from a larger pool, so that each student receives a different set of questions on the test.

Computerised test administration is also increasingly used. In this way, the student sits in front of a computer terminal, and enters directly into the computer answers to questions that appear on the screen. The test becomes automated and can be individualised, allowing students to take a test when ready rather than at a fixed time. The content of test can also be tailored to suit each individual, or the same test can be constructed differently for each student.

Each student's answers can be stored for use in accumulate individual and group data about questions, time to completion, response patterns. All these data provide useful information to the instructor who is committed to improving the test process. These functions make computerised test a favourite test way to seafarers in sea and become a part of on board training.

The these current examination in marine engineering has been facing a primary problem -- the current assessment way is not effective and accurate enough to

evaluate the competence ability of a person in operation and maintenance of complicated machinery and equipment.

Usually, there are some assessment statements which make students difficult to understand and judge some content in tests. At same time, it is difficult for assessors to design the test questions to evaluate a student in a practical skill or process by traditional way. These processes are difficult to describe and demonstrate because of that only in words and graphs. Current machinery and vessels have been complicated enough to try new assessment technologies in order to match the development of advanced marine equipment. Long time ago, hands - on skills assessment were occurred in work site or on board according to the behaviour of the seafarer. It was simple but took a long period of time, and without uniform and strict criteria. However, it is usually accurately and directly, everything in skills was showed by doing.

With the development of requirement in certificate of competence, examination becomes the uniform and national administrative. To increasing the efficiency of examination and decreasing the time spent, all the tests are in the style of reading and writing. The ability of competence is assessed by considering the duration of sea service. However, the time of sea service is not equal to the competence ability. Cadet Record Book only has a limited function in assessing the practical skills, because of various of influencing factors. So we can say it is a weak point in evaluating the practical skills of a marine engineer in Certificate of Competence examination.

The development of multimedia technology has been providing a wider space for computer based assessment. The demonstration of examination are not only by words, pictures and graphs, but also video, animation and audio. These multimedia technologies provide a fidelity and lively situation to student and makes it possible to

assess student's ability of practical competence by computer. Computer based assessment is a more accurate, objective and natural way than traditional way in the assessment of a student's ability in operation, dismantling, assembling, machinery diagnosing and trouble shooting. If there is no enough laboratory and equipment available for examination in certificate of competence, computer based test is a most suitable technical to evaluate a student's practical skill. For example, a student sits in a computer and takes a computer based test. The screen shows a maintenance process of a diesel engine by video together with explanation, which is difficult to describe in words and graphs. After analysis, he choose one answer or type the answer input, computer will store the data and give a score when he finishes his test. Student also can carry out an operation in a single mission computer based simulator, and computer will give the assessing records to his behaviour record and program.

There are also some limitations in computer based assessment that related to the restriction in only multiple choice, matching, or short answer format. Computers have difficulty in judging extended or open ended responses well. For many countries, it is difficult to equip many computers and organise the persons who are not so familiar with the computer.

4.6 CBT on the Web

Web Based Learning (WBL)

The rapid growth of WWW - based teaching materials has awakened interest in their use for local learning on campus in addition to distance learning applications. The possibility of disseminating appropriately designed teaching materials at a distance as effectively as traditional lecture is not a matter of question.

Web - Based Learning (WBL) has provided a great space to the utilisation of CBT. In fact, WWW - based learning has become one of the most effective methods in CBT and has enhanced CBT's function.

We believe the WWW may be an enabling technology to provide new opportunities for students to play a more active role in the acquisition of knowledge. This multi-media learning environment has the potential to increase the availability, accessibility, individual control and flexibility of teaching materials. If the codified materials traditionally disseminated in the classroom lecture can be effectively communicated using the WWW, then the time allocated for classroom lectures might be used differently - consolidating ideas, mentoring , gaining experience, and motivating independent study.

Usually, WBL includes following types of contents.

A. Web-Based Course Administration

These sites transfer basic operational course information. They typically provide access to course descriptions, faculty teaching assistant information, course syllabi, reading lists, assignments, lecture and lab times/locations, and, in many cases, links to relevant resources available on the WWW. Basic lecture notes (derived from class notes) may also be available.

B. Reference Text Books

These sites emulate the role and layout of the traditional text-book, but they include hypertext links and multimedia to increase functionality. The contents have the advantage of being searchable by keyword and offering audio, video, and interactive modules.

C. Lectures

These sites are intended to provide the codified information traditionally delivered in a classroom lecture. We view these as an expert's guided tour or story about a particular intellectual nugget. Each nugget covers roughly the same amount of material as a singles classroom lectures.

D. Laboratory Simulation and Experimentation

These web-based instructional materials allow students to interact with a variety of simulation programs or remote experiments. Applets can be created to provide simulations that allow users to modify/change variables, creating "virtual real lab experiences."

E. Recitation, Assignments and Grading

Web-based courseware targeted at recitations include interactive modules to assist students with difficult material or with complex topics. They may also provide reviews of basic materials needed as building blocks for a lecture. The sites are usually highly interactive and emphasise mechanisms for students to evaluate their knowledge of a subject with on-line quizzes. They can be used as a supplement to a traditional lecture/recitation course or as stand-alone modules.

F. Virtual Educational Institutions

Many different Web-based instructional materials are brought together in virtual educational institutions.

G. Collaborative Learning

Collaborative learning assumes that knowledge is formed as it is shared and reinforced through group discussion and interaction. Communication, listening skills, and participation are key factors in stimulating a good collaborative learning environment. This environment may be facilitated by the WWW as it has the benefit

of being both time and location independent. Thus collaborative communication may occur at any time between people in many locations.

More effective way in WBL

According to David R. Wallace (1998), there are some more effective way in web-based courseware for delivering materials presented in the traditional classroom time. After providing an overview of web-based educational materials, the effectiveness of two teaching approaches is compared using a product design lecture on visual prototyping. One group of students prepared for class using web-based materials and then received a lecture-style second coverage of the topic in class (web + class lecture). The other group of students prepared for class using the same web-based materials and then worked with the faculty, applying only a small portion of the subject matter, on illustrative examples (web + limited experience). The two groups then completed an assignment based on the subject matter, The average grade performance of the web + limited experience group was 10.8% higher than for the web + class lecture group.

Analysis of how the two student groups used the web - lecture resource showed that the form of class instruction had a strong influence on student motivation for independent study. The average time spent in web-based preparation by the web + limited experience group was 1.6 times greater than the average preparation time for the web + class lecture group. Sixty percent of the web + class lecture group prepared less than the least prepared student in the web + limited experience group.

These findings suggest that, if codified materials are primarily delivered using a medium such as the WWW, traditional classroom time might be liberated for potentially higher value-added activities such as mentoring and experiential activities.

Evidence that WWW can be used to deliver codified information traditionally presented in lectures suggests the possibility that classroom time might be available for different uses. Students receiving a web-lecture combined with limited topical coverage. experiential activity with faculty have got the high grade performance.

Web based courses

The WWW provides unprecedented flexibility for delivering teaching materials. In a previous experiment, a general structure for the web-based equivalent of a classroom lecture was developed. The premise of this structure allowed students to: follow lectures as a continuous story or reference subtopics directly, choose the order for receiving motivation, theory, applications and examples; and follow materials in video, audio, or text-and -image formats. After using the structure to implement the equivalent of a 90 minute classroom lecture on visual prototyping, a comparison of students receiving web-only instruction to those receiving classroom-only group performed differently and had a higher average performance. So that many Web based courses are developed, and some MEET courses delivered on the Web are available easily.

Java has a number of features that are very useful for the development of web - based engineering education modules.

Department of Mechanical Engineering, Colorado State University, has developed Web pages in thermodynamics, heat transfer, and fluid mechanics.

These applications function as an introductory tutorial internal combustion engines. When a computation is needed illustrate a point, a Java applet can be accessed to perform the calculation. The calculation range from simple algebraic equations to a Runge - Kntta differential equation solver and a liner system of equations mat solver. The student uses the applet by entering parameter values input boxes.

On the web page. These Java programs down loaded and resident on a remote student's web browser, can react to user input and change dynamically, not just run the same animation or sound over and over. The figure 11 and figure 12 show the representation thermodynamics web page and sample applet for engine performance.

Figure 11 Thermodynamic web page

Web based experiment

For engineering education and training, maybe the most important utilisation of WWW - based training is the laboratory simulation and experiment.

The internal combustion engine is a complex engineering system with rich thermal / fluid science applications. Allan Kirkpatrick and Bryan Willson, in Colorado State University, have also developed Web - based software written in Java to introduce thermodynamics, fluid mechanics, and heat transfer applications typical of internal

Figure 12 Sample applet for engine performance

combustion engines. In addition, an "on - line" engine research facility has been constructed to allow engine experimentation over the laboratory internet using Web browsers.

The developed web - based computational and experimental applications illustrate the principles of thermodynamics, heat transfer, and fluid mechanics as applied to internal combustion engines.

Currently, the number of well - equipped engine research laboratories at U.S. universities is declining due to the high costs of keeping a lab equipped with state - of - art equipment. Even at universities with well - equipped engine research facilities, access by undergraduate students is limited. At the same time, there is an increasing demand for students with a solid understanding of engine theory, engine control, engine applications engineering, combustion analysis and emissions control. In addition, there is a need to increase the availability of specialised laboratory

equipment for research use, and to give laboratory access to those who, for a variety of reasons such as physical disability or out - of - town location, are unable to be physically present in a laboratory.

A possible solution to such access problems is to make the laboratory equipment available on the Internet to remote users. There have been a number of recent initiative in on - line experimentation.

The developing "Global Engines Laboratory" (GEL) at the Colorado State University Engines and Energy Conversion Laboratory (EECL) can be accessed by students via the Laboratory Internet. Students are able to "log - in" through a Web browser, and access control software, which displays a virtual control panel on their computer. The GEL presently consists of an engine, a DC dynamometer, an industrial data acquisition / control system and extensive instrumentation. The engine is fitted with numerous sensors. All data acquisition and control is performed with a robust industrial computer manufactured by Opto 22. The engine is loaded with a DC dynamometer. The first test cell utilises six thermocouples, three pressure transducers and four fluid flow meters. 24 input / output channels are used.

From an internet web browser, students in the laboratory can control engine load, speed, and throttle, and run a wide variety of engine tests. Basic tests will allow users to characterise torque, power, and efficiency with variations in throttle, timing, A/F ratio, etc. The engine data acquisition and control parameters are shown in figure 13. More advanced tests will allow exploration of combustion pressure, indicated work, rate of heat release, and emissions formation. The ignition timing and air / fuel ration will be able to control. Additional measurement capabilities will be added to allow measurement of engine emissions and combustion pressures.

Figure 13 The engine data acquisition and control parameters of GEL system

The GEL has been designed so that, in the near future, off - site users with a standard Web browser and access to the Internet can access and run experiments on the GEL est cells. As shown in figure 13, a remote user first navigates to the Web site of the GEL, which supplies necessary information on how to access the test cells, set up experimental schedules, etc. Interactive Java applets are downloaded and executed on the user's Web browser, which provides control capabilities over the test cell. The user can now send commands to the test cell using the control panel embedded in the Web page.

As shown in figure 14, the GEL software consists of three main components:

- GEL Server: Custom server on the host laboratory computer
- GEL Client: Java applet on the remote student computer
- GEL Control : Control program on engine test controller

Figure 14 The components of GEL software

Data are continuously acquired from the test cell and sent to the controller. Local control loops are set up between the controller and the test cell. Desired channels of data are transferred from the controller to GEL Server. Data requested by the user are sent over the connection to the user, where they are displayed in graphical form. This process continues as long as the experiment is in progress, after which all connections to the user are shut down and GEL Server awaits new connections.

According to the experience of Colorado State University , for a high quality educational experience using a remote apparatus, the need to operate an experimental apparatus without on - site human input requires an experimental apparatus without on - site human input requires an extremely high degree of automation, requiring much higher level of development effort than would be the case for on - site operation.

CBT system on the campus net

The combination of the strengths of available teaching material and the flexibility of the WWW services forms a modern, highly accessible Computer Based Training System (CBTS). The CBT offer to the students all the needed information for certain disciplines. The CBTS also make students familiar with the new communication technology and develop their availability to approach particular problems using interactive software.

Some institutes provide campus-wide access to the teaching material. Students of the training system may access the information included in training system at their own pace so learning becomes more efficient.

Figure 16 An example of
Campus net system combined
with WWW service

One of the major aims of the combination is to offer a unitary method to integrate all the teaching materials in a single, consistent and easily updateable system. The system is shown in figure 16.

4. 7 The Role of Instructors of MEET in CBT

Joining the design and production of courseware

The instructors of MEET play a very important role in CBT design, development and delivery process. The efficiency and the result of CBT largely depend on the experience and behaviour of the instructors.

The instructors should join the training class of CBT methodology in order to improve their skills in delivery knowledge by CBT. The role of instructors of Marine Engineering Education and Training falls into two parts.

In the first part, the instructor should join the design and developing team and provide the support in cognitive and instructional category. The development of CBT courseware in marine engineering usually be done by team work. In the experience of designers (Seagull and Marine soft, 1998), the courseware is always better when several people collaborate. Because more skills and knowledge are involved in a development effort than one person typically has. A project team should include people with expertise in instructional design, programming, graphic and video arts, marine engineering, and subject matter. A team generally has more creative ideas than an individual and is collectively more critical.

As the development of a courseware is driven by principles of cognitive psychology, so the marine engineering instructor in the team will play a key role in the period of design. He / She has the responsibility to make other team members understanding the instructional methodologies and their various factors. He / She will give

suggestions when they evaluate the support materials or a part of their work. During the development, instructors usually assist programmers to design stroryboarding, to make graphics, animation and text materials, to edit the video materials, and to evaluate the program. At same time, the instructor need to get enough knowledge in programming and multimedia technology, in order to cooperate with other members. However, the instructor usually become "program expert and experienced designer" after he finishes the development of a CBT courseware, and he will play a key role in next courseware design.

Preparation and organisation of class

In the second part, the instructors should make a careful preparation in a CBT class. The instructors, who have no experience in CBT design or utilisation, should attend a training class so as to understand the CBT methodologies. CBT is a systematic process, which include curriculum design, facilities arrangement, software review, assessment design, instruction delivery, and sometime classroom organisation. The engineering CBT class usually be more complicated than normal course's. For the tutorial CBT, instructor's preparation and behaviour will influence the result of CBT and students' interesting. Student control, although not often improving learning, is generally found to improve student attitude and motivation. There are also other ways to increase motivation which may be implemented independently of student control. All these knowledge should be get by "new teachers in CBT". In marine engineering, many courses in CBT have large contents and complicated demonstration in multimedia. Some times, these CBT courseware have not close relation in content with course book. Some guides and suggestions should be given to the students by the instructor. The instructor also has the ability to reasonably combine normal classroom lectures, CBT tutorial, CBT simulator, marine engineering laboratory and CBT assessment together, and to form a systematic training program. At same time, CBT classroom organisation is also considered as a challenge job. The demonstration in the screen has attracted student's attention and interesting. The instructor not only

deliver instruction and guide but also monitor students attentions. The shifting of students attention usually make both instructor and students tired. The methods of organisation of classtime and students are also included in instructors' training.

CHAPTER FIVE Conclusion and Recommendation

Almost any development in the ability of the fast powerful computer of today has applied in the CBT technical. Especially the multimedia, world wide web and satellite communications have improved the technology of education and training a lot, and provide a wider space for the CBT development. With the large information and reference material to maritime field, one disc can hold the same volume of books as a small library. “The advent of the internet provides scope for a greater interactive role between maritime training managers, ship personnel, training institutions and approving authorities.” The person who possesses more Information Technology knowledge will dominated the competition and market. CBT will play an important role in improving the efficiency and quality of marine engineering education and training.

More and more CBT courseware have been developed in areas of marine engineering. The utilisation of these software will greatly enhance the marine engineering training in the case of their systematic and reasonable using. Those CBT software, which belong to the function of tutor, practical and assessment, have become welcome by individual learners and on - board training. The single and full missions simulations in marine engineering training have provided students more opportunities to make complicated and abstractive concept (process) easier to understand by practising and exercising in simulators. No doubt, more simulations programs will be developed in some skill and practising areas. CBT will become a necessary program which fills in the blank field between theoretic study and practical training.

However, the sources and purposes of these software are much different. The problems of CBT products now are focus on the design and application in training. Most of CBT software are designed and developed by marine machinery manufacturers who manage to introduce their products to users. Most of these courseware are excellent at multimedia demonstration, but poor at the area of engineering training, in fact, just touch a little about engineering. Some institutes have developed CBTs and simulators in education and training purpose. The facts show that more successful results have been achieved than the use of software from other sources. The reason for this should be that the designers of CBT are the experts and instructors in engineering courses, and they are assisted by computer programmers. It is not difficult for marine engineering instructors or engineers to develop because of the available of advanced high function multimedia editing software (for example, Autherware, Visul Basic). They know what contents should be described and noted, and what should be neglected. The elegant and quality CBT software comes from a reasonable organised team, and marine engineer or instructor should be the key members in the team. Every institutes can design and develop CBT, sometimes simulators by themselves.

There is a trend that institutes co-operation in CBT development in order to optimise the production and prevent repeat work in each individual institutes. The co-operation of maritime institutes will make CBT design and development standardisation. It is possible for some countries to establish a CBT system like textbook publishing system so as to make quality controllable.

We should not expect CBT solving all problems in MEET. The application of CBT is related to the economic conditions and technical background. With the improvement and development of CBT in developed countries, the difference of the technology in maritime education and training between advanced countries and developing

countries will become larger. The effective utilisation of CBT is depend upon the level of relation between man and computer. In some areas, instructors and students are lack of the relation feeling with computers, and sometime, do not believe CBT. And the facilities available do not allow widely using CBT. In this case, it is difficult to discuss the efficiency of CBT. Traditional training methods are considered to be more cost efficient and effective.

The flooding of CBT courseware maybe make instructor and students relay on computer too much. However, CBT can not replace the hands - on training. We should notice that technology is the tool but is not the driver. "What we must avoid above all is designing technologically sophisticated hammers and then wandering around to find nails that we can hit with them." That is a great temptation for all of us who are involved with computer technology because computers can do really fascinating things when they are not being stubborn. We would like to see how we can use those potentialities in education. So we need the further study of CBT methodology in MEET.

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