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The use of microcomputers in the training of deck officers

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THE USE OF MICROCOMPUTERS IN THE TRAINING OF DECK OFFICERS

By

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Côte D'Ivoire

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

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

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Last but not least, I thank my family for their affection, their understanding, and their moral support during this long separation. Though it has been difficult for both sides, I am very grateful to Ekissi Marie, my wife, who has been obliged to bring up our four children, alone.

A B S T R A C T

The changes in the maritime industry have led to major adjustments in the training of seafarers in general and deck officers in particular. There are innovations not only in the training programs, but also in the means to achieve them.

The maritime community is seeking ways to categorize the high cost simulators in order to make their training use compulsory. Obviously, not every maritime college will be able to take advantage of this valuable training tool.

This paper advocates the use of microcomputers in the training of deck officers, as a possible alternative to the costly simulators. It investigates the different methodologies that may be used by computer-assisted Instruction (CAI). It gives examples and illustrations of possible use of CAI in addressing subjects such as collision avoidance and use of radar that are important for deck officer training.

Moreover, it looks into some existing instructional software and some application programs and highlights their specific training features in different discipline areas of deck officer training. The delicate question of program evaluation has also been given some attention in line with the hardware prerequisites and the academic aspects of the problem.

The author gives some insights into the training potentials of a cargo handling program entitled Mariner.

He shows how this PC-based program may be used to teach ship stability and cargo handling.

In conclusion, the paper suggests some changes in the approach of the IMO model courses and recommends guidelines for the implementation of CAI in the ARSTM[1] of Abidjan.

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[1] Academie Regionale des Sciences et Techniques de la Mer (Regional Academy of Marine Sciences and Technology)

L I S T OF F I G U R E S

L I S T OF T A B L E S

ABBREVIATIONS

ARPA	Automatic Radar Plotting Aids
ARSTM	Academie Régionale des Sciences et Techniques de la mer (Regional Academy of Marine Science and Technology)
CAI	Computer Assisted Instruction
CAL	Computer Assisted Learning
CD-I	Interactive Compact Disk
COLREG	Collision Regulation
CPU	Central Processing Unit
DEMO	Demonstration
DOS	Disk Operating System
DR	Dead Reckoning
ECDIS	Electronic Chart Display
EGA	Enhanced Graphic Adaptor
ENS	Electronic Navigation System
FQ	Flashcard Queuing
GM	Metacentric Height
GMDSS	Global Maritime Distress Safety System
GZ	Righting Lever
IMO	International Maritime Organisation
KG	Height of Centre of Gravity above the Keel
LAB	Laboratory
LAN	Local Area Network
LCG	Longitudinal Center of Gravity
MARPOL	International Convention for the prevention of Marine Pollution from ships
MET (N)	Maritime Education and Training (Nautical): A WMU course
OBU	On Board University
OOW	Officer Of the Watch
PC	Personal Computer
RAM	Random Access Memory

SG	Specific Gravity
SOLAS	International Convention for the Prevention of Safety Of Life At Sea
STCW	International convention on Stanards of Training, Certification and Watchkeeping for seafarers
SVGA	Super Video Graphic Adaptor
TPC	Ton Per Centimeter (weight necessary to produce 1 cm draft variation)
VDU	Video Display Unit
VGA	Video Graphic Adaptor
VIP	Variable Interval Performance Queuing
VLCC	Very Large Crude Carrier
WMU	World Maritime University

CHAPTER ONE

GENERAL INTRODUCTION

1.1 BACKGROUND

The use of computers in education and training is an attractive issue which is currently being considered by the national educational structure of the author's country. The computer revolution is about to bring major changes in people's lifestyles and there is a fear that countries missing this revolution may suffer damage greater than that engendered by not taking part in the industrial revolution. Expressing his concern (anonymously), a senior public figure of Côte D'Ivoire acknowledged:

> "For various reasons, we missed the industrial revolution and are still suffering its aftermath. We must not allow ourselves to miss the computer revolution which is bound to utterly change the world, more than any revolution ever did."

The national computer board, which has been established to investigate computers as a teaching subject and as a learning tool, is still to release its conclusions. However, one may guess that only the formal education issue will be addressed, as was the case with a previous TV-based educational program.

But, unlike the public working environment and the formal education structure where computers have still a long way to go, the national shipping industry has been deeply influenced by the advent of computers, as is the world shipping industry. However, due to the technological developments in the shipping industry, there is a continuous widening in the training gap between national seafarers and those from developed countries. These developments call for better means to match the changes in the training requirements. This compelling issue has led to the choice of **'the use of computers in the training of deck officers'** as the topic for this dissertation.

Before getting to the core of the topic, it is worthwhile to consider with more insight, the difficulties faced by the training establishments of developing countries in general and by the "Academie Régionale des Sciences et Techniques de la Mer" (ARSTM, the Regional Academy of Marine Science and Technology) in particular, in the training of deck officers and seafarers.

1.2 MARITIME TRAINING NEEDS AND REQUIREMENTS

More than 90% of the country's foreign trade is performed by sea. Maritime transport has experienced continuous growth since the independence of the country in 1960. Therefore, the country very quickly developed shipping lines capable of handling part of this vital shipborne trade. Three maritime transport companies (one government owned & two private) were created concurrently with the establishment of a modern port and a maritime training centre. This training centre gave way later to a modern and relatively well-equipped maritime academy in response to the need to train more qualified officers and personnel for the growing shipping industry.

Whilst the country was trying to emerge as a maritime nation, maritime transport was experiencing a technological revolution. There have been technological changes and progress in:

- ♠ The design, construction and utilization of ships, and in cargo handling, resulting in greater automation of marine transport
- ♠ Navigation automation in the form of automatic position fixing, adaptive auto-pilot, and other navigational procedures
- ♠ Tthe handling and control of complex chemical and gas tankers
- ♠ The automation of main engines which now use integrated computers for central control and monitoring
- ♠ Shipboard radio communication systems, which are being replaced by maritime satellite communications desired to improve the effectiveness of the global maritime distress and safety system (GMDSS)
- ♠ Size of ships, some of which average 200,000 deadweight tons because of economies of scale reasons

All these innovations have resulted in greater needs for training: training not only to cope with new equipment and operational procedures but also to meet new safety requirements. Under the auspice of IMO, the 1978 STCW convention drew up minimum standards of training to be met by watchkeeping officers in order to achieve safer and cleaner seas. In addition to meeting these minimum training standards, maritime academies have to cope with the increasing automation of ship operations in terms of navigational processes, engine room monitoring, and cargo handling as well as shipboard communication (GMDSS) and shipboard safety monitoring (e.g. central control of fire-fighting). Furthermore, new navigational approaches are being developed which will require subsequent training adjustments. These new aspects of navigation are:

- The Electronic Chart Display System (ECDIS) with the possibility to include all navigational information (internal & external) sensors and to fade in the radar picture
- The integrated navigation and bridge systems (integrated ship control) which will allow all navigation processes to be handled electronically (except collision avoidance aspects)

The maritime training institutions of developed countries have responded to the challenges posed by these technological advances by promoting front-ended training schemes, dual or multi-purpose officer training programs, and the extensive use of simulators. For the developing countries, the well known `sandwich' programs are still in order, very often using limited resources to cope with the shift in the training requirements for deck officers. Most of these countries (including the author's) symply cannot keep up with the high costs involved in the training adjustments. This explains the increase in the training gap between the two worlds and the difficulties of the latter in complying with the STCW convention and further international training standards.

The ARSTM of Abidjan has been given two simulators (Radar and Engine room) by Japan, but this complex technological equipment is difficult to maintain. Moreover, advances in computer technology will allow for the developments of more sophisticated and more efficient simulators. Obviously, the ARSTM can neither keep up with the maintenance, and technological changes, nor afford the high costs of simulators.

On the other hand, because of the development of powerful microcomputers and the production of instructional and application software of increasing quality, microcomputers (and associated peripherals) are now one of the best means of keeping up with training trends and enhancing deck officer training. Microcomputers may be repaired locally and their costs (hardware and software) are far lower than those of simulators. Thus, they represent a good alternative training media for deck officers.

This paper intends to investigate the use of microcomputers as a teaching and learning tool in the training of deck officers. It will relate maritime subjects such as radar navigation to the methodologies used in Computer Assisted Instruction (CAI). Moreover, it will analyze some maritime (training) areas, showing how they could be addressed by some existing software. Eventually, an evaluation of CAI and some recommendations for its implementation in the ARSTM will conclude the study. Another aim of this work is to advocate the implementation of computer assisted instruction in maritime academies. The international nature of shipping demands that means be found to provide a common basis for the training of the core personnel who serve as deck officers in the operations of ships. It is believed that microcomputers may play this role if the maritime community takes proper action to avoid the problems which could stand in the way.

1.3 APPROACH TO THE PROBLEM

The use of computers (PCs) in maritime training is of recent origin. Apart from the Lufthansa training institute (Bremen) where the author was able to get a brief view of the practical use of PC-based drills and tutorials, it was difficult to obtain any insights into typical examples of CAI. It was also not possible to have access to instructional software in order to correlate the information derived from books with the actual facts. Furthermore, the books consulted were all about experiences in the formal education field.

Thus, the information gathered through computer publications, conference papers, and books, has been adapted to maritime training and to the discipline areas of deck officers' training. Some software promotional materials have been used to support the argumentation about CAI effectiveness. Fortunately, one software cargo handling program, **MARINER**, has been evaluated to show the teaching potential of computer-based instructions.

All maritime instructional software uses the methodologies experimented with in formal educational structures. The next section will thus use these methodologies to advocate CAI and try to relate them to the maritime field, especially to radar navigation.

CHAPTER TWO

COMPUTERS IN EDUCATION PROCESS

2.1 THE TRADITIONAL TEACHING ENVIRONMENT

Education has always been the cornerstone of the well-being of any society. In ancient African communities, contes were used to inculcate moral and social standards in people. The skills needed were acquired by the youngster through practice and ritual initiation. As the philosophy and the structure of a society change, so does the educational curriculum. The educational environment the author has gone through, which may be termed traditional, consist of the teacher, the learner, the program with the related textbooks, and the classroom with its traditional equipment. Apart from the science lab, where the learner could get feedback to his actions, the only interaction possible was between the teacher and the student. Thus, when the teacher was bad or failed to balance the different paces of learning of his students, there were limited possibilities to bring slow learners back on track, especially when the program was heavy and he had to complete it.

In the maritime world, where knowledge and competency are so crucial for safety, one cannot be satisfied with such a system. In the 70's educators in the author's country thought that the solution to these prevailing insufficiencies was to integrate the medium of TV into the system. What was the outcome?

2.1.1 THE TV BASED EDUCATION IN COTE D'IVOIRE

In 1971 the government of Côte D'Ivoire decided to carry out a TV based education program at the primary school level in order to overcome the weaknesses mentioned earlier. The program was telecast nationwide to every primary school classroom. It was activated by competent and specially trained teachers (masters) at a pre-determined time during the class session. There was no interaction between the master teacher, the teacher and the pupils in the classroom; it would have been impossible. The task of answering questions and carrying out skill instruction was left to the individual teacher in the classroom, with guidelines.

At first, the teachers protested as they felt this system would reduce their influence over their pupils and damage their teaching ability. Although they fully cooperated, there was no such improvement as anticipated. Some basic skills such as reading declined to a level far below the previous one as children were keener to watch TV. What went wrong?

Some people, too quickly, accused the teachers of sabotage and the course designers of being poorly fitted for the job. Were these the only reasons? Besides the introduction of the TV in the classroom, what was the difference between the traditional method of teaching and the TV-based education? The truth is that there was no difference from the interaction point of view. It is true that for part of the lecture time every pupil in the country was enjoying the same quality of teaching but the classroom teacher was still the only master of the instruction process. If his teaching lacked efficiency, the pupils' work would still fall short of their parents' expectations. So, what could the answer be?

Although there is no absolute truth, the author believes the answer may be *interaction*. When the author looks back on his school years, the subject discussed at length with the lecturers or his fellow students was the one best mastered. In a traditional classroom the instructor does not have time to discuss at length every topic with every student. Thus, it is the whole educational system which should be revised.

2.1.2 THE PRESENT ENVIRONMENT

The present educational system is not very much different from the one depicted above. Although new media such as videos and overhead projectors have been introduced in the instruction process, they are still a form of teacher centred learning and do not bring the improvement society is expecting. Christopher and Quentin quoted with reason Susan Markle who stated:

> "It is not what is presented to the student but what the student is led to do that results in learning .. One way transmission is passé in all media." (Christopher, 1989, 11)

Today, with the advent of computers a great opportunity is at hand for a spectacular improvement of educational and training outcomes. In developed countries where the computer has been in use for sometime now, the industry and some training institutions are taking advantage of it as a medium for delivering instruction. The schools and training institutions in the author's country which do have computers use them mainly to make teachers and students computer literate. The explanation of this situation may lie in Alessi and Trollip's admissions (1985, xi):

> " Our experience over the last decade indicates that the development of good computer-based instruction is both difficult and time consuming. It is not something that comes to most people. Good teachers are generally unaware of the capabilities of the computer, while good computer professionals do not usually understand the foundation of good instruction."

This chapter aims not only to stress the capabilities of computers in instruction but also to analyze the requirements for good instruction in order to make better use of computers in training.

2.2 CLASSROOM COMPUTER APPLICATIONS

Computers, as discussed in Chapter Three, are of many uses. In the training field an increasing amount of software which is designed to meet specific pedagogic objectives is available. As well, it is possible to combine other media with the computer in order to make the instruction more effective. Before investigating Computer Assisted Instruction (CAI), it may be useful to have a close look at the features of an effective instruction in general.

2.2.1 INSTRUCTIONAL REQUIREMENTS

In order to achieve an effective learning, instruction must be teacher centred and generate interaction between the learner and the instructor.

Moreover, it should also include a learner centred element and the output of the student should be evaluated. The first phase, teacher centred learning, i.e the presentation of the information by the instructor, must take into account the previous knowledge of the learner. It should be appropriately detailed in order to make it easy for the student in the interaction phase. During this phase, the instructor must be available to answer the student's questions and correct his mistakes when reacting to questions put forward. In the learner centred activity, the student has to practise the skill and the instructor intervenes only when necessary. Bearing in mind that learning occurs mainly through practice, the student must have the opportunity to practise as much as possible. Finally, the evaluation phase is intended to allow the teacher to make appropriate adjustments of the instruction and the student to see what remains to be done.

As one can see, the sequence described above would be difficult to implement since it would require the constant presence of an instructor in order to conform to the pace of learning of every student. This is one of the reasons we advocate *the use of computers in the training of deck officers*. To paraphrase the saying that 'the war is too serious to leave it entirely in the hands of soldiers', one could say that the training of deck officers is too critical for safety to let the nautical lecturers do it alone.

Although computers have the capability to handle all the requirements of good instruction, the exclusive use of computers in the training of deck officers is not advocated. Advocating computer based instruction does not exclude either teachers or the combination with other media.

2.2.2 COMPUTER ASSISTED INSTRUCTION

CAI, as an instructional aid, optimizes the relationships between programmed learning and traditional learning, and programmed learning and creativity, thus facilitating the achievement of set educational goals. It uses sequences of presentations with increased levels of difficulty. In general, there are three main types of programmed learning:

- ♠ Linear programmed learning, in which the student (or the user) passes through pre-determined frames without the possibility to interact with the information presented.

- ♠ Intrinsically controlled programmed learning, where each step of the student is determined on the basis of the answers provided to checking questions in the previous frame. A correct answer determines advancement; an incorrect response leads to repetition of the frame.

- ♠ Extrinsically controlled programmed learning, which contains the extrinsic expertise to make a decision on each step of the student, based upon all pre-history of his answers.

CAI uses different modes of programs which may encompass one or two of the above types of programmed learning. The classification of these modes in relation to the types of programmed learning is as follows:

- Linear programmed learning: **tutorial, modelling, calculation, browsing** (data base information retrieval)

- Intrinsically controlled programmed learning: **tutorial, drill and practice, calculation, simulation, gaming.**

- Extrinsically controlled programmed learning: **gaming and simulation.**

For the purpose of the study, only three of these modes, namely those commonly used in the design of software dealing with deck officer training, will be considered. **Tutorial, drill and practice, simulation,** and one of their derivatives, **assessment tests** will be examined in order to show their interdependency and the flexibility of their uses.

2.2.2.1 TUTORIAL

This methodology uses the linear or/and the intrinsic control approach. It may simply give a presentation of the information or it may present the information and guide the student in the learning process. A general structure of a tutorial (see Figure 1) consists of an introduction section, an information presentation section, a question section which requires student response input, a phase to judge the response, and a feedback or remediation section from which the student may be sent back to the information presentation section or proceed to closing of the program.

Tutorials are mainly used to address fundamental maritime disciplines such as rules, codes, regulations, maths and physics, and English. They may also help to teach the operation of navigational instruments.

THE INTRODUCTION SECTION

There must be an introductory section which will contain the title page, the objectives and directions. The introduction should also provide a section dealing with prior knowledge for the understanding of the topic. The student who does not feel comfortable with the topic will then go back to this prior required knowledge, before going through the actual presentation of the information. This prior knowledge section, as well as any section of importance for the understanding and the mastering of the subject about to be studied, should be clearly stated in the menu with guidelines to go to them.

PRESENTATION OF THE INFORMATION

The presentation of information consists of explanations of facts put before the students in order to allow them to master related subjects. When teaching with a tutorial, the presentation of the information may be performed by the instructor as well. When it is executed by the computer, peripherals such as voice output, plotters, overhead projectors and videos (CD-I) may be used to enhance the efficiency of the program. Hence, the presentation may take any form. Texts, graphics (still and animated images), colours, and sound, may all be used.

In assessing a tutorial, one must consider the quality of the presentation. This has to do with the proper length and layout of the text, the effectiveness of graphic information and the relevant use of colours. The length of a passage or the number of successive pictures between questions or between problem solving exercises must be divided into steps related to the interaction with the student. The layout must take into account the limitations of the screen display in order to avoid the ending of lines in the middle of a word or the beginning of a paragraph on the last line of a display or its ending on the first line. For the student's convenience, scrolling should also be avoided.

The use of graphics, as said earlier, enhances the effectiveness and the efficiency of the presentation. Yet one should not give prime importance to the embellishment of the pictures. Graphics presentations should emphasize the important information in a lesson.

> "Excessive detail or realism should be avoided in graphic presentations. Details can overload memory and confuse the student, who will not know what to focus on. Realistic pictures generally contain more details than simplified ones. However, simple line drawings may demonstrate a point more clearly than realistic pictures." (Alessi & Trollip 1985, 80)

Like graphics, colours play an important role in the presentation of information. Here again, their use must be closely related to the important information and to its applications in society.

GENERAL STRUCTURE OF A TUTORIAL

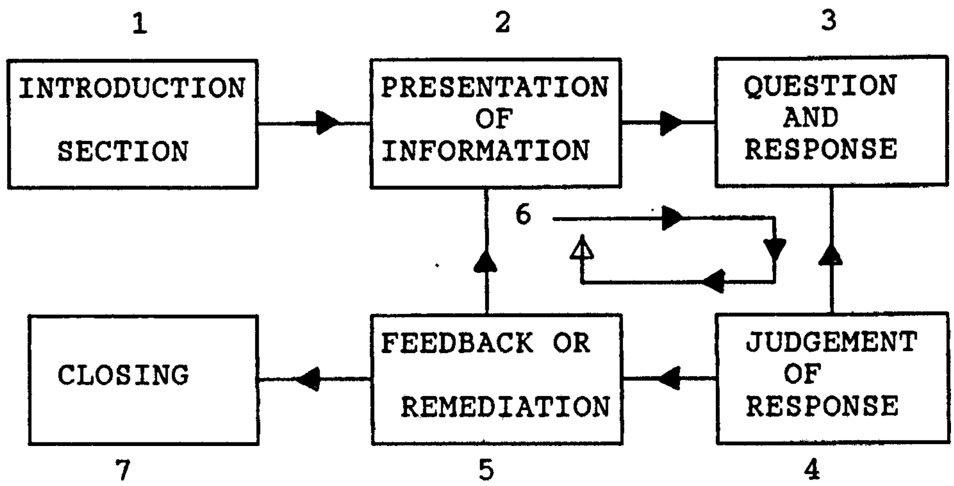


Fig.1

GUIDANCE TO THE STUDENT

After the information presentation section, the student is guided in the learning process through steps 3, 4, 5, and 6 (see Fig. 1). He is requested to input response to questions put to him. Then the answers are assessed and feedback or remediation provided. For a wrong answer, the program may advise the student that his answer was incorrect and send him back to the question once more. A consecutive failure will lead to a remediation and, eventually to the review of the appropriate material. The cycle will continue and end when the student has decided to stop or when he has covered all questions.

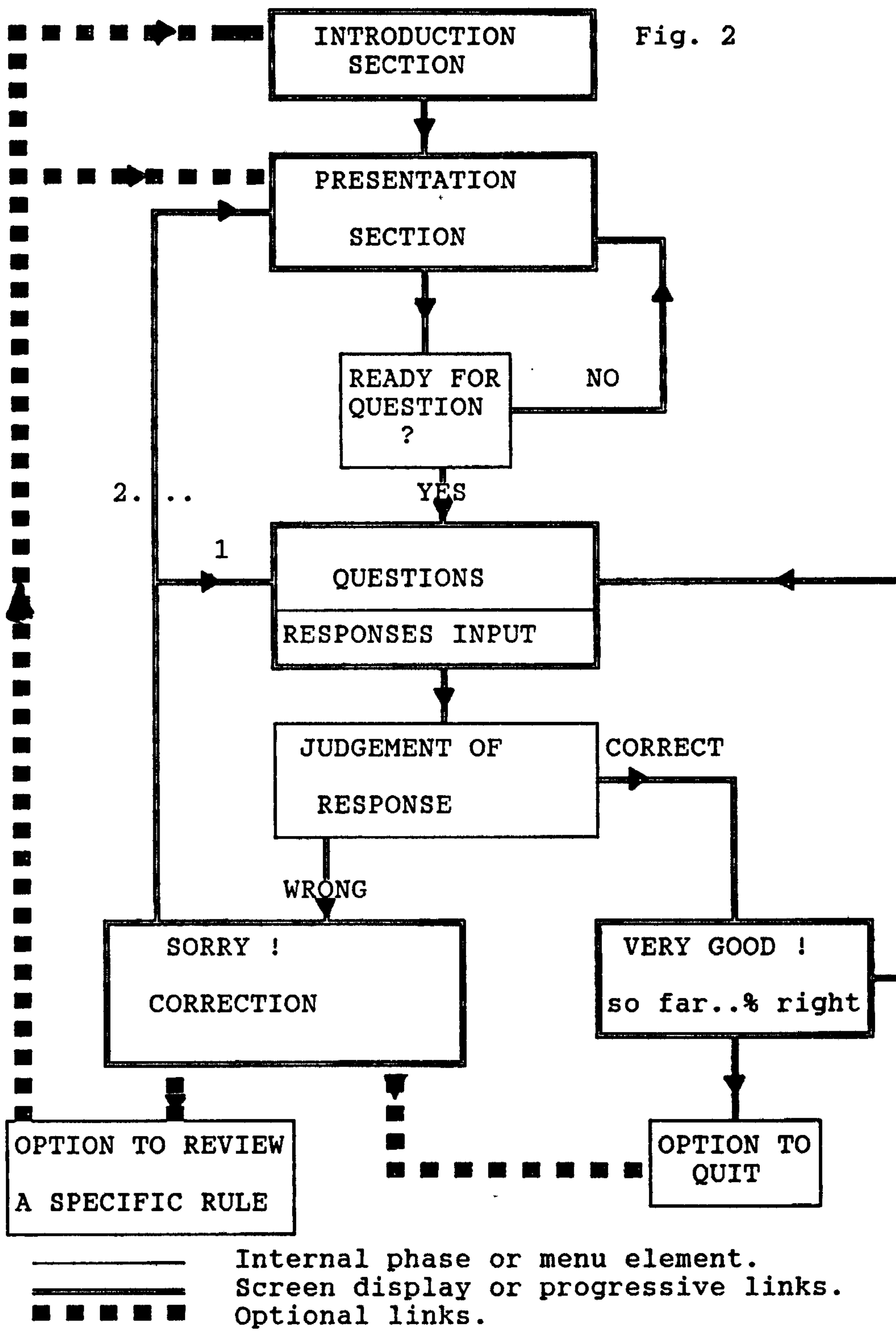
A Tutorial, as the name implies, provides a tutor for the learner; it guides and helps him get familiar with the new concepts developed. Because linear programmed learning does not provide for interaction between the learner and the machine, it is not considered suitable for deck officer training needs.

Consider an example of a tutorial dealing with navigation and radar navigation. The use of radar for navigation involves three areas of knowledge: the fundamentals of radar, the collision avoidance rules , and the implementation of the regulations in a radar environment. Two other model programs will be about fundamentals of radar and situational radar navigation, respectively in the drill and simulation sections. Thus, this following model tutorial will be about collision avoidance rules because of the importance of these rules for radar navigation.

2.2.2.2 MODEL TUTORIAL ABOUT COLLISION AVOIDANCE RULES

The program presents to the student (or the learner) the collision avoidance rules with comments on the key concepts and words. Then it offers the option of questions related to the rules studied. The student may choose to complete more than one rule before opting for the questions which will then cover the rules studied. These rules and related comments may be reached through files with corresponding numbers. The questions are based on case studies. The correction of the first failure will be in the form of a comment on the inappropriateness of the action envisaged whilst a second failure will send the student to the correct answer. The correction will be based on the conclusion drawn from the actual case. In addition to the correction, the student will be sent to the approriate comment on the relevant rule. The radar is supposed to be in use and radar images will depict the situations at hand at a critical moment of the avoidance manoeuvre.

FLOWCHART OF THE MODEL TUTORIAL



2.2.2.2.1 SECTIONS OF THE MODEL TUTORIAL

INTRODUCTION

The introduction, as stated above, will contain the title page, the prior knowledge required, the objectives of the program, and the directions for its operation.

THE TITLE PAGE DISPLAY

COLLISION AVOIDANCE RULES

INTERPRETATION WITH ACTUAL CASES

Producer's name and address

Press space bar to continue

fig.3

The title must be concise and avoid fantasy. In this first display, there is no need to display much information. The second display may be about the prior knowledge required.

PRIOR KNOWLEDGE

In order to take full advantage of such a program, the student must have some understanding of navigation and some background ship knowledge. In addition, he must be able to interpret radar images (see second screen in the next page, Fig.4).

DISPLAY OF THE REQUIRED KNOWLEDGE MENU

REQUIRED KNOWLEDGE

This program requires the user to have some understanding of:

- Φ Navigation
- Φ Ship knowledge
- Φ Computation of vectors
- Φ Use of radar in navigation
- Φ Seamanship

Press space bar to continue

Fig.4

THE OBJECTIVES

DISPLAY OF THE OBJECTIVES MENU

OBJECTIVES

After completion of this module, the student will be able:

- Φ To correctly interpret collision avoidance rules
- Φ To use radar information to evaluate the collision situation.
- Φ To take proper action to avoid collision.

Press space bar to continue

Fig.5 (third display)

The objectives have to be precise so that the student knows in advance what is expected from him. He will then concentrate his efforts in the right direction and this will enhance the learning process.

THE DIRECTIONS

Some programs do not incorporate the directions in their operations. Instead, these directions are in a separate document that students have to refer to when necessary. Including the operational directions in the program improves its interactive nature. In this case the directions are two-fold: 1. explanation of the characteristics (e.g. duration of a question display); 2. key for direct access to the major steps of the program. Below is a screen about the second aspect of the operation of the program.

DISPLAY OF THE DIRECTIONS

DIRECTIONS

Φ Direct access to the start of the lesson from any location <ctrl> <p>

Φ Direct access to a specific rule <ctrl> <n> (n = rule number)

Φ Access to the practice (Question-response) section <F2>. However the questions are locked until the related rules are covered.

Φ The help features may be reached, at every step, with the <F1> key.

press Enter to begin the lesson

Fig.6 (fourth display)

THE PRESENTATION OF THE INFORMATION

The information is presented in the form of texts. Some graphics will also be used to illustrate comments on specific aspects of the rules. The student has control over the display of the information. After studying a rule, he may choose to review it, go to the next rule or face questions related to rules covered so far.

Fig.7: <u>LESSON PRESENTATION DISPLAY</u>

Option *Quit* *Help*

RULE 17

(a)(i) Where one of two vessels is to keep out of the way, the other shall keep her course & speed.

(ii) The latter vessel may, however, take action to avoid collision by her manoeuvre alone, as soon as it becomes apparent to her that the vessel required to keep out of the way is not taking appropriate action in compliance with these rules.

(b)

When from any cause, the vessel required to keep her course and speed finds herself so close that collision cannot be avoided by the action of the give way vessel alone, she shall take such action as will best aid to avoid collision.

(c) A power-driven vessel which takes action in a crossing situation in accordance with sub-paragraph (a)(ii) of this rule to avoid collision with another power driven vessel shall, if the circumstances of the case admit, not alter course to port for a vessel on her own port side.

(d) This Rule does not relieve the give-way vessel on her obligation to keep out of the way.

Press Enter to view comments on R17

NEXT TO THE PREVIOUS DISPLAY

Option	*Quit*	*Help*

COMMENTS ON RULE 17

Φ A vessel is only required to maintain her course and speed in a two vessel situation. In the unlikely event of one vessel finding herself on a collision course with two vessels at the same time, being in one case the give-way vessel and in the other case the stand-on vessel, she could not expect to keep out of the way of one vessel and maintain her course and speed for the other.

Φ Rule 17 does not apply if the two vessels concerned are not in visual sight of each other, or if there is no risk of collision.

Φ A vessel which is required to keep course and speed does not necessarily have to remain on the same compass course and revolutions. Referring to the *Windsor-Roanoke case* recalled in Rule 15, a vessel bound to keep her course and speed may be obliged to reduce her speed to avoid some danger of navigation.

Press Enter for more comments on R17

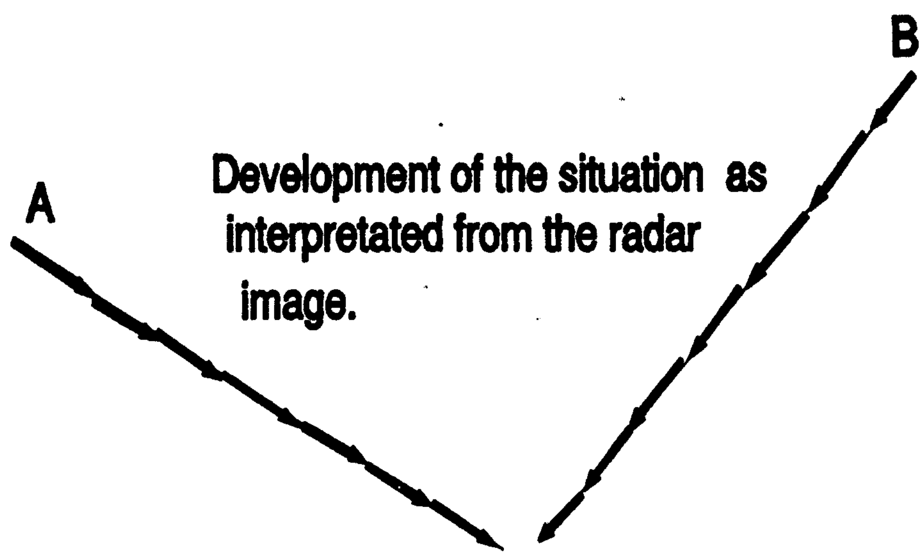
Fig.8

QUESTIONS RESPONSES AND REMEDIATION

When requested or at the end of the lesson, programmed questions will help the student strengthen his understanding of the rules covered. The instructor may use this section for his teaching as well. Below are sample display of questions, responses and feedbacks

DISPLAY OF QUESTIONS

Option *Quit* *Help*



Two power-driven vessels sight each other by radar at 12 nautical miles. The visibility does not allow a visual sight at that distance. However, the radar information shows there will be a very close passage which may involve a risk of collision. What is the adequate manoeuvre if the situation remains unchanged at 4 nautical miles?

1. Both **A** & **B** alter substantially course to port.
2. **A** substantially alters course to starboard and **B** keeps course and speed.
3. **A** keeps course and speed and **B** substantially alters course to starboard.
4. **A** keeps course and speed and **B** reduces speeds.

Input the number corresponding to the correct answer

fig. 9

Consider that the student has chosen answer number 3, *i.e.* **A** keeps course and speed and **B** substantially alters course to her starboard. The next display will then be as follows below (fig. 10).

Fig. 10: DISPLAY OF RESPONSES

Option	*Quit*	*Help*

VERY GOOD! SO FAR YOU HAVE GOT 100%

In accordance with Rule 15, this is the right manoeuvre. Answer 4 may have also been chosen. But if the reduction of speed is not substantial there is the possibility for vessel **A** not to notice the change in the development of the situation (in the radar as well as in visual sight). You are therefore right to stick to Rule 15 and 16.

Now suppose vessel **B** did alter course to starboard but slightly, and vessel **A** in an attempt to open the CPA reduced also slightly her speed (at 2 Nm from B). If the collision did occur, whom would you hold responsible?

1. **A** & **B** equally (50%-50%)

2. **A** 20% and **B** 80% because **B** is bound by the rule to take early and substantial action.

3. **A** 80% and **B** 20% because if **A** would have had altered her course to starboard in compensation for the action of the other vessel, the collision would not have occurred.

Input number corresponding to the correct answer.

Let us assume that the student has chosen answer number 3 on the first attempt and answer number 2 in the second try. Since the correct answer is number 1, the program will send him to review Rules 16 & 17 (a) (ii) and (b). In addition, it will provide adequate comment on the case (next screen).

Fig. 11 **SCREEN ABOUT RESPONSES**

Option *Quit* *Help*

SORRY, ONCE AGAIN YOU ARE WRONG!

REVIEW RULES 16 AND 17 (a) (ii) & (b) AND RELATED COMMENTS.

The two vessels are to be held equally responsible for the accident. Hence, though **B** did alter course to starboard, she did not comply with Rule 16 which states that the action must be early and substantial. As for **A**, the best action would have been to alter course substantially to starboard when there was still time. In the emergency case, if **A** had stopped her engine and reversed for example, the collision would have been avoided. Therefore the blame should be equally shared by both vessels.

Press Enter for more questions *<ctrl><18> for R18*

2.2.2.3 DRILL AND PRACTICE

This methodology does not actually teach, but rather allows the student to practise a skill. It is then assumed that the student has the necessary knowledge required to go through the topic. Hence, practice should be preceded by tutorials which present the information and guide the student. The drill may also be preceded by learning through textbooks and classroom lessons.

In the training of deck officers, computer-based drills may assist students in learning English (the language of seafarers), in physics and maths as well as in every area of deck operations (navigation, radar navigation, cargo handling etc..). In this section, a model program will provide an example of a computer-based drill in radar fundamentals.

GENERAL STRUCTURE AND FLOW OF A DRILL

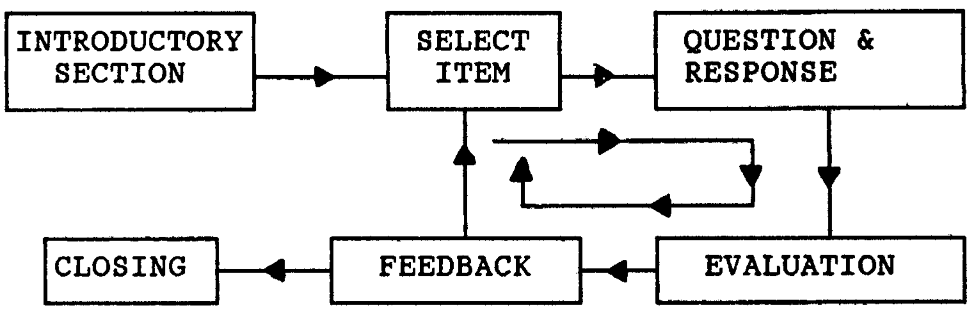


fig.12

As depicted by the figure above, a drill consists of an introductory section followed by a cycle that is repeated many times. When an item is selected and the student answers, the program internally evaluates the answer and gives the feedback about the response. The introductory section contains the title page and directions that should be clear and complete in order to allow the student to go back to them when he deems it necessary. It may refer to the necessary knowledge required for the drill but it should not contain sections dealing with prior knowledge as in tutorials, since the aim is to provide practice and develop interactive skills.

There are three ways in selecting the questions: the question Items may be selected in a specific order, randomly or by the student. The random selection and the possibility for the student to choose a question should be avoided because this contradict one of a drill's aims that is to gradually help the learner to master a particular subject. The program should direct item selection procedures in order to effectively achieve its objectives. It should base the selection on the performance of the student. Organized queuing is a method that determines in advance the order of item presentation and, based on the student's performance, reorganizes the arrangement of items. *Flashcard queuing (*FQ*)* and *variable performance queuing* (VIP) are two such organized queueing methods.

In the FQ method, if the student misses an answer, the program gives the appropriate feedback and the question is put at the end of the previous list when the second question of this list is displayed to him. When the response is correct, the item is taken off the list. Though this method is quite good, the long period of time between the presentation of a missed item and its repetition is a serious handicap for its effectiveness. This weakness is overcome by the second organized queuing technique, the variable interval performance queuing (VIP -see Fig.13). In this method, the positions of a missed item are arranged in advance so as to allow a frequent repetition of items the student has not mastered. The VIP queuing method, though more appropriate for the learning of languages, may be a means of enhancing the teaching of subjects such as radar navigation, as well.

2.2.2.4 MODEL DRILL ABOUT RADAR FUNDAMENTALS

This computer-based drill is a multiple-choice exercise consisting of packages of questions about the basic principles, the components, the operations, and the navigational use of radar. A package of questions is related to a specific subject (e.g. package No 1 for basic principles) and is composed of three lists of five questions each. The lists of questions are ordered in ascending level of difficulty (i.e. list No 1 is easier than list No 2). The drill uses the variable interval queuing technique referred to above. When there are no more questions left in a list, the student may continue with the next list and leave the subject when all lists have been completed.

PATTERN OF VIP QUEUING

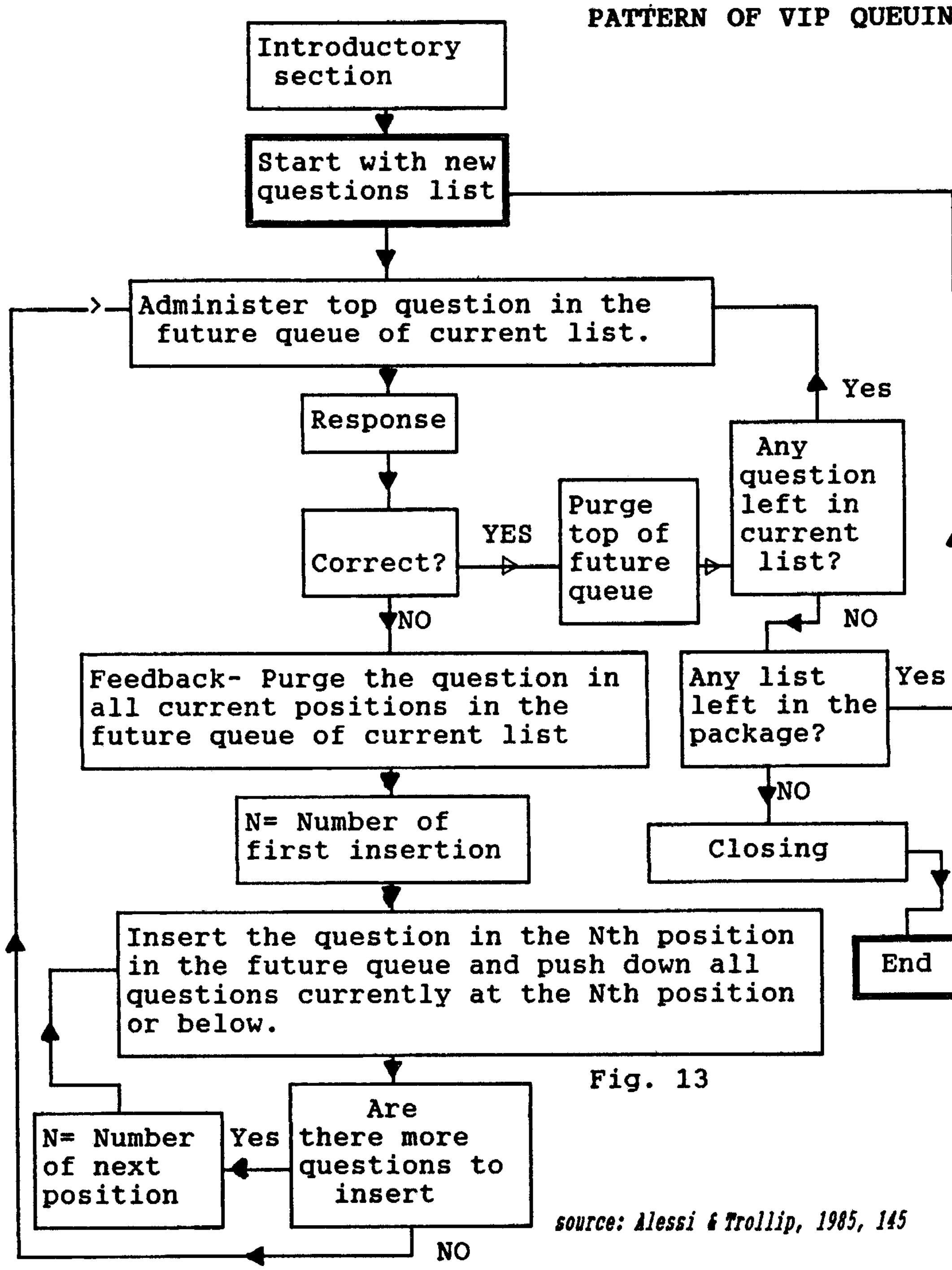


Fig. 13

source: Alessi & Trollip, 1985, 145

Consider the drill package about basic principles of radar and the first list of related questions. These questions could be about:

- The characteristics of the emitted signal
- The characteristics of the antenna
- The sensibility of the receiver
- The discrimination power
- The minimal detection distance
- The new positions of a missed question will be in the third and the fifth (or last) row
- A question whose answer is correct, is taken off the list
- A question cannot follow itself.
- At the end of the exercise, the student will have the option to go to a new package.

INTRODUCTION

The requirements for a title page and clear and efficient directions are similar to those for tutorials and will not be repeated here. As for the objectives, they are to make sure that:

- The student is familiar with the principles behind the Radar;
- He knows the main units of a radar and their functions;
- He knows how to operate the radar;
- He understands the parameters leading to deficiencies; and
- He is familiar with the interpretation of radar images.

SAMPLE OF AN EXERCISE

As said, the program will rearrange internally the order of the questions in the list, based on the student's performance in answering the questions. Take five questions from the list of radar parameters mentioned on the previous page. The questions are ordered according to the first queue in the program.

(A) Choose what could be one advantage and one disadvantage (respectively) of a very high antenna.

(B) What is a bearing discrimination?

(C) When can two close targets be distinguished separately?

(D) What are the frequencies used by Radar?

(E) What is a noise in a Radar receiver?

Fig. 14 <u>DISPLAY OF MODEL DRILL QUESTIONS</u>

Package option *Quit* *Help*

EXERCISE No 1

LIST No 1 QUESTION A

Choose what could be one advantage and one disadvantage (respectively) of a high radar antenna.

1. Detect small target close to own ship-- Decrease sea-return
2. Detect far -- Increase sea-return
3. Better discrimination power-- Less brilliance of the CRT.

Input number for answer.

Assume the student has chosen answer 1. Since the correct answer is 2, he will get the appropriate feedback and face question B. The new internal order will be: **B C A D E A.** If he finds the correct answer to B, the new order will be: **C A D E A.** Assuming he misses C, the internal queue of the list will this time be: **A D C E A C.**

The student will then have once more to answer question A, hopefully correctly because of the feedback he received from his previous failure. This feedback will be either in the form of a text or a text combined with a graphic which will give a brief explanation of the right response. Below is a display of a sample feedback related to the failure of question A (when answer 1 is chosen).

Fig.15 **DISPLAY OF RESPONSES**

Package option *Quit* *Help*

Read comment and try again question A, later!

COMMENT ON QUESTION A

The height of the antenna above the sea level determines the geographic range of the radar as the height of human eye determines the farthest he can see. Onboard vessels this height is limited by technical criteria: too low, the Radar horizon will be limited; too high the sea return will be increased.

Press space bar to continue

2.2.2.5 SIMULATION

Computer-based simulation is the most popular and powerful instructional program. It uses imitation or replication of the real world. It may deal with the four phases of the instruction package discussed at the beginning of this chapter: namely the information presentation, the guiding of the student in acquiring the skill, the provision of practice to enhance performance, and the assessment of the skill gained by the student.

In the training of deck officers this instruction program already plays a major role and its training implications are bound to amplify. Some maritime training institutions are even partially replacing the sea time required for deck officer training with a period of time training in simulators. Why is simulation so valued by seafarers?

The answer to this question lies in the tremendous responsibilities placed on seafarers in general, and particularly on deck officers who are in charge of the ship on behalf of the master. An accident at sea can cause serious damages to the environment, enormous losses of properties, and deaths. Moreover, people are more and more environment conscious. Therefore, the deck officer, in handling the cargo or in manning the ship sometimes in congested waters and in a troubled environment, cannot afford to make the slightest error. Though the traditional training system (shore-based and sea training) works well, the deck officer does not always face the serious situations which very often lead to catastrophic accidents. With simulators or PC-based simulators, however, the deck officer has to navigate through hazardous coastal waters in reduced visibility or avoid collision situations in a heavy traffic zone, thereby acquiring the sensitivity for the situation that leads to responsible and effective control.

Since the author is advocating in this dissertation the use of microcomputers for the training of deck officers,the focus will mainly be on PC-based simulation rather than on simulators, which, due to their high capital and maintenance costs, cannot be afforded by many institutions.

Simulation programs can be divided into four main categories that are: physical, procedural, situational and process. Each of these categories can be used in the training of deck officers.

PHYSICAL SIMULATIONS

These programs deal with learning about instruments and the way they work. The student can see the picture of the instrument displayed on the screen and learn about it as well as how to operate it by triggering the appropriate button with the help of a mouse. Unlike simulators, where the bridge is duplicated and where the simulated operation is similar to the real one, simulation in PCs does not offer the opportunity to correlate the manipulation of a physical tool with the happening on the screen. Today, however, it is possible, with the advent of the touch screen input, to design software which will allow the operation of an instrument displayed on the VDU by physically touching buttons representing functions one wants to activate.

For example, the display of a radar set will allow the student to manipulate the different functions right on the screen. He will be able to learn the operation of the radar as well as some basic principles such as the relation between the length of the pulse and the bearing discrimination. When for a given radar image he first selects a short pulse length (0.1μs) and then chooses a longer pulse (1 μs), he will see that not only do the echoes get stronger (brighter) but also that those which are close to each other on the same bearing tend to merge. In addition, he will find it difficult to distinguish the small echoes near the ship because of the brighter sea-return.

Physical simulation on PCs may give students from remote and poor training institutions the opportunity to study the numerous, diverse and complex instruments fitted in the bridge of a modern ship.

PROCEDURAL SIMULATIONS

Procedural simulations teach sequences of actions such as the procedures to be followed when getting a ship alongside a quay or getting it underway, when starting a radar set or the main engine, to name but a few. The student, complying with the sequence of actions (the procedure), acts and the computer program responds, giving information or feedback about the related effects as it would be in the real world.

Many simulation software programs in use in maritime training institutions are procedural simulations. The physical simulation described above is usually part of a procedural simulation for which it serves as a vehicle. Referring to the example about the physical study of the Radar set, PC-based procedural simulation will complement this study and allow the sequential operation of the radar. With a software containing the different units of the radar set the Instructor will be able to teach how to start the radar, how to operation it, and how to use it in navigation.

SITUATIONAL SIMULATIONS

In situational simulation the student plays roles in different situations created by the program based on facts. Unlike physical or procedural simulations, these do not teach the uses of physical objects or procedures but expose the student to situations he has to master.

Situational simulations play an increasing role in the training of deck officers. Many maritime academies use bridge, engine room, and cargo handling simulators to enhance the training of their marine officers. Some of these institutions, like Singapore Polytechnic, have developed simulation training for more than a decade now. Among the programs in use at this institution are:

- ♠ Navigational control of a ship while transitting and manoeuvring in hazardous and congested waters (use of radar and ARPA in effective collision avoidance is included);
- ♠ Upgrading training in plotting techniques, coastal navigation and collision avoidance for naval officers; and
- ♠ Realistic risk of collision situations for home-trade officers.

Most of the subjects mentioned above are simulator based. The simulator is linked to an Electronic Navigation Systems (ENS) room that is fitted with most of the modern electronic navigation instruments, e.g. ARPA, Satellite Navigator, Omega, Loran C, Decca Navigator MK 30, Automatic Radio Direction Finder, and Echo Sounder (Barker, 116, 1989). Though very effective, this training would be difficult to implement in every maritime training institution because of the very high capital and maintenance costs of the associated technology.

Today, however, the rapid advances of software in the area of ship operations and the increased power of computers allow most situational simulations to be done in PCs. Programmers are, for example, producing programs with a view of 360° for the own ship. Combined with appropriate peripherals and other support facilities such as overhead projectors and a large blackboard (or similar screen) the microcomputer can generate an environment very much like the bridge simulator one. The only difference will be the operational part of the training, i.e. the training provided by simulators on the real hardware fitted in ships' bridges and engine rooms. Numerous software packages exist already which deal with cargo handling, radar and other electronic navigation simulation on PCs. This move should be be encouraged in order to achieve IMO's aims of cleaner seas and safer navigation.

Situational simulation may also be used to address the many human issues nautical students are bound to face during their careers. The maritime community attributes eighty per cent (80%) of the total shipping casualties to human error. A good proportion of this percentage is believed to derive from poor relationships within the crew, deficient communication due to language barriers or poor management, and a bad relationship between the ship and the outside. Maritime educators are being asked to lower the level of the now famous human factor element. While the focus today is on the competency side only, the author humbly believes that it would be an error to overlook the human relations issue. Fortunately, it is possible, by combining knowledge from social studies (different cultures) and from shipping, to build situational simulation programs which can handle this issue properly and hence contribute to the reduction of this distressing eighty per cent.

PROCESS SIMULATIONS

Process simulations are programs where the student inputs selected values of different parameters at some steps of the simulation and then watches the process taking place. They are used by economists for forecasting the outcome of their plans, and by scientists for studying the behaviours of ecological systems when varying some pollution parameters.

In the training of deck officers, process simulations are used for ship manoeuvring and engine simulations. In these simulations, the action of the student generates a chain of occurrences within the programmed structure. Whilst ship-handling or engine-room simulators combine the physical equipment of the bridge or the engine-room with the process taking place, process simulations on PCs deal with the second aspect, i.e simulation of the developments taking place without the combination of the operational gear. In a PC-based propulsion plant simulation for example, the student will have the possibility to study the working of the components of the engine. When he triggers a valve to shut it, he will observe the rising of the temperature and the build-up of the pressure which will progressively affect the working conditions of the whole engine. The instructor may create a fault in the structure and have the student try to find the cause of the malfunction and correct it.

PC-based process simulation may also be used to teach meteorology in order to allow the student to master the forecasting of weather, to strengthen the students' awareness of pollution matters or to study variation in sea states.

2.2.2.6 MODEL SITUATIONAL SIMULATION

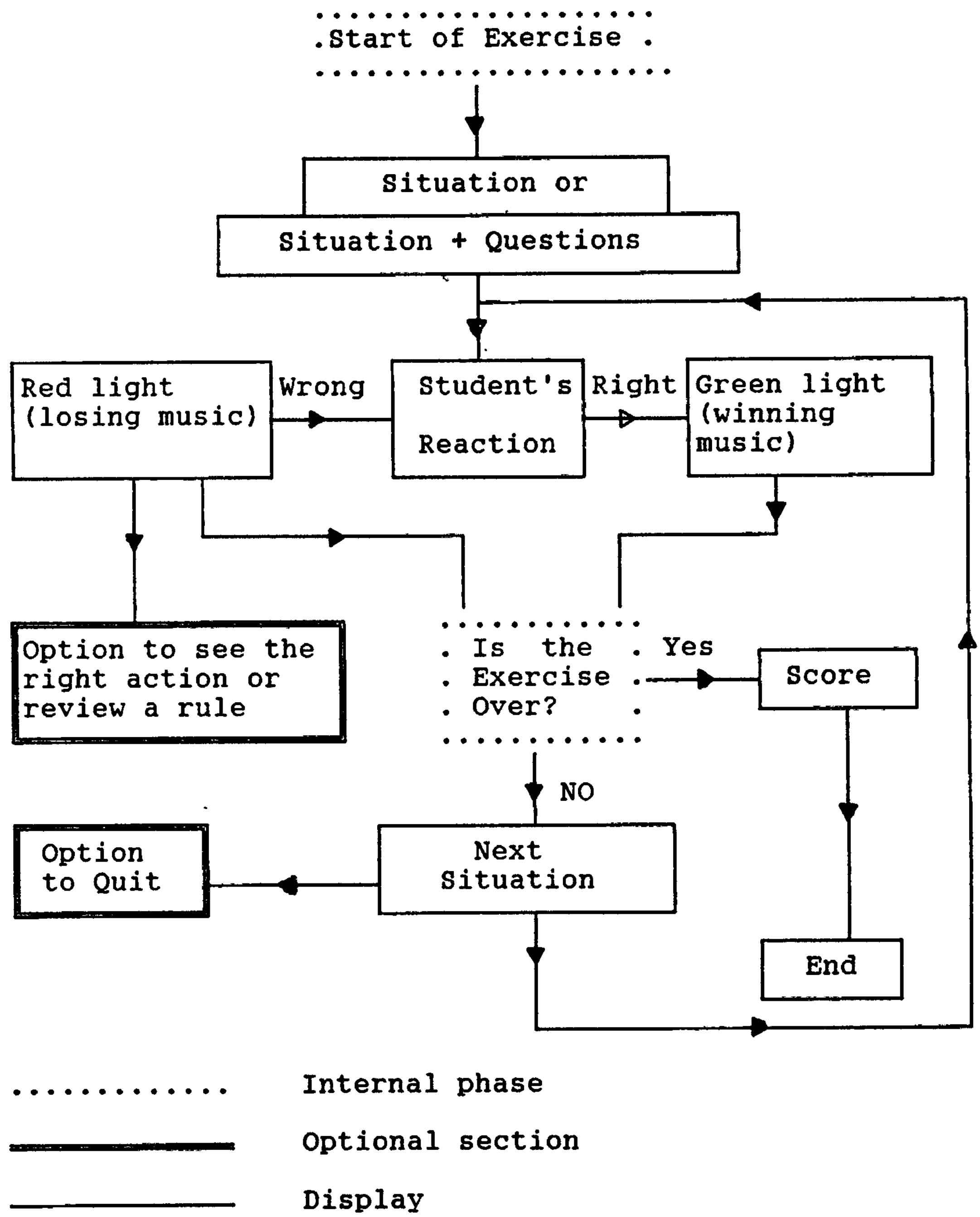
Situational simulations may combine physical, procedural and process simulations. They allow the instructor to expose students to any aspects of ship operations.

As an example, in the training of deck officers', an instructional simulation may involve navigation in long congested waterways with varying obstacles such as the weather (fog and rain), shoals, and many fishing and other vessels with properly exhibited lights and shapes corresponding to the nature of their activities.

The student will be required to follow navigation rules and avoid collision by observing a CPA of at least one nautical mile. Modern navigational equipment such as Radar ARPA, GPS receivers, ECDIS, and LORAN C will be available to him. In addition, he will have the possibility to switch the screen to a radar view, to a chart view (ECDIS with automatic position fixing system) or to the actual scene view.

Some fun may be added through the evaluation process to empower the motivation and learning capacity of the program. For example, when a wrong decision is made, a red flashing light followed by a sad sound will indicate that the student has failed to take the right action. On the other hand, a successful decision will be acknowledged by a quick flashing green light and a short triumphal piece of music.

Fig. 16 Flowchart of the Model Simulation



FEATURES OF THE SIMULATION

THE OBJECTIVES

The student enjoying the above example will be expected to gain the following skills:

♠ The ability to navigate with radar
♠ Conduct of vessels in restricted visibility
♠ Knowledge of lights and shapes displayed by vessels related to their type and state.
♠ Knowledge of the Rules of the Road.
♠ Collision avoidance ability in:
  ♠ overtaking situations
  ♠ crossing situations
  ♠ head-on situations
  ♠ used of sound and light signals
  ♠ safe speed in restricted visibility

INTERACTION

The instructional effectiveness of any simulation lies, for an important part, in its ability to provide good man-machine interaction. The program will achieve this effectiveness through simplified operation, high quality responses to input actions, and the proper control of its operation by the student.

The operation of the program will be simplified by the use of very few keys to manoeuvre the ship - e.g left or right arrow keys to turn to port or starboard, up and down keys to stear a linear route ahead and backward, respectively. In addition, the bridge main instruments will be represented by some boxes at the underside of the screen. When triggered, they will provide the information requested by the user, on one corner of the screen.

As depicted by the flowchart in figure 16, the student will have the possibility to consult the program for a correct manoeuvre and a right interpretation of the information provided by the radar screen. In addition, he may choose to review rules related to the situation faced.

The possibility for the instructor to vary the behaviour and the position of the target ship and the environment (weather and sea) conditions will enhance the quality of the exercises. The number of vessels present at one time will not be more than five in order not to overcrowd the scene.

2.2.2.7 ASSESSMENT

This section will deal with the last component of computer-aided instruction, the assessment of the skill or knowledge gained by the student.

The main purpose of a test is to assess the student's knowledge. The result of this assessment may lead to the ranking of students in terms of their performance, the award of certificates, the issuance of diplomas or even the securing of jobs. The instructor may also use these results to reshape his teachings.

PC-based assessments are of two types: 1) the computer may generate the test, administer and score it; 2) the instructor may score a print-out of a programmed or written test administered by means of computer. The second category of PC-based assessment is mainly used in application programs. The cargo handling software evaluated in Chapter Five is a case in point. The tests may be within a tutorial, a drill or a simulation program, or they may stand alone.

Considering the current assessment software, it must be said that most computerized tests are simple and do not always ascertain the mastering of the topic by students. Hence, they (first category types) are mostly multi-choice on which students may perform well with some luck.

However, computerized tests based on simulations offer many advantages in terms of the tailoring of tests to suit individual students, the storage of information derived from the students' performance for the improvement of the instruction or testing process, and the accuracy and fairness of the scoring.

2.3 PROGRAMMING

A program is a set of instructions that tell the computer what to do. For this purpose many computer languages have been developed of which Basic, Prolog Fortran, PL1, Pascal, Cobol, and APL are the most important.

The programmer is a person who masters these languages and solves problems by writing instructions that give orders to the computer. The instructional software, referred to throughout this essay, is the programmers' contribution to deck officers' education and training.

Programming as a subject has been taught in schools of developed countries for more than a decade now. Though the outcome is controversial, a majority of educators is in favour of increasing the teaching of computer programming. As Coburn and Kelman put it,

> "The argument for student learning to program is preparation for computer-related careers. More

> and more jobs in society involve use of computers, many calling for actual programming skills. Even for those jobs that do not directly deal with programming, some understanding of how programs work can be very helpful" (1982, 50).

The question is: should programming be included in the curriculum of deck officer training? Throughout this Chapter, the importance of computer-based training for the shipping industry has been demonstrated. Since the trainers would have to be former deck officers, engineers and other sea professionals, there is no doubt about the necessity to introduce basic programming into the deck officer training curriculum.

For the time being, outside programmers may help since one does not need to be knowledgeable in maritime matters in order to write a program dealing with this field. This truth should not impede the encouragement of the programming vocation within the maritime community, especially in poor training institutions where local expertise in computers could help in minimizing costs.

CHAPTER THREE

MARITIME TRAINING
A COMPUTER APPROACH TO TEACHING

3.1 INTRODUCTION

The shipping industry, as far as bridge operations are concerned, has two main directions of development. On one hand there are the high technology vessels, operated by some shipping lines of developed countries. These vessels, with a very small crew, will be navigated by one man under most conditions. On the other hand, there are the traditional vessels with relatively simple equipment and a relatively large crew, operated by shipping lines of both developed and developing countries.

The training requirements for deck officers navigating these two types of ships obviously cannot be alike. Whilst the latter vessels can be navigated by a traditionally trained deck officer, the operation of the advanced technology vessels requires the use of highly sophisticated techniques. The deck officer, in addition to the traditional navigational tasks, has to operate and monitor various technical systems. Which training is this paper addressing ?

Though in the author's country the vessels in use are of the traditional type and will be so for the forseeable future, the general trend is towards the gradual replacement of the existing ships by high technology vessels and no shipping line can afford to ignore this fact for a long time. Although up to now the training requirements for deck officers have not changed that much, the shift in the working environment of seafarers calls for a new and better approach to deck officer training.

Computers, the vehicle of the present evolution in the bridge environment, have also proved to be a good teaching and learning tool in this transition phase of deck officer training. Computer-based instruction is slowly but steadily making its way into the training process of seafarers. In addition, a lot of software programs designed for shipping industry use, ashore as well as on board, appears to be a very powerful teaching medium. The use of such programs is increasing in a number of institutions through simulations, tutorials, drills and tests.

OBJECTIVES

This chapter is intended to investigate the use of instructional and application computer programs in the training of deck officers. It will show the superiority of computer assisted instruction over the traditional way of teaching and highlight the tremendous training potential of computer programs in ship operations.

The different discipline areas of deck officer training will be addressed, namely the supporting subjects, and the nautical and engine aspects and the business aspects. Moreover, the subjects the author intends to teach in his home academy will be given more emphasis. Some ideas about the use of computers in the teaching of navigation, seamanship and bridge operations will be discussed with the aim of reducing the burden put on both teachers and students by the continuous changes in the working environment of deck officers. This chapter does not deal with the necessary changes that will occur in the training curriculum of seafarers. Rather, it advocates the use of computers to improve deck officer training outcomes based on the present curriculum. The use of computers in maritime training is also believed to pave the way for the major changes which will no doubt occur in the education and training of seafarers in general and of deck officers in particular, reflecting the profound changes that the shipping industry is already undergoing.

3.2 DISCIPLINE AREAS

3.2.1 SUPPORTING SUBJECTS

The competition between shipping lines for a better share of the market has led to the option of reducing the crew in the major shipping lines of developed countries. This move has greatly modified navigation practices on modern ships where integrated computer related systems are used to control not only the engine and the handling of the cargo, but also the navigation process.

The deck officer or the bridge operator, as he should be named, acts now as an active observer, monitoring and controling complex systems. Therefore, he needs a more solid education in mathematics, physics and other scientific subjects than before in order to cope with the increasing sophistication of the bridge operations.

Maritime colleges, whose entrance levels are generally below university standards have to adjust to the new situation and new training requirements since their graduates may have to operate the modern ship of today or the second hand high technology ship of tomorrow.

Using the demonstration power of computers, teachers can improve greatly the teaching of mathematics and science subjects. The teaching of mathematics and science involves the use of abstract concepts that are not always easy to grasp. In a traditional classroom, because of the large number of students and the consequent heavy workload for the teacher, it is almost impossible for each individual student to seek assistance and to clarify any doubts he might have in solving problems.

Furthermore, the slow learner, whose pace of learning is being ignored, will tend to drift away from any abstract concepts, complicating the task of the teacher.

Through a good man-machine interface, these problems can be easily solved. The use of microcomputers not only offers the opportunity to relate a concept taught with the actual facts in navigation as well as in engineering or other areas of deck activities, but also allows the review of the subjects taught at one's own pace, consolidates the skills involved in problem solving through practice, and hence enhances the total understanding of the science subject. Moreover, the teacher, freed from the previous burden, will have now the time to monitor the learning progress of his students and adjust his teaching accordingly.

There are many 'computer assisted learning' programs in the fields of maths, physics, and chemistry on the market. For example, Control Data, a software producer based in Australia, offers a lot of courseware in mathematics, physics, and chemistry. These programs cost $120, $145, and $150 per subjectc and per unit for maths, physics and chemistry, respectively. These software programs are listed as folows:

MATHEMATICS

- Limits
- The Derivatives
- Techniques of Differentiation
- Derivatives of Trigonometric Functions
- Application of the first Derivative
- Application of the second Derivative
- General Properties of Continuous and Differential Functions
- The Definite Integral--The Indefinite Integral (2 units)
- Physical Applications of the Definite Integral
- The Natural Logarithm
- The Natural Exponential Function
- Other Logarithm and Exponential Functions
- Integration by Substitution and by Parts
- Lengths of Curves
- Introduction to Series
- Additional Topics on Convergence and Divergence of Series
- Power Series

PHYSICS

- One-Dimensional Kinematics
- Two-Dimensional Kinematics
- Particle Dynamics and Gravity
- Work, Kinetic Energy and Power
- Potential Energy and the Conservation of Mecanical Energy
- Impulse and Collisions
- Rotational Kinematics
- Rotational Dynamics
- Angular Momentum

- Oscillations
- Charge, Matter and Colombus's Law
- The Electric Field
- Gauss' Law
- Capacitors and Dielectrics
- Current and Resistance
- Magnetic Field of a Current
- Faraday's Law
- Inductance and E/M Oscillations

CHEMISTRY

- Classification of Matter
- Atoms, Molecules and Ions
- Thermochemistry
- The Physical Behaviour of Gases
- The Electronic Structure of Atoms
- Liquids, Solids and Intermolecular Forces
- Chemical Reaction Rates
- Gas Phase Equilibria
- Acids and Bases
- Free Energy, Entropy, Equilibrium
- Electrochemistry
- Main Group Chemistry

At the request of the customer, these programs may be made to fit DOS, UNIX or any other operating system. Since it has not been possible to try out any of the software packages above, the author cannot assess their quality and teaching potentials. The exhaustive lists above give evidence of the potential applications of CAI in teaching fundamental science subjects at maritime academies.

Lacking the expertise to design effective courseware, one has to rely on available CAI materials, making sure the software chosen provides a good man-machine interaction, allows the learner to control the learning process, and contains a sound graphic display design. The teaching of maths and physics involving the use of many abstract concepts, the graphic component of such programs is very important. As put by Barker,

> "It is important to realise that too many static graphic displays are not effective. Graphics with animation, enlargement, overlapping of color pictures and superimposition of graphs will definitely enhance the learner's ability to learn. An interactive (and participative) graphics display facility in which the learner has the flexibility and opportunity to build up graphic images as he inputs data is a most desirable facility to have." (Barker, 1989, 85)

To demonstrate the superiority of CAI over the traditional teaching methods and its effectiveness in the learning of maths and science, consider the experiment carried out by Tan and Yong (Barker, 1989, 86).

This experiment involved two samples of four hundred students. Both groups were tested in maths and science subjects prior to an initiation course. Then group I took the computer assisted learning induction course while group II was given the prescribed materials for self-study with the possibility to consult available teachers in the traditional way. On the completion of both one-month courses the two groups took a post-test consisting of multiple-choice questions like the first one.

Figure 17 shows the diagram of the experiment and Figure 18 the graphical representation of the findings.

The results of the experiment show that the two groups performed better in the post-test than in the previous one. Group II, which took the traditional course, showed a gain in mean score of around 1.5 per cent and a reduction in the failure rate of only 5.8 per cent, whilst the improvement of the mean score of group I was 11.9 per cent with the failure rate reduced by 37.4 per cent. The improvement of the mean score and the reduction of the failure rate in the traditional learning process were multiplied by seven through the use of the computer-based learning method. Thus, group I who took the computer-based induction course performed significantly better than group II who took the traditional course.

A similar experiment with two groups of students following the same procedure, but with this time a group of teachers coaching group II with CAI materials whilst the CAI group (group I) was left in the previous situation yielded the results in the Table below.

Table 1: Second experiment results

GROUP	GAIN IN MEAN SCORE	REDUCTION IN FAILURE
GROUP II (coach by teachers using CAI materials)	13.9 %	36.5%
GROUP I (CAI COURSE) [without teacher]	11.8%	22.5%

In the light of this experiment, teachers may feel comfortable for computers are not about to take their jobs. Although instructional and shipboard application programs can help students and generally learners in their studies, the contribution of the teacher is of great importance because of the inevitable limitations of computer programs. Using the teaching potentials of computers, teachers can greatly improve the students' learning output.

In the teaching of mathematics and other disciplines related to the training of deck officers, computers must be a medium that enhances the quality and the comprehension of the transmitted information. Having this in mind, the next sections will discuss the applications of computer software in the teaching of nautical, engineering and other subjects in deck officer training.

Diagrams of experiment validating CAI effectiveness

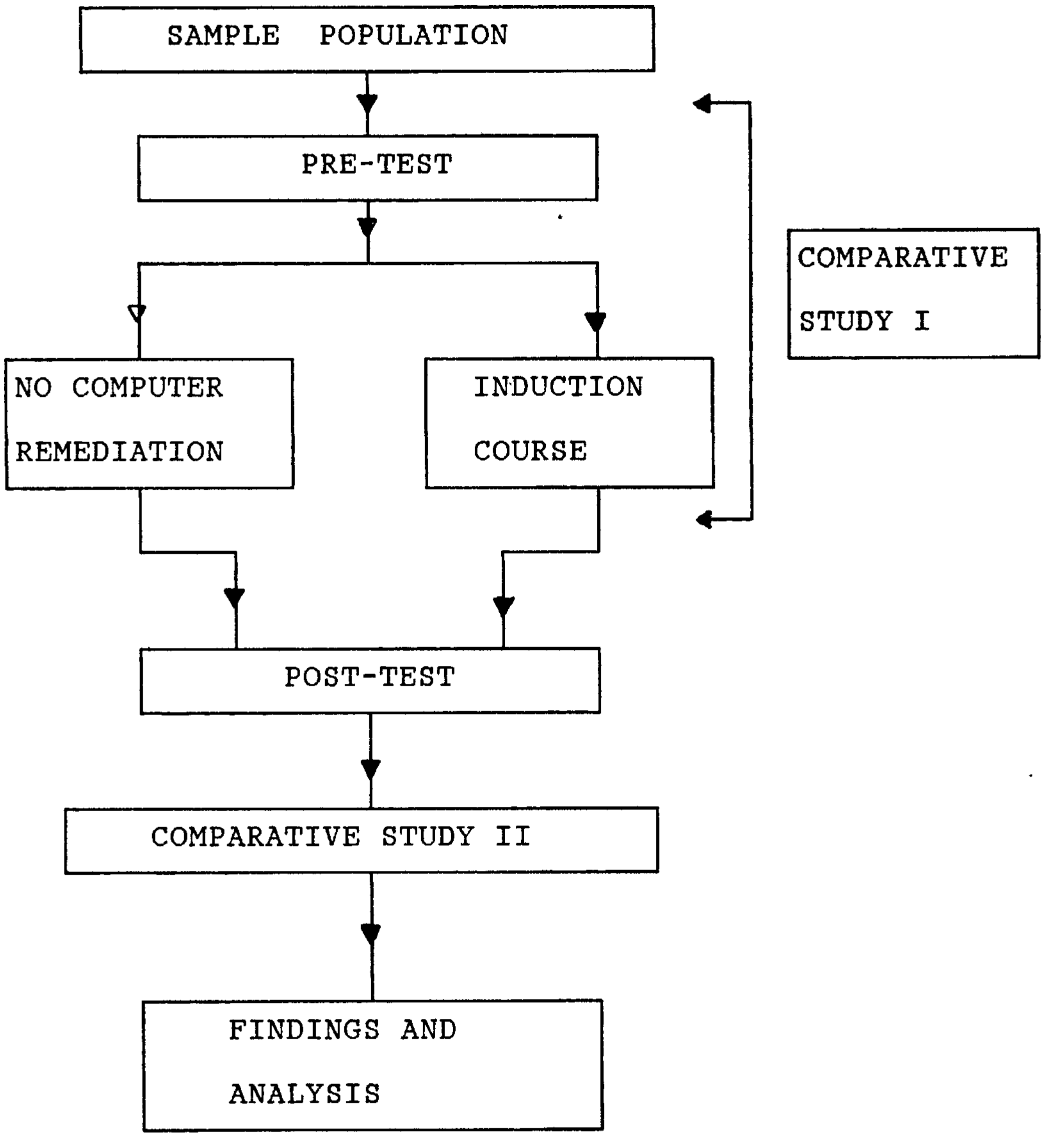
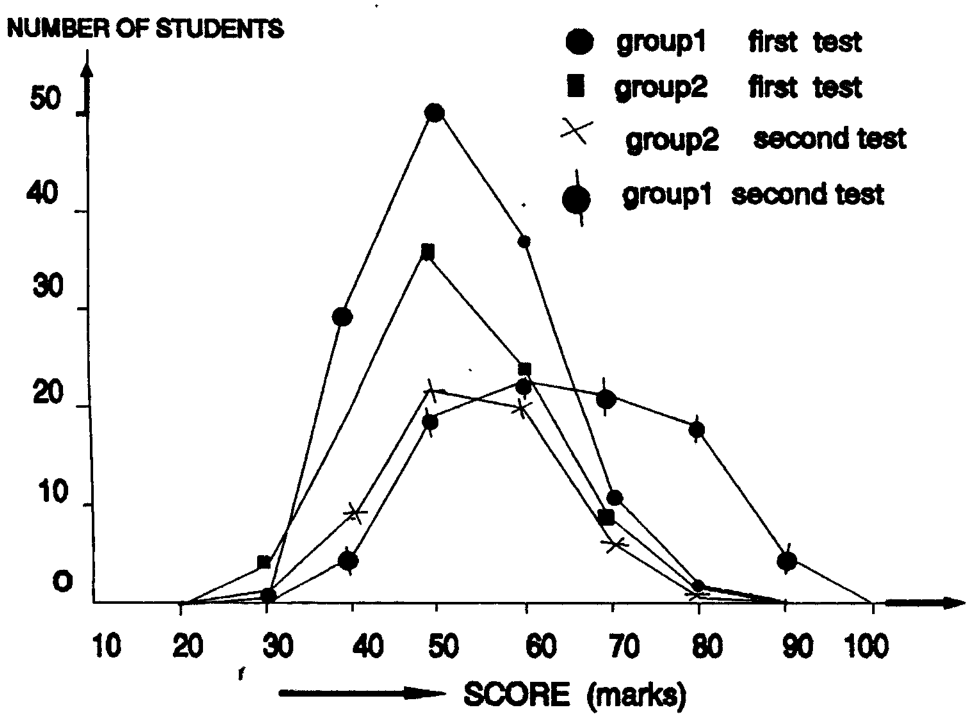


Fig.17

Students' Results in The CAI experiment

fig.18



All students who took the first test did not take the second test. Source: Barker, 1989, P.88

3.2.2 NAUTICAL TRAINING

The main tasks the deck officer has to perform during his watch (alone or with his team) are:

- Keeping the pre-planned track using position finding and course correction methods.
- Detecting of navigational hazards and aids, and avoiding hazards to navigation by radar and visual look-out.
- Checking status information from systems to be monitored (cargo, propulsion, energy and fire control).
- Reacting to alarms from internal technical systems, external messages or visual observations.
- Observing weather conditions.

♠ Doing documentation.
♠ Managing the onboard activity schedule.

To perform these tasks, the deck officer must have sound knowledge of a wide range of disciplines which are involved in planning, execution and termination of the voyage. He must be conversant with the disciplines contained in the exhaustive list below.

♠ Collision avoidance regulations
♠ Radar observation and plotting (ARPA)
♠ Electronic position fixing systems and echo sounders
♠ Use of magnetic and gyro compass
♠ Aids to navigation such as, buoys, navigational marks and vessel lights
♠ Navigation calculations, almanacs and tides
♠ Meteorology
♠ Ship manoeuvring and handling
♠ Ship construction and stability
♠ Emergency procedures on board
♠ Fire prevention an fighting
♠ Personal survival and life saving
♠ Cargo handling (containers, oil, chemical and gas)
♠ Pollution aspects of shipping
♠ Personnel management, organization and shipboard welfare
♠ Communication (equipment and procedures)
♠ Engineering and electronic systems.

In addition, as an intermediary between business people, the deck officer must have a solid acquaintance with business aspects of shipping such as accounting, voyage estimates, chartering and maritime law.

The above list has been purposely made exhaustive in order to show the apparent contradiction between the shipping industry's desire to have highly trained officers and the broad range of knowledge the latter have to master. Even with the automation of the bridge and the consequent ease of the workload of the deck officer, the case is worsening since the officer, without being freed from previous knowledge requirements, has now to be an electronics expert. The danger is that, he might know a bit of everything but nothing in depth.

The best way to avoid this danger is, once more, training with computers as a medium for delivering instruction. This section will give an overview of the many possibilities microcomputers offer in the nautical aspects of maritime training.

COLLISION AVOIDANCE REGULATIONS

Collision avoidance, one of the biggest concerns of navigation and the shipping industry, can be dealt with successfully through CAI. A number of computer programs exist which combine the existing regulations with practical operations on scene.

More than books or a formal lecture, computer software has the capability to present in a better way instructions related to the rules of the road linked with appropriate sections of IMO conventions for safe navigation and clean seas. Tutorials, drills, and simulation can be used, each mode with its specific features, to enhance the presentation of the information by means of graphics, sound, colours and specific effects.

An **intelligent simulation** organized around expert systems can show the information in the form of texts and demonstrate the concept with moving pictures, appropriately using colours and sound and taking advantage of the vast amount of information contained in the system. The knowledge gained by the student can be measured, showing his weak points, relating the appropriate response to the specific article of the regulation governing this area of knowledge. Moreover, the student or the remote user will have the privilege of practising as much as he deems it necessary in order to master the subject.

For example, **Officer Of the Watch (OOW)**, an educational software package produced by PC Maritime Ltd, addresses the collision avoidance issue. As put by the producer's promotion brochure;

> "it is a powerful three dimensional 'Rule of the Road' simulator designed to teach all the procedures and strategies for minimizing the risks of collison at sea and maximizing student instruction." (PC Maritime Ltd, 2)

The program runs on IBM and compatible PCs comprising a hard disk, a floppy disk drive, a 80286 or 80386 processor, and a co-processor. A VGA colour monitor and a mouse are required. A printer may be added to the hardware to allow the print-out of the student's performance. Supported by very good instructional manuals, the programs are easy to install and may be used in a PC network. The **OOW** package consists of two programs: Officer Of the Watch and OOW Course Designer.

The first program is made up of pre-programmed exercises which may be used in a classroom or a self-study environment. The program provides three views to the user who may choose to navigate with the radar, the electronic chart, or with the three dimensional view (actual scene). During an exercise, he may switch to any of these views.

The three dimension view only provides the forward panorama (see fig. 19). However, the student (or the user) has the possiblity to switch to the port, the starboard, or the aft view. In addition, any distant target sighted may be enlarged (use of binoculars) for a better appreciation of the hazard it represents.

This powerful program is built on an expert system with a knowledge base of the international regulation for the prevention of collisions at sea. In the navigation process, the student (the user) has to answer some programmed questions before moving on. When he feels the need for some guidance to carry out the exercise, the student may get it from the expert system which provides four levels of information. This information consists of basic target information, detailed target information, information about the encounter status, and the explanation of the required actions.

This reference to the expert system, the time spent by the student in answering a question as well as any action taken by him are recorded, allowing the instructor to evaluate the student's performance.

Hence, the instructor may not only look into specific actions taken by the student, but also replay the exercise on the electronic chart view. This replay shows the time based track of vessels in the vicinity of the own ship. It can be paused when the instructor wants to highlight a specific point of the student's performance. In the same way, this replay may be speeded up if the instructor has nothing to say about the actions taken. Thus, he has a wonderful tool for breaking the gap between teaching and practice. Theory and practice are linked in the same unit, allowing any possible combination and hence greatly enhancing the quality and the comprehension of the instruction.

The **OOW Course Designer**, the second package of the program, has been designed to allow the instructor to direct the exercises presented to the student towards a specific aim.

For example, the instructor wishing to emphasize radar navigation may design his own exercise where the screen will be limited to the radar view only. He may create exercises on any aspect of collision avoidance, with the desired environment. The quality of the traffic, organization (buoy markings) of the available sea areas, type of weather, period of the day, and the sea condition are under the control of the instructor. As well, the instructor may pre-determine the behaviour of the target vessel, which will be made to follow navigation rules or planned to behave as a rogue vessel.

When he wants to emphasize the study of lights and shapes displayed by ships, the instructor may favor the 3D visual view whereby the student will make decisions based on the recognition of lights and shapes displayed by encountered vessels and navigational aids (buoys, lighthouses & landmarks).

When designing an exercise, the instructor also has the possilbility to put faults in the various instruments of the own vessel to oblige students to take action in critical conditions. Eleven ship types may be used in the exercises. These ships range from a tug with tow to a war ship and a VLCC. The exercises are easy to design: the targets are placed relative to own ship and directed by means of waypoint management facilities.

The two programs provide a good insructional tool for the planning of exercises meeting the levels of given students. However, the effectiveness of this software unit lies, for an important part, in the instructor's ability to design sound navigational exercises. Officer Of the Watch may be used not only to teach collision avoidance, `Rules of the Road', and radar navigation, but also, to a certain extent, aids to navigation.

3 Dimension forward view

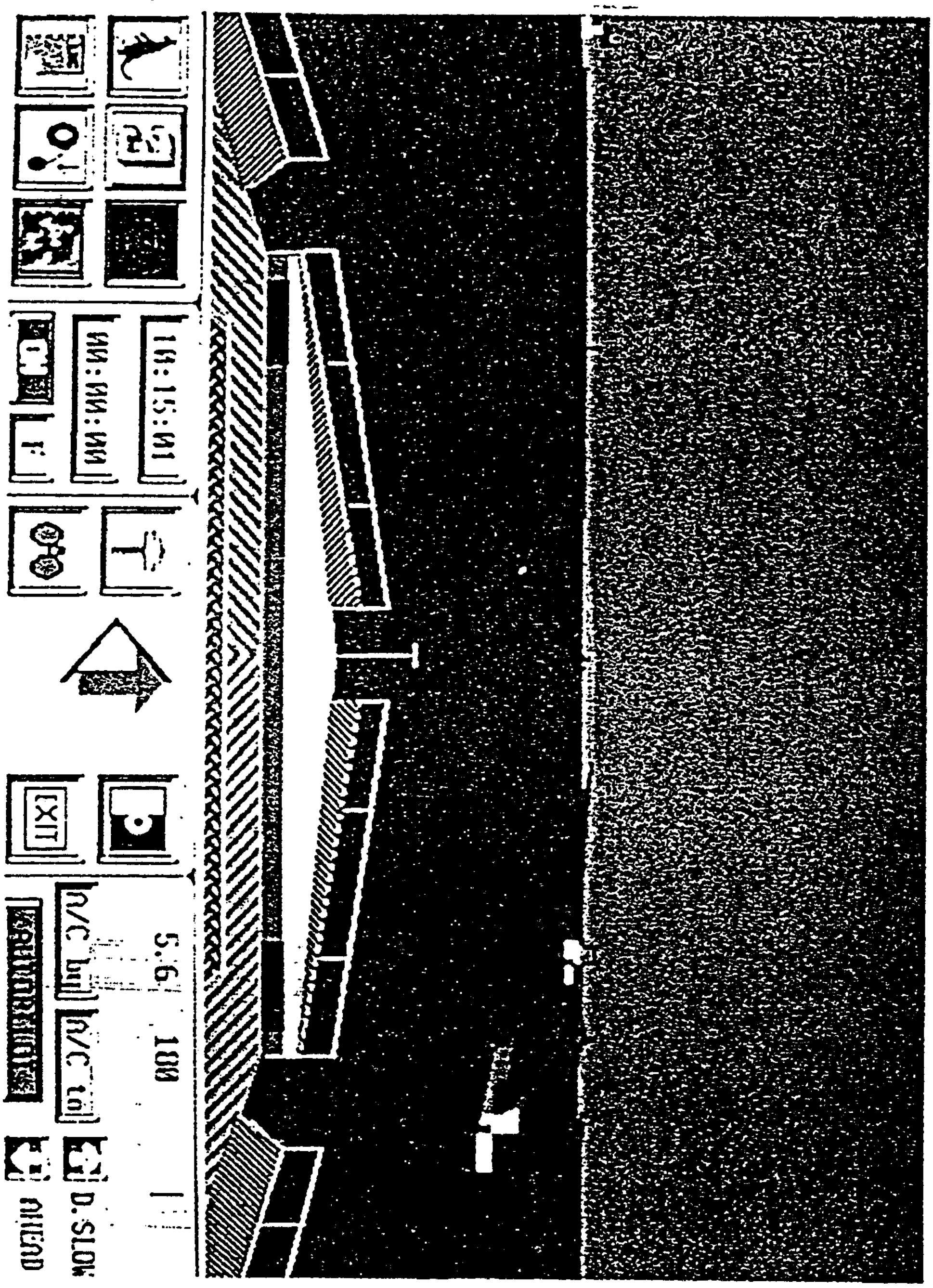


Fig. 19: Illustration of OOW exercise

Many other programs such as **SISRADAR and Principles of Radar** also address the collision avoidance issue. SISRADAR, a radar navigation program produced by Sea Information System Ltd, is an excellent drill type training program which is in use in various versions in many training establishments (e.g Kalmar -Sweden). **Principles of Radar** is another drill type radar training program. Marketed by Videotel International Ltd, it deals with the fundamentals of radar and collision avoidance.

RADAR OBSERVATION AND PLOTTING

The radar is a critical aid to navigation, especially in collision avoidance, where it will continue to play a major role, thanks to ARPA and to the continuous improvement of technology in this area. Although radar's contribution to the reduction of ship accidents has been recognized worldwide, it has been found, after investigations of some serious shipping casualties, that some ship officers have insufficient knowledge in the use of this important navigation aid.

Computers today offer deck officers the opportunity to strengthen and refresh when necessary their knowledge in the operation and use of the radar and associated technology. Radar simulators are now commonplace in many maritime training establishments. Because of their low costs, radar simulations on PCs are also being adopted by a number of training schools and ships. Moreover, microcomputer software in the form of tutorials and drills is available for instructor or learner use, in schools as well as on board ships.

Some of these programs teach the theory of the propagation of waves and their use for target detection, whereas others concentrate on the operation of the radar and its actual navigational uses. One such program, **PRINCIPLES OF RADAR**, referred to earlier, combines the two sides of this subjects through a drill, which may be tailored by an instructor to suit his classroom needs. The drill contains eight sections:

- ♠ Basic principles
- ♠ Radar components & operations
- ♠ Display controls & procedure
- ♠ The radar beam & performance specifications
- ♠ Target response & false echoes
- ♠ Effects of weather & installation
- ♠ Collision avoidance
- ♠ Position fixing by radar

The program, designed to test a student's understanding of radar, can also be run as a distance learning kit (e.g. on board ship). Each section contains 16 primary questions arranged in sequence. When an answer to a question is incorrect, the student is referred to the appropriate section of the text and asked a backup question linked to the question he missed. When the program is rerun, the options will be displayed in a different order in a random way.

One important feature of this program is that the questions are accompanied by a complementary graphic or animated screen. In addition, the program scores questions and keeps a record of the students' progress, allowing the instructor to analyze the outcome of his teaching and hence adjust it when necessary.

The other program alluded to above, **SISRADAR**, is a true PC radar simulator. It has four versions, of which versions 3 and 4 (the most recent) have won over many maritime colleges (e.g CMC[1], AMC[2], DNC[3]). These versions

---

[1] *Cardiff Maritime College in UK*

[2] *Australian Maritime College, Australia*

[3] *Durban Nautical College, South Africa*

require IBM and compatible PCs with a 80386 processor or above, and a VGA (version 3) or SVGA (version 4) colour monitor.

In addition, SISRADAR version 4 requires a second VGA monitor that displays information from simulated electronic navigation aids.

This latter version provides different number of `own ship' options. These network options range from `two stations plus instructor' to `ten or more stations plus instructor'. In addition to the interaction between `own ship' and target vessels, there is also an interaction between `own ships' of the different stations. Both programs run on a novel compatible networking hardware and software.

Although a dedicated keyboard is attached to the system, the standard computer keyboard may also be used to control the radar.

One important feature of SISRADAR is the possibility for the instructor to change the aspects of shiptypes, area, and navigational aids. A special digitising software allows the user to define his own coasline, depths of maplines, the position of buoys and racons, as well as locations, frequencies and group codings of radio beacons.

The student has the possibility to practice with any type of ship in any water configuration. Furthermore, the program provides all the radar modes (fig. 20) and all the ARPA features found in modern radars. It also provides electronic navigation aids as follows:

- Echo sounder with variable scale and rate
- Decca receiver with selectable chain
- Loran with selectable chain

- GPS
- Direction finder or VHF DF

With programs like the ones described above, nautical teachers have an inestimable tool to raise their instruction to a very high level of effectiveness. They have the possibility to make use of two or more programs to achieve any educational goal desired.

They may, for example, use a program like Principles of Radar to teach about radar fundamentals and have their students practise with SISRADAR version 3 or 4.

Unfortunately, the present prices of computer programs may not allow every teacher to take advantage of the complementary software. As this problem will be tackled in a later Chapter, it is now appropriate to consider another important aspect of navigation and collision avoidance: aids to navigation, e.g. buoys, navigational marks and vessel lights.

AIDS TO NAVIGATION

The teaching of aids to navigation, an important backup for collision avoidance, is dealt with by many programs that teach about ships' lights and shapes, sound signals, buoyage systems, navigational marks, and the international code of signals. These are tutorial and drill software programs that may be self-sustained or used by the nautical teacher to match a particular training objective.

Programs such as **Ship's Lights & Shapes, Buoyage Systems,** and **International Code of Signals** cover navigation signals and marks. The good thing about such programs is the possibility for the teacher to free himself from classroom work and have the students tutored by the programs before testing them by means of computers.

SISRADAR Screen

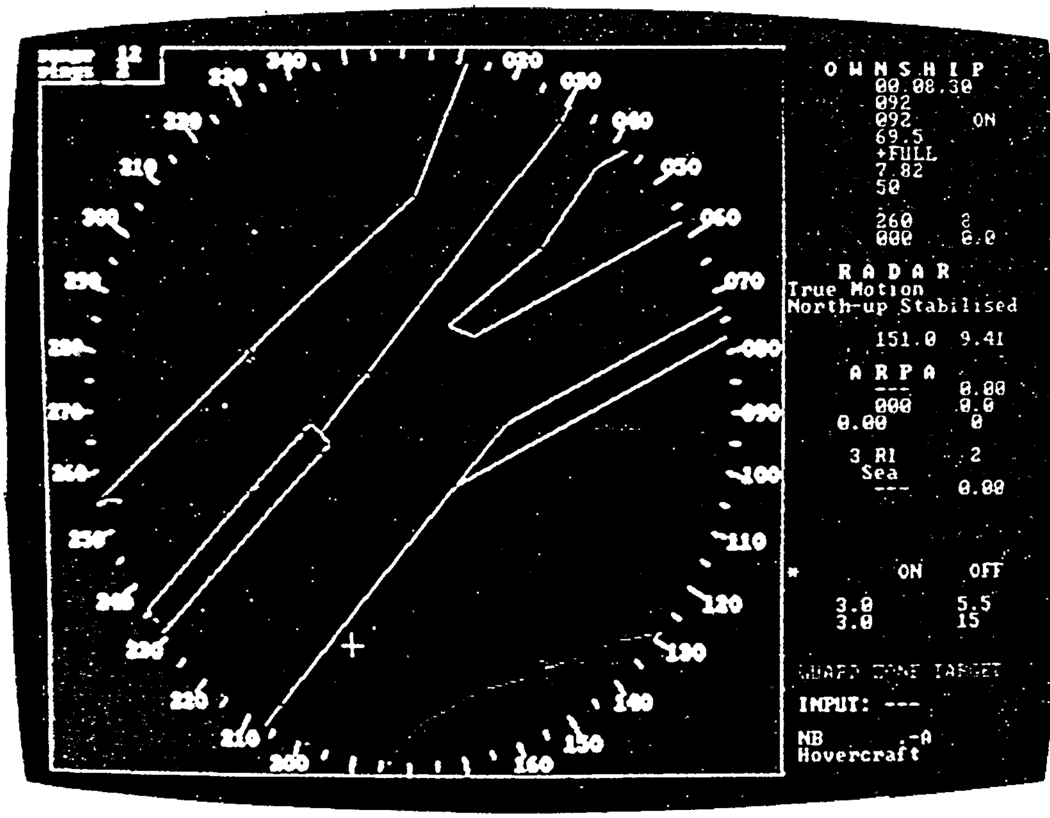


Fig. 20: Illustration of SISRADAR exercice

NAVIGATION EQUIPMENT

Critics of the automation of ships stress the complexity and the variety of the electronic equipment fitted in the bridge. They fear the deck officer could mishandle the automatic devices when confused by a serious emergency situation and further endanger the safety of the vessel. The only way to overcome this skepticism is to provide thorough training in the understanding and operation of the equipment, particularly through computer program which give the remote user the opportunity to study or become familiar with the equipment and its use.

Hence, physical simulations, tutorials, and computer-based drills can enhance the deck officer's confidence in the use of the bridge equipment. Through physical simulations, for example, every maritime training institution, irrespective of its location or its financial means, can study any instrument relevant to the present or future needs of the national shipping lines.

The student will be able to study in detail the different parts of an instrument, their interrelations and their functions. He will also be able to study the operation of the instrument and all necessary precautions related to its handling. Since the deck officer does not need to know how to repair the instrument, maintenance training for the instrument will not be necessary.

The author has to confess here that software producers do not share his enthusiasm about the teaching potential of such programs. Although the production of such software is technologically possible today, most computer sofware designers and producers prefer to combine physical simulation with the provision of a replica of the physical equipment to make it more realistic. A representative of **NORCONTROL**, one of the leading companies in the area of maritime training simulators, has admitted the possibility of using the 'touch screen' features to study any instrument on the PC screen, but he believes it is better to utilize a replica of the real equipment, as they do in high costs simulators.

ELECTRONIC NAVIGATION

Today, with the availability of a wide range of electronic navigation devices that fix the position of the ship automatically, navigation has become an easy task as the entire process can be taken care of electronically. Consider the list of navigational equipment below:

- ♠ Automatic track keeping facility, connected to a track monitoring system or a radar.
- ♠ Automated position finding system, with various sensors (Loran, Decca, GPS etc..) integrated by microcomputer using statistical methods to determine the most probable position.
- ♠ Track planning and way point management system.
- ♠ Track plotter or electronic seachart (ECDIS)
- ♠ Radar with automated plotting aids (ARPA) and track planning supplements.
- ♠ Telex and Satnav communication (GMDSS).

This list may lead to the belief that the deck officer on modern ships only needs to know how to operate these electronic instruments for the navigation of the vessel.

The reality is that more than ever, the deck officer needs to have sound knowledge and skills in navigation in order to be able to check the results of the electronic systems. In addition, he must have a good understanding of the propagation of radio waves so as to be aware of the deficiencies leading to errors in positions.

Computer programs can help the student keep up with new developments in navigational practice. **NAVMASTER**, one of the programs mentioned earlier, may be used to teach students about electronic navigation. It is a self-tutoring program that teaches by explaining, demonstrating, asking questions and checking answers. **NAVMASTER** is made of 8 units which are as follows:

- Introduction to radio waves
- Wavelength
- Groundwaves
- Skywaves
- Error patterns
- Hyperbolic geometry
- Loran C
- Decca

The program introduces the learner to the terminology of electronic navigation, explains how the radio waves behave and teaches how to recognize likely errors in position. The learner is expected to have a good grasp of how electronic navigation systems work, why they are subject to error, and when. **NAVMASTER** looks at Loran C and Decca systems in details, teaching how these two systems use radio waves, and how their design introduces further errors.

Using the demonstration power of this program, the nautical teacher has the opportunity to show in a better way the limitations of radio waves due to weather and distance factors. Other programs, such as **PC NAVIGATION** produced by PC Maritime Ltd, will help him shape his lectures as he wishes. This latter program may also be used to teach traditional navigation skills, dead reckoning (DR), and tides.

METEOROLOGY

The ability to foresee the development of the weather has for a long time been an important skill for navigators. Today, with the high reliability of weather forecasting and the improvement in communications, this skill is declining. But the deck officer still needs to understand the process governing the formation of clouds and winds as well as the relation between the weather and the sea condition in order to be able to take full advantage of the information received.

As explained in Chapter Two, process simulations may be used to teach about weather development in an interactive way: the student inputing some variables and watching the occurrences. Meteorology programs teach the fundamentals of cloud formation and recognition, depressions and anticyclones, tropical weather systems, sea states, and weather reports used in the shipping industry. A program named CLOUDS (part I & II) produced by Marine International Ltd treats the above mentioned topics, targeting maritime students as well as students in aviation and geographical disciplines.

In addition to the educational software, many shipboard application programs also have very powerful training capabilities that can be used by nautical teachers in the form of drills, tests, or demonstrations to improve their teaching. The next sections will explore the use of such programs in passage planning, ship construction and stability, ship manoeuvring and handling, and cargo handling.

PASSAGE PLANNING

Passage planning is the generic term to mark the achievement of the appraisal, planning, execution and the monitoring phases regarding the passage of the ship from one berth to another. This subject, embracing many areas of ship operations, students very often fail to integrate the knowledge gained in different disciplines into the passage planning performance. With the ability of computers to interrelate information, this problem can easily be solved.

Many programs utilised by shore staff as well as by ship's masters for weather routeing, fuel or speed optimization, and route planning may render valuable service in the teaching of passage planning. In this respect, the use of programs like **Oceanmaster NAVEY System** produced by Anchor Marine Ltd and **PC Wayplanner** and **PC NAVIGATOR** produced by PC Maritime Ltd may be considered. **PC Wayplanner**, for example, features electronic chart and deals with chart correcting, navigation, pilotage, route optimization, tide and current prediction, voyage estimating and route planning.

SHIP MANOEUVRING AND HANDLING

After covering all the topics necessary for passage planning, the instructor can have students practise with the programs mentioned above in order to enable them to have a better grasp of the subject. The instructor may use programs such as **Mathman** and **Marine Simulation** to improve his teaching about ship manoeuvring and handling.

Mathman, a British program produced by Burness, Corlett & Partners Ltd deals with naval architecture and also with the prediction of standard manoeuvres taking into consideration the squat effect, the bank interaction, the wind and waves forces, and tides and currents. These mathematical manoeuvring packages will help the instructor improve nautical students' understanding of the motion of ships when subject to the various environmental forces that are the:

♠ effect of wind
♠ effect of shallow water
♠ effect of waves
♠ effect of bank suction
♠ close proximity interaction

Another PC-based ship manoeuvring simulation program worth to be mentioned is **PORTSIM**. This program is the property of SSPA Maritime Consulting (Sweden). Alike **Matman**, it deals with the ship motion dynamics. But, unlike **Matman**, **PORTSIM** has been designed for training purpose. Both programs may also be used for manoeuvring investigations.

PORTSIM offers three versions; version A provides one ship and one port, version B comprises version A plus 3 tugs, and version C is the expanded version of B with an expert system for generation of user's own ships, port and fairways. In addition to the two generation software programs (SHIPGEN and PORTGEN), this latter version also comprises one load module. The display is in the form of a chart view with own vessel and tugs represented by rectangular specks (fig. 21). Even though the program is very good in adressing many aspects of the teaching about ship manoeuvring, the lack of a three dimension view is a serious limtation for its use as a ship handling simulator. Another disadvantage, apart from its high cost ($6,200 to $31,250), is that it cannot take advantage of a network environment.

One of the most important features of the program is the possibility to replay the performance of the student, at a compressed-time simulation mode.

SHIP CONSTRUCTION AND STABILITY

In the same way that computers have contributed to boost ship design and construction with a very high degree of effectiveness, they also have the capability to improve the teaching of naval architecture, ship stability and related subjects.

Hence programs used in the ship building industry such as **Structural Analysis** (W.H. Ltd), **OMSEC** (American Bureau of Shipping) and **Mathman** (mentioned earlier) may help nautical lecturers design their instruction and provide better insights into ship structure. **Structural Analysis** may be employed for the teaching of hull form and strength analysis, naval architecture, and ship design and stability. Other training applications may be strength and trim calculations.

The ship stability and other cargo loading related calculations are addressed by several cargo loading programs of which **Mariner**, which will be described in Chapter Five, presents many interesting features for the study of the forces acting on the ship during the loading process. Furthermore, these programs may be used to teach students the proper way of cargo loading and discharging.

Berthing with 3 tugs

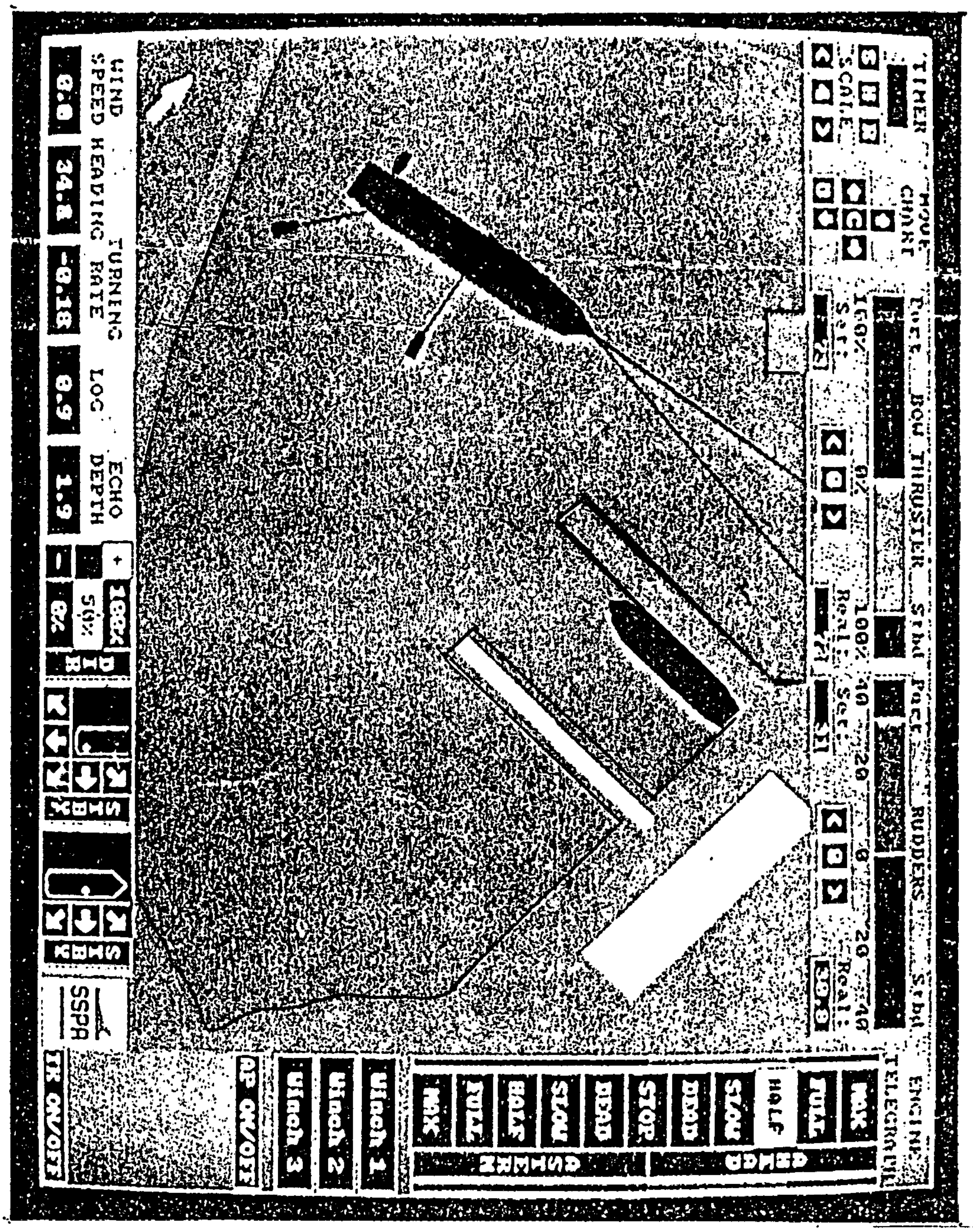


Fig.21: Illustration of PORTSIM exercise

CARGO HANDLING

With the increasing variety of cargo transported by sea and consequently the increasing specialization of ships, the deck officer faces many qualification requirements for the operation of various types of ships. He needs specific qualifications to operate an oil tanker, a chemical tanker or a gas carrier as the hazards linked to each type of cargo are particular and require specific precautions. Hopefully these qualifications can be acquired through computer based training with the advantages stressed in earlier sections.

Many such programs are used in the shipping industry and on board ships to refresh or upgrade the knowledge of seafarers in this area. For example, the **On Board University**, with the approval of Gothenburg Maritime Academy (Sweden), is producing training programs dealing with the operation of tankers. One such program entitled **Advanced Tanker Operation** consists of six parts and addresses various subjects which are as follows:

- Safe loading and discharging
- Safe tank operation
- Chemical tanker operation
- Safety on board
- Specific properties of oils
- Design aspects and equipment aboard a tanker

This program, based on the SOLAS, MARPOL, and STCW conventions, is primarily designed for shipboard use but can also be tailored by the nautical teacher for his specific objectives. Some other programs from the same company treat container operations, dangerous goods, fire fighting, and other emergency situations which may arise in the handling of cargo, whether it be dangerous goods, liquid or gas.

The nautical teacher has at hand a wide range of programs in many areas of ship operations. The efficiency and effectiveness of their uses depend very much upon the instructor's ability to choose the appropriate program and match it with his teaching objectives.

3.2.3 ENGINEERING

With the introduction of dual purpose training in most of the major maritime nations, the deck officer will increasingly be required to have more engineering knowledge. Whilst in countries such as Côte D'Ivoire there are still differences between the deck officer and the engineer, the marine officer is totally polyvalent in most of the developed countries: he may choose to become a master or a chief engineer based on his performance in both departments and/or on his wishes. When addressing the engineering aspects of deck officer training, this new training trend should not be overlooked.

Hence, while the traditional deck officer may be given sufficient knowledge (and understanding) by computer-based instruction, the modern deck officer, who is an engineer as well, needs more practical training in order to be able to deal with the actual maintenance of engines and related auxiliaries fixed on board. In any case, it is worth using computer programs to complement the theories taught in class, enabling the student to test his knowledge and to take risks in a cheaper way.

A number of engine simulations can help in carrying out this complementary instruction. There are physical, procedural, situational and process simulations that instructors can use to support their teaching in the subjects of automation, the analysis of engine characteristics, and engine monitoring and performance. In this respect, 'TUTSIM' produced by Meerman Automation in the Netherlands is worth mentioning here. It is a continuous dynamic systems simulation for micro computers that can be used to teach about shipboard automation.

Many software packages used in engine-room simulators may also be suitable for PCs. As explained in Chapter Two, the only missing part will be the operational one. Since the growing power of microcomputers allows the use of the software backing the high costs simulators, the only obstacle to overcome is the lack of commitment to fully exploit the training opportunities offered by PCs.

3.2.4 MULTI-SKILLED ASPECTS

As in the nautical aspects of deck officer training, computers give maritime lecturers the possibility to enhance their teaching about the business side of shipping. Programs exist which deal with cost effectiveness, maintenance and stock control, accounting, chartering, cost tracking, and voyage estimates, to name but a few.

In order to meet his managerial functions, the deck officer needs to have some fundamental knowledge of business. He must be conversant with accounting, voyage accounting, cost tracking, and insurance claims. In addition, he must be able to evaluate the ship performance in order to plan passages in the most economical way, considering all the factors that may interfere in the execution of the voyage.

Because of the intensive nature of a deck officer training program, business aspects are not usually allocated the time they deserve and are mainly dealt with when on the job. Thanks to the wide use of computers in the shipping industry, there are a large number of programs available that may allow the maritime teacher to cover these topics effectively in less than the time frame available. Though these pieces of software are not originally instructional, they may offer means to address issues somewhat neglected by instructional software designers.

Veson Computer Systems, a software producer based in New York, has a number of application programs that are used by shore as well as shipboard staff for the commercial management of ships. One of their products, namely **ACT 2000** is employed for accounting and voyage accounting. It performs payable and receivable accounts, transaction breakdown by vessel, foreign currency transactions, and account analysis; hence it may be a very good shipboard management learning tool for the student. Another program of interest for the business aspects of shipboard management might be **Marine Accounting and Management Information System** produced by Computer Science Corporation (Belgium). It addresses, among other commercial subjects, cost tracking, chartering analysis, documentation control, insurance claims, and strategic planning.

In the end, as demonstrated throughout this chapter, computer programs may be found in practically every area of deck officer training. Though their values may sometimes be questionable because of the shipping industry hesitation to adopt clear guidelines and take clear position concerning the use of PCs in the training of marine officers, they may offer very good opportunities for the improvement of teaching outcomes. For the time being, maritime training institutions have to rely on individual initiatives for the pedagogic design of educational software. As will be demonstrated in Chapter Four, the choice and the proper exploitation of a computer program are the critical elements that determine a CAI system's effectiveness.

3.3 POSSIBLE COMPUTER USE IN THE ARSTM

In this section, the author will indicate the subjects to start with in the implementation of computer assisted instruction in his academy. Taking into account existing facilities, the hardware arrangements to match the training option advocated will also be investigated.

SUBJECTS TO BEGIN WITH

It is obvious that because of the initial costs of CAI implementation, it would be difficult to take advantage of the many possibilities offered by micro computers at once. In fact, no maritime training college is using a full capacity CAI system. Most academies use a combination of simulators (engine room, bridge, or radar) and microcomputer laboratories to address the major subjects in the training of deck officers. Therefore, in introducing computers in the training scheme of the ARSTM, it is advisable to start with subjects of a broader scope such as **navigation, cargo handling and stability.**

In the previous sections, some software which could be used in the teaching of navigation or cargo handling and stability was highlighted. Among these software programs, some will be selected to help nautical teachers conceive their lectures, exercises, and assessments.

In the teaching of navigation, computers could be used in the following subjects:

- ♠ Aids to navigation (IALA - Buoyage systems)
- ♠ Ships' lights and shapes
- ♠ Safety and Emergency Procedures
- ♠ Radar navigation (ARPA)
- ♠ Electronic (Integrated) navigation

For the teaching of cargo handling and stability, dangerous goods (solid) and container handling linked to stability calculations may be selected as subjects to be taught via the computer media.

For navigation, the software program matching the above chosen subjects are as follows:

Program names	**Producer/Marketing Co.**
♠ Buoyage Systems	Videotel Mairne International LTD
♠ Ships' Lights and Shapes	"
♠ Safety Challenge Series	"
♠ Principles of Radar	"
♠ SISRADAR	Sea Information Systems Ltd
♠ Officer Of the Watch (OOW)	PC Maritime LTD
♠ NAVMASTER	Videotel Marine International Ltd

For cargo handling, **OBU-Dangerous Cargo** and **Mariner** are the software programs selected for the study of dangerous cargo regulations and the handling of bulk cargo and containers with the provision of stability requirements.

The nautical teacher may use the computer in three ways to achieve his objectives. He may associate the computer terminal with a projector or a TV-video (Interactive CDI) during the lecture in a classroom environment; or he may bring the students to a Computer laboratory to perform drills linked to previous lectures, and have the students practise the skills learned at their own pace and in their own free time. Finally, he may choose to assess the students by means of computers. Below is a table which summarizes a possible computer use arrangement.

Table 2: <u>COMBINATION OF COMPUTER PROGRAMS FOR TEACHING</u>

SUBJECTS	**LECTURE WITH CAI**	**PC LAB:**	**PC-BASED TEST**
AIDS TO NAVIGATION (IALA)	BUOYAGE SYSTEMS with projector	BUOYAGE SYSTEMS	NO TEST
LIGHTS & SHAPES; COLREG	SHIPS' LIGHTS & SHAPES; OOW (projector)	BOTH PROGRAMS	TEST WITH OOW
SAFETY & EMERGENCY PROCEDURES	LECTURE WITH (CD-I) NO COMPUTER CONNECTION	SAFETY CHALLENGE SERIES	NO TEST
RADAR NAVIGATION (ARPA)	PRINCIPLES OF RADAR WITH PROJECTOR	PRINCIPLES OF RADAR; SISRADAR; & OOW	TESTS WITH THE TWO FIRST PROGRAM
ELECTRONIC NAVIGATION	NAVMASTER (PROJECTOR)	NAVMASTER & OOW	TEST WITH OOW
CARGO HANDLING & STABILITY	MARINER (PROJECTOR)	MARINER	TEST BUT SCORED MANUALLY
DANGEROUS CARGO HANDLING & REGULATIONS	DANGEROUS GOODS (CDI OR PROJECTOR)	DANGEROUS GOODS	NO TEST

CAI CLASSROOM ORGANIZATION

The ARSTM has very good building facilities and a newly installed computer network for administrative use. This computer network is also exploited by the students to gain some basic skills in the use of computers. However, the size of the central processing unit (RAM, hard disk and speed) may not allow for the intensive use that the CAI system requires and therefore may need to be upgraded.

For the purpose of the study and taking into account possible limitations of funding, the existing local area network should be extended to the classrooms which will be provided with a terminal, a large screen projector and, if possible, a Video-TV and a CDI player. In addition, the existing Computer Lab should be expanded so as to have a total number of fifteen (15) terminals. The network will then comprise a server that will nourish the following units.

- ♠ The Administrative Section,
- ♠ The Instructor Terminals,
- ♠ The Computer Lab Terminals, and
- ♠ The classrooms Terminals.

The the central unit will be used as the principal PC server whereas The students' terminals will act as requesters in the network. The PCs performing in the administrative section of the network will also operate as requesters. The PCs used by instructors will act as requesters and secondary servers. This way, there will be the possibility to combine PCs of different power in order to minimise costs.

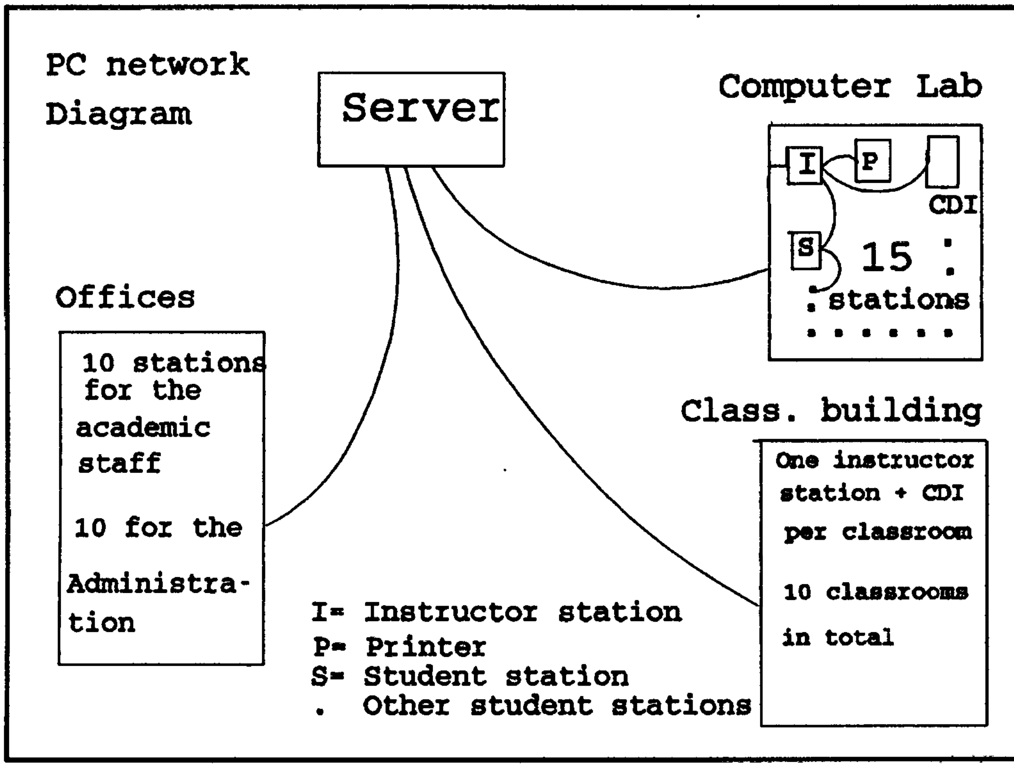


Fig.22

The classroom desks may be arranged in a U shape or in columns depending on the size of the classrooms. In any case, the projector or the video set should be appropriately placed so as not to block the students' view. The classroom will accommodate the sole instructor computer terminal (or station) for teaching use. This terminal will be connected to an overhead projector, a video-TV and a CDI player.

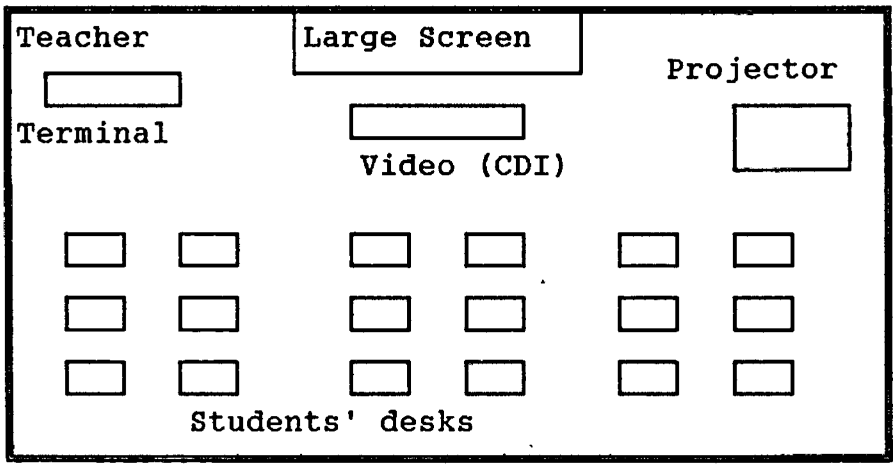


Fig. 23: Classroom schema

The Computer Lab should house the students' terminals and the instructor's terminal. It may also contain a screen and an overhead projector to allow some CAI lessons in the computer laboratory. It should be organized in U shape and shall not contain more than fifteen terminals in order to allow the instructor to better monitor the students' work.

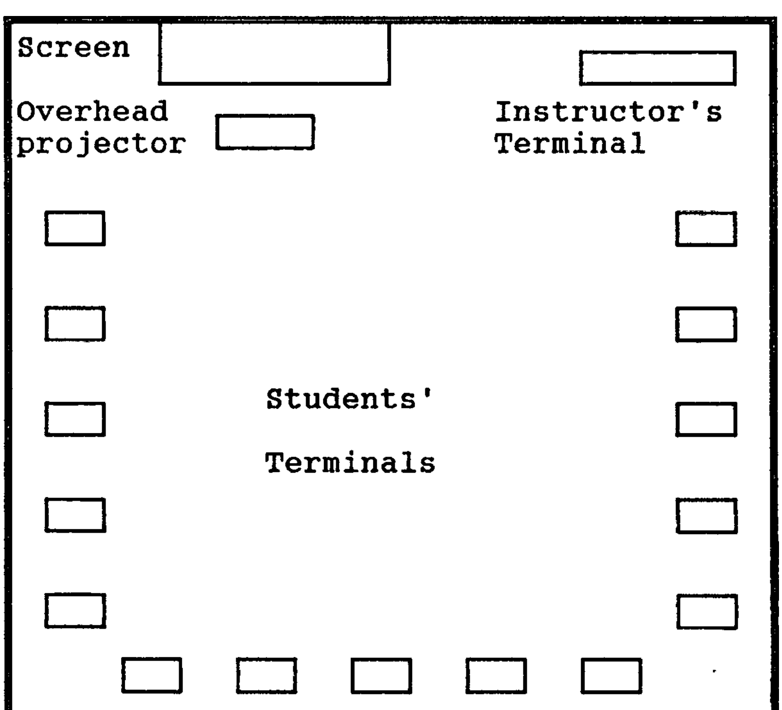


fig. 24: Computer Lab shema

CHAPTER FOUR

EVALUATION OF COMPUTERS IN MARITIME TRAINING

The implementation of CAI in the 'ARSTM' of Abidjan, in view of the limited resources of this institution, may be a demanding task. However, because of new trends in maritime education and training, the institution has to find a means to cope with the technological developments in shipping and related training pressures.

It has already acquired radar and engine room simulators, donated by Japan. Unfortunately, because of the lack of local expertise in their maintenance, and finance limitations, these simulators have lately experienced some major breakdowns, disturbing the course of the lectures.

Local expertise in microcomputers, on the contrary, is available in the market and may allow an easier implementation of a CAI system. But the implementation of a computer assisted instruction program in the ARSTM is not solely linked to maintenance and financial matters. In introducing CAI, one has also to consider:

- the adequacy of the environment (staff qualifications, facilities),
- the appropriate hardware and related systems,
- the specifications of the software to be used,
- the possible obstacles to be encountered, and
- the advantages to be expected.

This section intends to analyze and weigh the obstacles that may impede an effective CAI implementation and the advantages that make the CAI choice worthy.

Furthermore, it will deal with the manpower prerequisite, the software and hardware requirements, and eventually the funding aspects of the problem.

4.1 DRAWBACKS

Like every human initiative, the introduction of computers as a teaching medium in the training of deck officers is bound to encounter or generate some obstacles, the first being its very novelty. Hence, an unprepared staff may fear the intrusion of this new medium in their routine and resist, as was the case with the implementation of TV-based education in the author's country. Thus, there is the need to train the staff (instructors and lecturers) to become acquainted with the use of computers in teaching in order to minimize this threat.

Another managerial problem may be the difficult choice between the purchase of computer courseware and the hiring of a new teacher. Because of budget limitations, this unavoidable problem should be dealt with by considering the degree of CAI involvement in the whole training process. This latter consideration leads to the serious problem of the initial investment cost, which may be a major obstacle to CAI implementation. Furthermore, poor maintenance of the system may be a matter of concern as teachers would have to revise their teaching strategies. This may give the sceptics some additional reasons for the rejection of the CAI system.

Other CAI pitfalls lie on the wide variety of hardware producers and the consequent software and hardware compatibility problem. Since most courseware producers will not allow the user to try out programs before purchasing them, there is also the difficulty in selecting suitable ones. Hence, some programs may be pedagogically poor and give more emphasis on the minor subject areas, whereas the areas the teacher would like to accentuate are inadequately addressed.

Other arguments used against the CAI system are:

- The student's possible loss of basic skills in navigation such as navigational computations and use of tables;
- The possible loss of sense of reality and thus, possible development of too much self confidence as students become used to making mistakes without sheer consequences;
- The inadequacy of the PC simulator environment in contrast to the bridge simulator environment which does not differ very much from the real one;
- The difficulty of appreciating distances in PC-based simulations whose moving pictures are not truly three dimensional.

Although some of these criticisms bear some truth, the nautical teacher, who is the real master of the training process, has the possibility to tailor his teaching to match set objectives. The first criticism (basic skills loss) for example, is not exclusively relevant to CAI but also to the trend of modern navigation where computer-related instruments tend to handle all navigational computations, assigning to the deck officer a supervisory role.

Finally, for those institutions which have, or plan to have, teachers with programming skills, there is the constraint of allowable time. Programming is highly time consuming and should not be a concomitant of teaching.

Nevertheless, nautical teachers may take advantage of the development of very powerful authoring systems (program generators) for the design of their specific programs (lessons).

4.2 ADVANTAGES

Although the advantages of CAI implementation have been mentioned here and there in the course of previous chapters, this section will emphasize the major benefits that are offered by this teaching methodology. The main advantages are as follows:

- ♠ The bridging of gaps in maritime training.
- ♠ Training efficiency through interactive skills.
- ♠ A quicker and easier learning process .
- ♠ Opportunity to take risks and build self confidence.
- ♠ Students' acquaintance with the use of PCs as a working tool.
- ♠ Improvement of students' learning motivation and comprehension.
- ♠ Suitable individual pace of learning.
- ♠ Possibility to upgrade and refresh knowledge at one's own convenience.
- ♠ Ease of teachers' workload.
- ♠ Reduction of progress monitoring process.
- ♠ Fairness and accuracy in assessment.
- ♠ Gain in time and cost effectiveness.

Consider the findings of the `Institut Maritime du Quebec' which carried out a trial use of PC-based simulators with visuals. In an address to the Second International Manning and Training Conference, David Edmonds praised the training ability of PC-based simulators:

> "they accomplish traditional tasks more efficiently.. the learning process is quicker and easier.. and it is relatively easier to make sure that the students attain the desired objectives.. the time saving is more substantial at the lowest level of training, *ie* with cadets and watchkeeping mates. At a higher level (chief officer and master) the advantage of the system is mostly at the level of improving comprehension.." (David Edmonds, 1992, 1).

Although this acknowledgment of the effectiveness of CAI only refers to PC-based marine simulators, the graphics capabilities and demonstration power of PCs are such that the other methodologies are also very effective. Computer-based tutorials, drills and many application software are used by a growing number of maritime training establishments to improve their training efficiency.

One of the most important advantages of the use of computer in teaching over traditional methodologies is the bridging of gaps in the training of deck officers.

For the instructor, there are gaps between the supervised learning in classrooms and the students' private studies. The instructor now has the possibility to monitor students' private studies, using drill or simulation software. This will enable nautical students to develop skills at their own pace. CAI also allows the instructor to surmount the inconvenience related to separate classroom teaching and bridge simulator based instruction by offering the opportunity to integrate the two aspects of the lecture in the classroom. This prospect may help to improve the instructor/trainee ratio (in contrast to bridge simulators) because of the possibility to associate other media such as a projector with a computer terminal for the handling of a larger student, in a classroom environment.

For nautical students, there are gaps between the theory gained in classrooms and the application of the knowledge in the field. These gaps can be overcome by the use of CAI. Students can, soon after the theory, practise the skills to build self-confidence for the real world. In the open-ended (sandwich) schemes, students returning for their final courses very often find themselves short of most of the theories and skills learned two or three years earlier, especially when they have not had opportunities to apply some of them in the real field. With appropriate software on board ships, students have the possibility to refresh their knowledge and to practise skills for situations very seldom encountered in everyday navigation, and thus be better prepared to undertake the last section of their training.

The fact that PC-based training can take place everywhere combined with interactive capabilities and the flexibility of much computer software, enhances the training efficiency of CAI. The student's learning motivation and comprehension are improved by the intelligent use of the graphic capability and demonstration potentials of PCs.

As confirmed by the study of the 'Institut Maritime du Quebec', the learning process is quicker and easier and the student has the opportunity to take risks in a cheap way. In addition, working in a CAI program environment will accustom the student to the use of computers as a working tool, an ability which is important because of the increasing use of computers in ship operations.

For maritime colleges a CAI program may prove to be very cost-effective in the long term as it will allow them to run more short courses and progressively eliminate the need to purchase training equipment, as it will be replaced by computer software programs. A CAI program also helps maritime training establishments save money because nautical students will get some skills in navigation as well as in other areas of ship operations without the heavy costs that would be involved in the actual use of ships.

Finally, CAI programs provide the maritime teacher a means of easing his workload as well as improving his teaching. Authoring and course design software programs may help plan his lectures and vary the exercises given to students. Some programs will help monitor the progress of students and hence manage classes in more efficient way. Equally important, the nautical teacher has the advantage of using the computer to test his students and keep some test data banks for future use.

The fairness and the accuracy of computer-based assessment may eventually be used by the establishment as evidence of its performance in case of outside scrutiny.

4.3 CAI IMPLEMENTATION

4.3.1 GAINING THE DECISION MAKERS' ENDORSEMENT

The introduction of CAI in the training schemes of the ARSTM must be planned carefully so as to avoid the mistakes which led to the abandonment of the TV project.

Firstly, the administration must seriously weigh its capacity to sustain the relatively high cost of the initial investment. It may need to produce a plan aimed at convincing the governing body of the necessity of CAI implementation. This plan will highlight the advantages of CAI in the light of the trend of technological development in shipping, demonstrate its costs effectiveness in the long term, and outline the steps to be taken to develop the use of computers in the training of deck officers.

Secondly, the teachers should be closely associated with the project. Familiarization courses provided to the teaching staff may help in gaining their vital support and full involvement. Finally, after the acceptance of CAI by all the interested bodies, the next important step will be the practical management of the acquisition and installation of computer hardware and software.

4.3.2 HARDWARE AND SOFTWARE ACQUISITION

The hardware and software requirements are closely linked but for clarity's sake they will be dealt with separately. This section offers a general approach to the complex questions of selecting a computer system and some views on the delicate questions of hardware and software evaluation.

SELECTING COMPUTER HARDWARE

One constant element in the personal computer industry is change. The strong competition between various PC hardware manufacturers such as IBM, Apple, Commodore, COMPAQ, and DEC, to name but a few, has led to the continuous improvement and variation of computer hardware features. This technological instability combined with the variety of hardware trademarks, each one very often bearing different specifications, complicates the choice to be made.

In addition, one needs to consider the other components such as printers, projectors, and videos (CDI) to be fitted within the computer network. In Chapter Three the author advocated the Local Area Network (LAN) option. A LAN is a collection of microcomputers that share hardware, programs and data. There are different LAN topologies with various types of connections and the choice of the arrangement, here again, depends upon the available means and the intended use.

In the light of the above considerations, and taking into account the existing facilities mentioned earlier, the selection of the appropriate hardware may require that attention be paid to:

- ♠ The possibility for all departments taking advantage of the computer network without impeding its teaching implementation,
- ♠ The quality of the selected hardware representation,
- ♠ The hardware compatibility problem, and
- ♠ Hardware and software compatibility: hardware with which most maritime courseware can work.

Today, most computer hardware on the market is technologically very compatible. Unfortunately it does not always use the same operating system for reasons of competition. Therefore, one has to rely on one trademark in order to avoid having to undertake costly adjustment. In Côte D'Ivoire, Apple and IBM have the best representation, but because of the compatibility of several computer brands with IBM, this latter hardware seems to fit the situation better.

In selecting the hardware system due, attention must also be paid to the type of processor (*e.g* : 80386 or 80486) and to the type and characteristics of peripherals such as the Video Display Unit (VDU). Hence, much modern courseware runs only with some specific processor (*e.g with math co-processor*) and requires a colour VDU (VGA or SVGA) with particular resolution.

Considering the rapid evolution of the computer technology during the last five years, it would be advisable to select hardware which is likely to stay on the market for some time. A sensible choice at the present time could be:

♥ **The server PC** (central unit)

- ♠ 80486DX 66 MHz microprocessor with a math co-processor
- ♠ 32 MB RAM
- ♠ 2 GB Hard disk
- ♠ One disk drive (3½")
- ♠ 2 GB backup DAT tape
- ♠ A super VGA colour monitor
- ♠ 3 network cord

♥ **The instructor and staff terminals**

- ♠ 80486DX 33 MHz microprocessor with math co- processor
- ♠ 8 MB RAM
- ♠ 85 to 200 MB hard disk
- ♠ 3½" disk drive
- ♠ Serial, Parallel ports
- ♠ Super video graphic adaptor colour monitor with S3 accelerator, local bus; 14 to 16" screen, low radiation

- ♠ network card
- ♠ Laser or ink-Jet printer[4]

♥ **The student terminal**

- ♠ 80486SX 25 microprocessor with math co-processor
- ♠ 4 to 8 MB RAM
- ♠ 85 MB hard disk
- ♠ 3½" disk drive[5]
- ♠ Serial, Parallel ports
- ♠ Same monitor as for the instructor

♥ **The network**

- ♠ Cheapernet or Ethernet network
- ♠ Novel 3.11 (or higher) network protocol for 50 users

SELECTING SOFTWARE

The choice of the courseware is a critical element for the success of the implementation of a CAI system. The courseware requirements, which will guide the selection of the hardware system, must be considered carefully before purchasing any nautical courseware. In this respect, the four elements which follow should be taken into account:

1. The program content
2. The support pedagogy
3. The program operation
4. The program effectiveness

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[4] Printers will be attached to selected intructor stations

[5] *For reasons of network security, the CPU of students' terminals may not have floppy disk drives.*

THE PROGRAM CONTENT

The content of the software should suit the level of the students. A program dealing with basic radar navigation, for example, may be of great interest for low level nautical students but boring and hence very ineffective for those at chief mate or master level. Therefore, the selection of any program must take into account the curriculum goals. The goals and objectives of the materials must be clear: this means that the responsible staff must also do their homework and define clear objectives to be met by the computer courseware. The discipline areas addressed must be analyzed so as to make sure each element is given the importance it deserves. The accuracy of the content contained in the materials must also be checked. No matter what its sophistication, a program that conveys incorrect information is very dangerous because of the confidence the students will place in the computer.

THE SUPPORT PEDAGOGY

The purpose of CAI is to provide the teacher with a tool for improving the effectiveness of the instruction. Hence, it is important that the **nature** and the **quality** of the **feedback** provided by the courseware are carefully investigated.

The program should be very interactive. One should make sure **modification** is permitted to meet individual student needs. Hence, CAI should enable the teacher to adjust his instruction to the students who have some difficulty with the topic. Depending on the objectives to be met by the software, one will also have to investigate and answer the following questions: Is the software package self-sustained or does it require the intervention of the instructor? What is the level of the software, i.e. its interactive capability particularly when used for assessment? Can the program be used with various types of classroom arrangements (individual, small group, large size classroom)? Does the program take advantage of networks in order to simulate communication and interaction between vessels operating? Does it make use of a variety of learning modes (visual, verbal, numerical)? How well does the program use graphics and sound capabilities?

In their efforts to win over the maritime training market, many software producers have provided very flexible programs in terms of their pedagogical support. But many programs are too simple or inadequate. Therefore it is the task of the teaching staff to identify which software on the market will match their needs.

THE PROGRAM OPERATION

The first requirement the software must fulfil is, obviously, its fitness with the hardware system in possession or about to be purchased. In this respect, the operating system used by the software is of importance. **DOS** prevails but is not the only one. Novel, OS2, Unix are also used by some instructional software.

Windows and **UNIX**, two operating environment systems, are new players in this field. Many of the large packages will function under a variety of operating systems, including networks. When the problem of the operating system and/or operating environment systems is overcome, one must see that there is good and clear instruction manuals for the teacher as well as for the student.

Some programs begin with the major directions which users have to refer to should some difficulty arise in the course of the material. At every step, it should be possible to access specific directions (help features) which should be clear and accurate. The extent to which the student (or the teacher) has control over the program operation is also important; for a difficult operation will add to the difficulty of the topic and decrease the student's motivation.

The program should be free of bugs and breaks, and handle user errors in a nice way. In some programs, if the user touches by mistake the wrong key in response to a request, he loses all the work previously entered. A well designed program will trap such errors and send the user back to enter the response correctly.

STUDENTS PREDICTABLE OUTCOMES

Because the software selection, as developed above, is a very delicate task, the responsible body for this selection should not make the final decision without thoroughly testing the software. Some producers provide demonstration (Demo) programs to potential buyers but unfortunately these Demos are very limited and of little help. Some others give the opportunity to look into their products but with stringent conditions. In any event, the potential buyer should assess how effective the learning process is measured against the program's intended objectives, and how effective it is compared with non-computer instruction in the same area of maritime training. Thus, there is the need to go for software with an established reputation if there is no possibility to try out a new product with, hypothetically, more quality.

4.4 FUNDING POLICY

There is no doubt that proposing the implementation of CAI in the atmosphere of economic crisis prevailing in the author's country might seem startling. It may be asked where the money will come from to sustain the relatively high initial investment cost. Hence, although the prices of microcomputers are experiencing a dramatic and continuous decrease due to technological developments and competition, the software is still very expensive. As an example, the program **Officer Of the Watch**, mentioned in Chapter Three, costs $ 6000 per unit and its component the **OOW COURSE DESIGNER** costs $ 4500 (service contract included; see Appendix A). Taking into account the fact that more than a single software program will be needed to carry out effective CAI, the task awaiting CAI promoters may seem insurmountable. Indeed, how will this project be financed?

The ARSTM is, as its name implies, a regional academy and therefore gets its funds from member governments' contributions. The economic turmoil of these member countries has a great impact on the institution, which is seeking ways to gain some independence from this uncertain financial support. CAI may be the project which will bring new contributors in the funding arena if marketed sufficiently.

The shipping industries which benefit from the training provided by the ARSTM do not participate in its financing. Since all educational matters (formal, technical, and professional) are the government's responsibility in the member countries, these industries show little interest in the training of their personnel. Nevertheless, the introduction of a new technology that is known for its productivity may well convince most of them to make the move expected by the ARSTM.

By promoting short and well targeted training courses for the fishing industry, the pleasure fleet, and the shore (port) personnel, by demonstrating to the shipping lines (inside and outside the country) the great advantages and the savings they will enjoy when the officers are trained through computer means, it is certain that the ARSTM will bring these needed contributors to help implement CAI for their own benefit.

CHAPTER FIVE
SAMPLE SOFTWARE: MARINER

5.1 EVALUATION OF MARINER

Mariner is a shipboard application software designed for the simulation of loading and unloading operations. It is tailored to a specific ship for which it assists the deck officer in routine calculations and in the loading process.

5.1.1 THE PROGRAM OPERATION

Mariner is a stand alone software which runs under DOS 3.0 (or above) on an IBM PC (or compatible) with a colour monitor (EGA or VGA). A math co-processor is optional.

It is a very user-friendly program. The directions are not part of the program but are contained in its documentation. Although there is no **help** feature, the clarity of the documentation and the simplicity of the menu make the exploitation of the program very easy. The menu is composed of three parts:

- The display of the ship to allow the user to carry out the operations and view them as they take place.
- The display of the features of the ship as modified by its current status.
- A menu bar with four options (File, Edit, View, Quit).

The File menu allows the user to direct the program. It consists of seven options: Load (retrieval of saved work); Save (to save current work); Delete (to erase unwanted saved work); Title (for the entry of title of the current condition); Freeboard (for the entry of summer or tropical loadline); and Water SG (for the entry of the specific gravity of the water).

The Edit menu allows the user to load or unload the holds and the tanks. The View menu provides the user with the feedback to his actions. It consists of the displacement summary, the stability status, the longitudinal strength features, and the report which allows the user to obtain a printout of the different tables and graphics. Finally, the Quit menu allows the user to go back to DOS.

An instantaneous access to the current sea-going status is possible via the F9 key. When the sea-going conditions are not satisfactory, this status is also provided by the displacement summary. The program is apparently free of bugs or breaks except at the report level where an off-line printer may cause some problems if the operation is carried out.

5.1.2 THE SUPPORT PEDAGOGY

Mariner is a program whose primary aim is shipboard operations. The interactive feature, which might be expected in instructional software programs, is limited. Nevertheless, it does provide training in operational capabilities. The instructor is free to adapt it to his teaching. It can be used to back up the teaching about safe cargo handling (bulk cargo), stability, and longitudinal stress.

The instructor may also use it as a **drill** to strengthen the understanding of these subjects. For this purpose, the students may be asked to complete a written exercise with the program. Being a stand alone program, it cannot simultaneously serve two or more classrooms in a network system. However, a network version should be available.

The use of graphics is very good though the graphic variations are very slight. The nature and the quality of the feedback are also very good but not flexible. The impossibility to vary the ship (beam, length, and wayplan) limits somewhat the efficiency of the instructional use of the program.

To use Mariner, the nautical student (or the deck officer) needs some background knowledge of statical stability, forces, and moments as well as some knowledge of the requirements for the safe shipment of dry bulk cargo. Hence no explanation is contained in the materials about the results achieved and the presence of the instructor is necessary at a first stage. Finally, an overhead projector connected to the PC will enlarge, among other things, the scale of the draft and trim variations and therefore enhance the demonstration made by the teacher.

5.1.3 THE PROGRAM CONTENT

As mentioned in the introduction of this chapter, Mariner is a cargo loading simulation program. It deals with stability requirements when loading or unloading the cargo in harbour and offers the possibility of checking the current sea-going and harbour status of the ship against the requirements set by IMO. For the light condition and at a given loadline (summer and tropical) for specific gravity, the following elements are displayed:

- ♠ The Displacement.
- ♠ The Longitudinal Centre of Gravity (LCG).
- ♠ The height of the Centre of Gravity above the Keel (KG).
- ♠ The ship Metacentric height (GM).
- ♠ The Spare Capacity.
- ♠ The Trim.
- ♠ The Forward Draft.
- ♠ The Aft Draft.
- ♠ The Shear Force as a percentage of the allowable Shear Force for sea and harbour conditions.
- ♠ The Bending Moment as a percentage of the allowable Bending Moment for sea and harbour conditions.

These elements of the ship's status are internally handled and upgraded as the ship is being loaded or unloaded. In addition to the ship's current status, Mariner provides:

- ♠ **Displacement tables,**
- ♠ **Stability conditions,**
- ♠ **Longitudinal strength conditions.**

The Displacement tables consist of tables which show the individual and overall conditions of the holds and the status of the tanks. When the sea-going condition is not satisfactory, the abnormal items are displayed in red showing the non-conforming areas such as displacement, the draft forward, the shear force and the bending moment as percentages of allowable conditions.

The Stability conditions provide the ***intact stability diagram*** (*GZ* curve), the ***intact stability table,*** and the ***damage stability diagram.*** In the ***intact stability diagram,*** G_fZ is plotted against the angle of heel (up to 60°) or the angle of downflooding if this is less than 60°. From this diagram is extracted:

- ♠ *The maximum righting lever (GZ) and the angle at which it occurs,*
- ♠ *The initial metacentric height (G_fM_0),*
- ♠ *The areas to: 30°, 40°, and 30°-40°.*

These values and the current KG_f are then compared to IMO criteria in the intact stability table. For grain cargo, the grain heel angle, the residual dynamic area as well as the grain heel moment are also provided. The range of stability and the angle of vanishing stability are not given and cannot always be extracted from the diagram because of the scale chosen (60° angle of heel). But the flooding hazard for an angle of heel above 60° may explain this omission. The ***damage stability diagram*** is a plot of the maximum values of KGf against the ship's draft. The current KG_f must be within the area under this curve in order for the ship's condition to meet the SOLAS dry cargo vessel requirements.

The longitudinal strengths are provided in the form of tabulated values of shear forces and bending moments at critical points along the ship. Two related diagrams show the graphical representations of these forces. These diagrams present the limits within which these values must lie in order to comply with IMO criteria.

The Feedback provided by Mariner contains enough materials to deal with the loss of stability and structural damage hazards associated with the shipment of dry cargo. Some elements of statical stability, stability during the voyage, and structural damage due to improper distribution of the cargo may be addressed by using Mariner.

5.2 INSTRUCTIONAL USE OF MARINER

The program may be used to teach nautical and engineering students at any level. This use of the program, as shown by its content description, may be threefold. It may be used:

- ***For safe and efficient operation of the cargo and the ship.***

- ***As a drill (shipboard or school) tool to learn how to load and unload a bulk carrier with respect to IMO criteria***

- ***By the nautical teacher, for illustration of the theory and practice in hands-on exercises, and as an assessment tool.***

5.2.1 SHIPBOARD USE

The possibility for the deck officer to try out the loading and unloading operations beforehand will allow him to better plan his actions. He may also use the program to check his stability computations and make sure the ship conforms to IMO criteria before sailing. A newly embarked deck officer can use it to have an easy familiarization with the ship's cargo operations. Hence, Mariner may be a very good on the job training tool for deck officers. The instantaneous upgrading of the ship status, the GZ curve, the stability features, and the longitudinal strength information will help him develop the right reactions in loading and unloading the bulk carrier.

5.2.2 CLASSROOM INSTRUCTION USE

Not all stability subjects can be addressed using Mariner. However, the contents of the feedback provided by this program may help the nautical teacher to enrich his teaching in respect of a number of them. The program may be used to illustrate any of the following:

- ♠ Forces and moments
- ♠ Centroids and the centre of gravity
- ♠ Shear force and bending moments
- ♠ TPC and displacement curves
- ♠ Transverse statical stability
- ♠ Curves of statical stability
- ♠ Final KG determination
- ♠ Trim
- ♠ Effect of freeboard on stability
- ♠ Effect of density on draft, trim, and displacement

The teacher has the possibility to use various elements of the feedback to address a given subject (on the list above). He may, for example, illustrate the effect of the specific gravity (SG) of the seawater on stability by inputting, for a given displacement, the maximum SG value (1.030) then the minimum s.g value (1.000) and use the differences in the maximum values of the righting lever (GZ), the shear force, and the bending moment to support the point he previously made. The important problem of draft and trim changes will also be highlighted. This feature may also support the explanation of the relationship between the height of the initial metacentre above the keel and the ship's underwater volume.

Varying the load and the distribution of the cargo, and consequently acting on the max. GZ, S.F, and B.M, the nautical teacher, with the help of the display of feedbacks to the inputs, will better explain not only the stability problem in a rough sea (with important angle of heel) but also the stress forces applied to the ship in harbour.

The program provides information about the height of the centre of gravity above the keel (KG) of each individual hold and tank. The instructor may use this information to build an exercise whereby, for example, the nautical student will be requested to compute the necessary weight to achieve a given final KG.

The instructor may choose to use the ship's draft for given displacements and plot a graph of displacement curves (TPC against mean draft) to illustrate the concept of TPC (mass to change the ship's draft by 1 cm). This will allow him to build various types of exercises in which a draft constraint, for example, may require the student to compute the required load to add or to remove.

Using Mariner to teach stability will also allow the nautical teacher to stress the importance of major factors to take into account when loading a ship such as the max. righting lever and the angle at which it occurs, the height of the centre of gravity, the stress on the ship's structure (shear forces and bending moments), and trim. Thus the nautical teacher will also be teaching the proper way to handle loading operations.

In addition to its potential in enhancing the deck officer's understanding of ship stability subjects, Mariner may be used as an assessment tool. Unfortunately, the development of reasoning will not appear in the report resulting from the students' work. However, the output will clearly demonstrate whether the students have mastered the subject or not.

Mariner is a very practical shipboard simulation program, but there are in the same discipline area more sophisticated ones. Some of these programs may be connected to on-line tank gauging systems and draft sensors.

One such program, **PLANMASTER**, allows the user to define the desired bayplan and ship profiles. It is designed for ballasting analysis, breakbulk loading, container loading, hazardous cargo, loading calculations, ship stability, and stress and trim calculations, to name but some of its important features for training. The version of **Mariner** used deals with bulk carriers only (with continuous holds) and one cannot take advantage of the possibility to move the weight from different levels of holds in order to illustrate the behavior of GZ and consequently the actions on the ship stability.

Below is a sample report of a laden ship to achieve a trim of less than 2 m and a max GZ of less than 2 m.

CONDITION: FULLY LOADED WITH BAGS OF RICE

Date. 25th August, 1993 Time 14:00

Voyage No 1 From: Abidjan To: Rotterdam

Fig.25

Sample ship loaded with rice and its full bunker

DISPLACEMENT SUMMARY **Table. 3**

Holds	%	Stowage Factor	Weight(t)	LCG(m)	KG(m)
Hold 1 rice	70	0.8850	7,491.0	70.02	9.66
Hold 2 rice	80	0.8850	9,570.9	42.60	10.04
Hold 3 rice	90	0.8850	10,767.3	13.80	10.77
Hold 4 rice	85	0.8850	10,169.1	-15.00	10.40
Hold 5 rice	90	0.8850	9.034.7	-42.58	11.99
Cargo in Holds			**47,032.8**	**11.56**	**10.60**

1F SWBT (P)		0.0
1F SWBT (S)		0.0
1A SWBT (P)		0.0
1A SWBT (S)		0.0
2F SWBT (P)		0.0
2F SWBT (S)		0.0
2A SWBT (P)		0.0
2A SWBT (S)		0.0
3F SWBT (P)		0.0
3F SWBT (S)		0.0
3A SWBT (P)		0.0
3A SWBT (S)		0.0
4F SWBT (P)		0.0
4F SWBT (S)		0.0
4A SWBT (P)		0.0
4A SWBT (S)		0.0
5F SWBT (P)		0.0
5F SWBT (S)		0.0
5A SWBT (P)		0.0
5A SWBT (S)		0.0
FPT		0.0
1 DBWBT (C)		0.0
2 DBWBT (C)		0.0
3 DBWBT (C)		0.0
4 DBWBT (C)		0.0
5 DBWBT (C)		0.0
APT		0.0
Total Ballast	**0%**	**0.0**

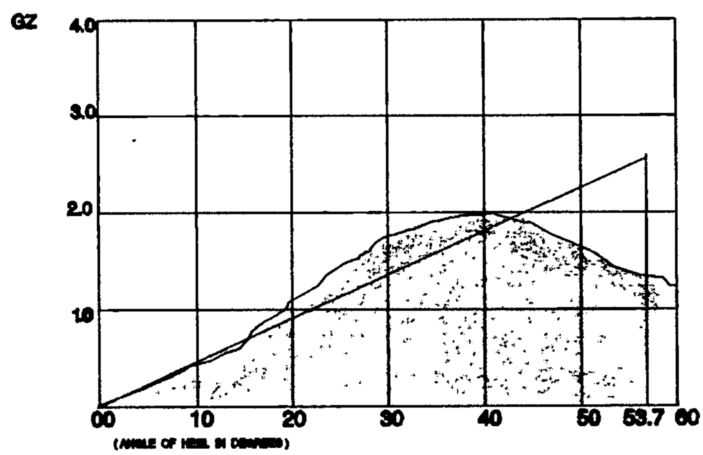
Holds	%	S.G	Weight(t)	LCG(m)	KG(m)	FSM
FWT (P)	100	1.000	92.7	-86.57	17.39	109
FWT (S)	100	1.000	92.7	-86.57	17.39	109
CFWT (P)	100	1.000	205.0	-92.91	17.40	143
CFWT (S)	100	1.000	205.0	-92.91	17.40	143
Total Water	**100%**		**595.4**	**-90.94**	**17.39**	**504**
FOT (P)	100	0.990	593.4	-60.19	11.39	541
FOT (S)	100	0.990	550.9	-60.19	10.70	541
FO Set (P)	100	0.990	81.4	-63.44	14.23	9
FO Srv (P)	100	0.990	71.2	-63.44	14.23	6
Total Fuel	**100%**		**1,296.9**	**-60.57**	**11.43**	**1097**
ER DOT (P)	100	0.900	99.4	-84.62	11.49	144
ER DOT (S)	100	0.900	99.4	-84.62	11.49	144
MDO Srv (P)	100	0.900	25.8	-63.40	17.29	4
Total Diesel	**100%**		**224.7**	**-82.18**	**12.16**	**292**
LOST (C)	100	0.900	20.8	-74.83	1.10	13
LO Str (P)	100	0.900	19.1	-69.39	17.29	3
LO Set (P)	100	0.900	19.4	-67.00	17.29	3
Cyc LO (P)	100	0.900	18.3	-71.79	17.29	2
Total Lub Oil	**100%**		**77.5**	**-70.82**	**12.95**	**21**
CWT			0.0			
Oily Bilge	100	1.000	22.8	-81.36	1.18	
Bilge Hold	100	1.000	49.0	-84.02	1.14	
FOOFT (P)	100	1.000	67.1	-63.39	12.67	
Sludge (P)	100	1.000	14.8	-69.40	9.09	
Total Minor Tanks	**84%**		**153.6**	**-73.22**	**6.94**	
Total Deadweight			**49,381.0**	**7.61**	**10.70**	**1914**
Lightship & constants			**12,862.3**	**-10.27**	**11.68**	**1914**
DISPLACEMENT			**62,243.3**	**3.91**	**10.91**	**1914**

FLOTATION:

Seawater S.G	1.025
Mean draft amidship	11.92 m.
Trim between marks	1.93 m.
Draft at fwd marks	10.97 m.
Draft at aft marks	12.89 m

INTACT GZ (FLUID)

Fig.26



STABILITY STATUS	ACTUAL	IMO CRITERIA
GM	2.62 m.	0.15 m.
Area to 30°	23.41 m^2	3.15 m^2.
Area to 4o°	42.08 m^2	5.16 m^2.
Area 30°-40°	18.68 m^2	1.72 m^2.
Max. GZ is	1.99 m	0.20 m.
at angle of	41.51°	>= 30°
Flooding Angle (Of) > 60°		
KG	10.94 m.	11.88 m.

DAMAGE STABILITY DIAGRAM

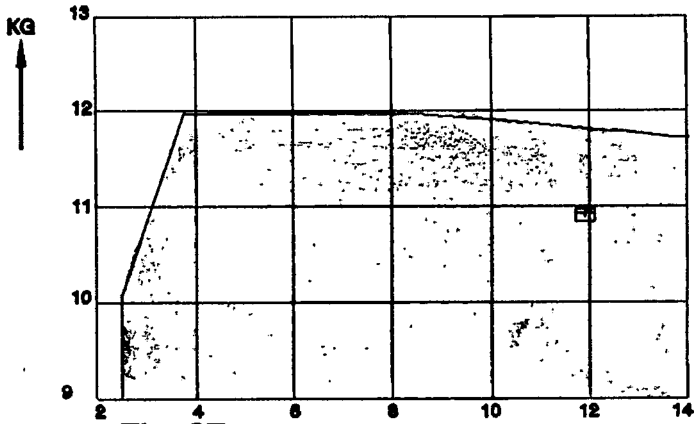
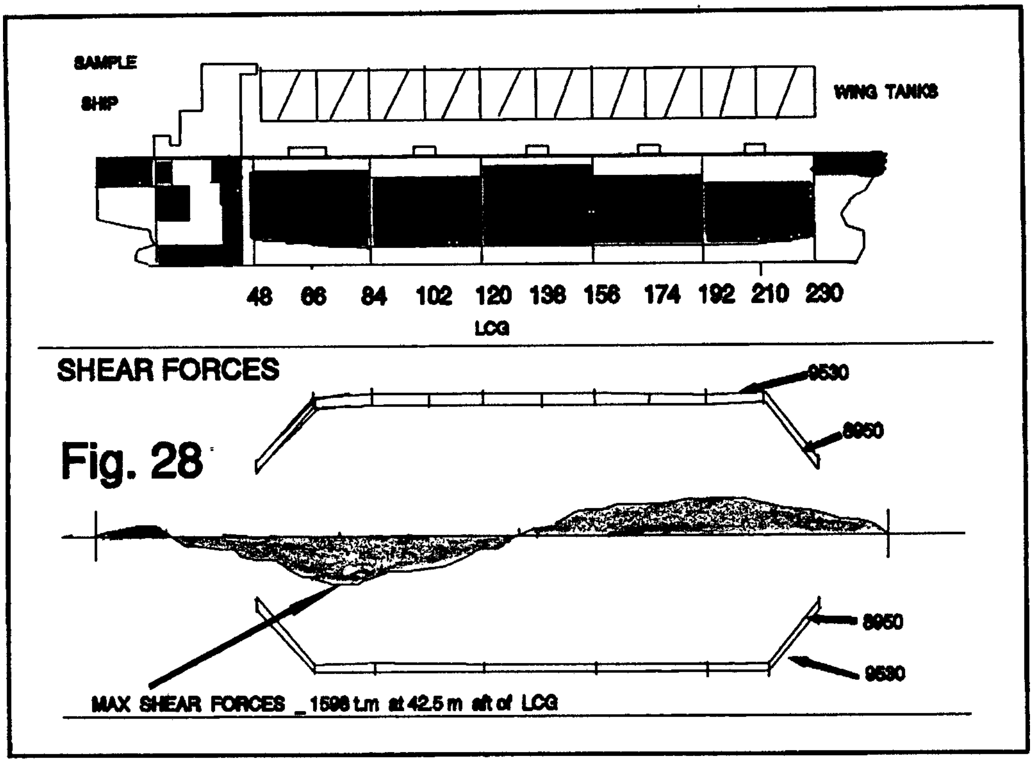


Fig. 27

The small square shows that the condition of the ship is in the safe area (under the curve).



Maximum shear forces = 1598 t. at 42.5 m aft of midships

<u>Shear Forces</u>

Location	Actual t.	Seagoing Allowed	%	Harbour Allowed	%
Bhd. 48	1214	4290	28.3	5040	24.1
Fr. 66	1598	8340	19.2	9100	17.6
Bhd. 84	1168	8620	13.5	9300	12.6
Fr. 102	841	8950	9.4	9500	8.8
Bhd. 120	534	8950	6.0	9530	5.6
Fr. 138	186	8950	2.1	9530	2.0
Bhd. 156	859	8590	10.0	9270	9.3
Fr. 174	1020	8120	12.6	8950	11.4
Bhd. 192	1308	8120	16.1	8950	14.6
Fr. 210	1270	8410	15.1	9150	13.9
Bhd. 230	759	4880	15.5	5160	14.7

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 SUMMARY

The rapid evolution in shipping technology in the field of ship operation constitutes a challenge for maritime training institutions. Unfortunately, the problem is tackled in disparate ways. On the one hand, the training institutions with greater means have adopted new training schemes (front-ended training schemes) whereby the students have a continuous three or four year training in the academy and are intensively trained by means of expensive bridge or engine-room simulators with an allocation of one and half or two months annual sea training. In some of these training institutions, PCs are used as well to address other subjects not treated by the high cost simulators. On the other hand, other training institutions, mainly those in developing countries, continue using the well-known `Sandwich' training schemes with little equipment to match the increasing technological requirements. If this figure is not altered, one might fear a dramatic increase in the technological gap existing between the shipping industries of the two worlds and a consequent ill-fated international shipping community.

The answer to the problem lies in the adaptation of the education and training schemes of poor countries to the changing shipping industry. Deck officers, a key component of ship operation, ought to be equally well educated everywhere because of the international nature of shipping. Thanks to the sharp and continuous drop in microcomputer prices and to the substantial development of maritime applications in the instructional software market, it is now possible to use the microcomputer media to improve deck officer training and to tackle the technological gap, whose rise would be bound to endanger the well-being of the international maritime community.

But the introduction of low-cost PCs in the training of deck officers is a multi-faceted issue. This paper has analyzed the major aspects of the issue, namely the **adoption of suitable methodologies** for CAI implementation in the training of deck officers, **development of maritime courseware market**, likely **pitfalls** to be faced and **advantages** to be expected, and the **capability of the teaching staff in selecting** appropriate courseware and in **integrating** it in their teaching.

One shipboard application software package has been described at length in order to underline the training possibilities that such a program offers. Unfortunately, it has not been possible to have access to, and a deep insight into a typical instructional program in order to evaluate it and sustain the argumentation about the effectiveness and teaching potentials of CAI. However, considering the claimed quality of programs such as **Officer Of the Watch**[6] and **SISRADAR** version 4, CAI programs have the potentials to improve the training of deck officers.

Computer-based tutorials and drills are used to address fundamental and applied sciences of importance for navigation and ship control, maritime regulations, and various operational principles. Some science teaching software produced by Control Data (Australia) and

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[6] *The author has been exposed to and impressed by a quick demonstration of OOW*

tutorials and drills software such as Clouds and Principles of Radar marketed by Videotel International (described in Chapter Three) are cases in point.

The innovation brought by computers is the possibility to use happenings in the field in a classroom environment. Although PC simulators are considered to be less effective than bridge simulators, they are believed to offer an acceptable alternative.

Naval academies as well as Maritime academies are increasingly adopting PC-based simulation for the training of deck officers: e.g. PC Navigator for the French Naval Academy and OOW for the Gothenburg Maritime Academy. Furthermore, they give students the opportunity to have more practice and hence a quicker and easier grasp of the subject.

As seen in Chapter Three, computers may be used not only to address subjects related to navigation but also to cover subject areas such as engineering, maritime law, and business.

In the light of the reiteration of the arguments used to advocate the need for CAI implementation, the reader may get the false impression that computers can do everything in the training of deck officers. Despite their many potentialities for training, computers cannot handle the entire complex environment in which deck officers work. As put by the late Dr. Yakushenkov, from the Leningrad Marine Research Institute, in an address to WMU students,

> "The profession requires implantation of a high sense of responsibility, overcoming natural

weaknesses, ability to deal with people in conditions of limited space for a long time. This demands direct contact with an experienced teacher having authority over students... It is believed that the use of computer-based programmed learning can in no way completely replace the training practice on real ships. The thing is that the ship's officer is not only a person possessing a certain amount of knowledge but is also a seaman, *i.e.* a man with specific psycho-physiological abilities which may be acquired only in actual sea conditions."

In addition, as demonstrated by the experiment with maths students recalled by Barker (1989, 85), a CAI without a teacher is less effective than the one coached by a teacher. Thus, Bridge simulators as well as PC-based training should not aim to entirely replace sea training or get rid of the teacher. Although some equivalence of sea time has already been granted to bridge simulator training in some academies, the inadequacy of the PC-based simulation environment should not allow such equivalence.

Nevertheless, taking into account the continuous improvement of computer technology (both hardware & software) and considering the proven effectiveness of CAI in some academies (Gothenburg, 'Institut Maritime du Quebec'), the use of PCs as a teaching tool may contribute, to a great extent, to enhancing the professionalism of deck officers.

But the production of quality instructional software is directly related to the extent of software use in maritime training institutions- in other words, to the development of a large and profitable maritime instructional software market. A case in point is the development of very powerful programs in the area of ship operations because of the high demand. Although some of these programs may be used for training as well, they are not designed for instruction and may present some inconveniences. Therefore, the maritime community should encourage the development of the instructional software market.

The next section will consider the skill based training, an area where the international maritime community may promote the use of computers to solve the standing problem of IMO Model Courses.

6.2 ALTERNATIVE APPROACH TO THE IMO MODEL COURSES

In attempting to maintain or increase their share of international shipborne trade, developing countries are finding it increasingly difficult to keep pace with the rapid evolution of shipping technology which has engendered major changes in ship operations and safety requirements, and consequently led to continuous shift in training requirements. In its strategy for bridging the technological gap which restricts developing countries' ability to comply with international conventions, IMO has established the now well known Model Courses to meet the training standards requirements.

The IMO Model Courses have been classified into seven groups of which three (groups I, II, and VII) are of interest for the training of seafarers. These three groups are:

Group I Basic and modular specialized training courses for seafarers.

Group II   Advanced specialized training courses for seafarers.

Group VII   Courses for the award of some of the certificates specified in the 1978 STCW convention (e.g. Model course for Chief Mate and Master).

Fifty one (51) of these courses have already been published, but their implementation suffers because of the lack of continuous financial support and the shortage of qualified local teaching staff. Although WMU is committed to educating and training teachers to solve this problem, a step forward in the promotion of equivalent skills and qualifications for all seafarers' (and in particular deck officers') would be the encouragement of the production of instructional software based on the model course concept.

The international maritime community has two options for the achievement of this goal. It may select one or two software producers with a good reputation for the quality of their programs in the maritime field and negotiate an agreement covering prices, quality, and the coverage of topics as well as on the operating systems and hardware systems to be used.

Although this option presents the advantage of price control and close cooperation, it may result in missing opportunities to have better products elsewhere. The second option would consist of providing guidelines (e.g IMO model courses) to interested software producers for the production of maritime instructional software, and of advising training institutions on the ones which have passed IMO's scrutiny. These programs could also include adequate tests to assess the skills gained by the students.

Although the implementation of computer assisted instruction is out of reach for some training institutions today, it is believed that most training establishments will be able to adopt this valuable teaching technique in the near future. IMO has the responsibility to provide guidance to this rising teaching technology market so as to avoid the proliferation of programs that do not always meet the quality and the standards one would expect in maritime education and training.

6.3 FUTURE DEVELOPMENT

The future of the use of microcomputers in the training of seafarers in general and of deck officers in particular will very much be influenced by the steps taken today. In the author's country, educators had also expected TV-based education to introduce major changes in the structure and content of school programs. When this failed, the whole thing was abandoned. The only reminders of this experience are the support textbooks which are still in use in the traditional way.

Some people think that computers will follow the same path once the interest generated by the new technology diminishes. These skeptics foresee the future use of computers in much the same lines as overhead projectors and cassette tape recorders are used today. They think the educational and training structures are so entrenched in the structure of the society that no technology can significantly alter them.

Others envision another scenario whereby advances in computer science will lead to the development of intelligent tutorial systems able to teach, test, and keep records of each student's educational program in a systematic way. In such a scenario, central planners would develop large-scale learning systems that will determine the course of education and training in formal education as well as in industry oriented programs.

Although those who prefer diversity may fear the advent of centralized computer based education in formal education, such a system, if effective, would be welcomed in the shipping industry where the community is fighting to promote common qualifications and hence equivalent training standards for seafarers.

6.4 RECOMMENDATIONS

As suggested in Chapter Four, before getting to the actual phase of CAI implementation, it is important to start with the following steps:

1 Build the governing body's support.
2 Secure financial contributions by the industry and government funding through the budget.
3 Train the teaching staff in computer science (e.g. computer literacy).
4 Involve the teaching staff in the investigation and the decision making process.
5 Collect all available information on existing software.
6 Provide the library with adequate literature to allow all interested parties within the establishment to become familiar with computers.
7 Select the appropriate software.

Once these steps are completed, one has to deal with the organization, the infrastructure, and the actual training policy. The scope of infrastructure to be installed depends on the scale of CAI implementation.

However, these two aspects will be considered separately for the clarity of the argumentation.

ORGANIZATION

'An idea shared is an idea bound to succeed'. This maxim could guide the introduction of the new technology in the teaching repertoire. One person, whatever his expertise in instructional computing, should not be solely in charge of deciding everything dealing with the delicate issue of the instructional use of computers. In the same way, it is not a good thing to let teachers carry out the program on an individual basis. Instead, a steering committee composed of key members of departments, a representative of the administration, a computer specialist, and eventually the head of the library will have a better chance to overcome the problems likely to impede the implementation of CAI.

In the very centralized form of administration at the ARSTM, such a committee will have a greater possibility of success if headed by a key administrator. However, because the head of the committee has to be knowledgeable about computers and their instructional uses, and must devote much time to this function, it would be advisable to designate a computer specialist as head of the steering board. If there is no person of this quality, the librarian may devote time to this busy task. If possible the committee should invite one or two industry representatives to the meetings in order to obtain their full involvement.

The role of this computer steering committee is multi-fold. The committee will:

♠ Provide the forum for discussing computer matters

- Evaluate the needs (investigate what is feasible and what is not).
- Analyze proposals put forward by members and teachers.
- Evaluate, select, and catalogue the software.
- Advise the administration on proper actions to be taken in CAI matters (equipment, maintenance, new developments).

Although the final decision is in the hands of the administration, the committee must commit itself to the success of the system. Within the committee, each individual member should be assigned specific tasks in the interests of greater efficiency and teamwork.

The head of the committee, for example, may be assigned the task of keeping records of available information on appropriate software and keeping up with new developments in computer hardware and maritime instructional software. In addition, based on decisions agreed upon by the committee, he will advise the administration on CAI matters.

The librarian will provide appropriate literature in order to allow all interested parties to refresh their knowledge when necessary.

The academic representatives will be assigned the task of investigating CAI implementation in their respective subjects of interests. For example, by conducting a program trial, they will provide a basic evaluation of the program that will serve as the focus of the committee's discussions.

Financial and administrative matters will be delegated to the representative from the administration.

This representative will have to investigate all implications other than academic linked to the implementation of CAI.

Eventually, the industry representatives will provide the committee with their views on deck officer qualifications and the extent of support the industry may give to a particular training initiative.

INFRASTRUCTURE

The infrastructure related to the implementation of CAI has two components: the physical facilities and the computer hardware systems.

In addition to the microcomputer lab in existence, the ARSTM has some rooms available to house CAI related installations. Very few things would need to be done at this level. The electrical installations are of a high standard and could be used for the computer wiring system. Unfortunately, the voltage of the electricity in the area is not very stable and may require some care. The purchase of some surge suppressor would settle this inconvenience.

Despite the existence of a central air-conditioning system, it would be a good idea to have a backup cooling system in the form of individual air-conditioning units in order to ensure the continuous cooling of the computer rooms during working hours.

As for the computer hardware system to be installed, an IBM or a compatible brand would seem to best fit the situation, as suggested earlier. From the beginning it may be advisable to carry out the implementation at a small scale. A PC-network of eleven microcomputers, of which ten will be located in individual classrooms for teaching use, might be a very good start.

At this experimental phase, this network does not need to be connected to the administrative computer network since there will be very little for the administration to exploit. Each classroom hardware system will comprise the microcomputer hardware (CPU, VDU, mouse and keyboard), a CD-I player, a TV set, and a projector. One printer linked to the central server will be used in the network. A communication network providing means of sharing programs or files should be preferred to a resources-sharing network where only the resources such as printers are shared.

During the first phase of CAI implementation (as proposed), students may experience some difficulties in practicing on their own because of the limited resources. Therefore, it is important to rigorously regulate their private access to the programs. After the likely success of the first phase, one may move onto the installation of the computer lab and the extension of the number of classrooms fitted with computers. The scope of CAI implementation will dictate whether to have the same network for the administration and the training departments or to establish separate networks. Computers also offer very good prospects for school and classroom management. These potentials should not be overlooked.

TEACHING ASPECTS

As explained earlier, the teachers should be familiar with computers. During the first phase of CAI implementation (with limited resources), they should be selected on a voluntary basis, because starting with someone who would not commit himself to the change may jeopardize the success of the project. The selection of the subjects, at this early stage, will depend on the resources available and on the qualifications of the volunteer teachers. Because the limited number of computers cannot allow extensive student self-access, software dealing specifically with drills and tutorials should be avoided at this stage. Instead, simulation software that may encompass drills should be preferred. Some effective ways of using PC-based simulations have been the subject of experiments by the `Institut Maritime du Quebec':

> "We were led to new ways of using a simulator .. we used `briefing-exercise-briefing'.. where the student does not have to perform .. he is asked to observe, note the facts, and understand .. following the demonstration the student carries out an exercise in which the principle or principles which have been demonstrated are applied .. we have found this approach so effective that it is now used in each field of learning each time it may be useful" (David Edmond, Oct. 1992)

This teaching method may be tried on an experimental basis and adopted if it produces the results acknowledged. When CAI is implemented on a larger scale, some programs dealing with regulations, rules, collision avoidance and radar navigation as well as with other basic nautical subjects should be available in the computer lab so that the students can have sufficient free practice in these fundamental subjects.

Computer assisted instruction offers many possibilities for the training of deck officers. The production of more high quality software programs is expected as more producers are collaborating with maritime academies to meet the training requirements. The rapid development of computer technology combined with improvements in software will make available programs which will match, to a great extent, the high cost simulators.

Officer Of the Watch (OOW) a PC-based training program described in Chapter Three has won the 1993 sea trade award for safety at sea because of its standards of excellence in addressing the collision avoidance issue. programs like **SISRADAR** version 3 and 4 have been ordered by more than 28 maritime colleges from Africa, Asia, western Europe, and Australia. The ARSTM must adapt to this trend in training in order to continue to improve the competitiveness of the national shipping industry.

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APPENDIX A

LIST OF COURSEWARE

▼ INSTRUCTIONAL SOFTWARE

Denomination (Subject Area)	Producer or Marketing Co.	Computer Hardware	Price
Buoyage Systems (IALA Buoys)	Videotel International	IBM & Compatibles DOS[7]	$ 800
Clouds Part I & II (Meteorology)	"	"	from $ 800 per Unit
Marine Questions (COLREG, Safety, Eng.)	"	IBM & Comp.(640K) EGA Monitor (512K)	From $ 750
Marine Simulation (Manoeuvre, Eng.)	Danish Maritime	IBM, UNIX	$50000
NAVMASTER (Electro. Navigation)	Pilot Software Ltd	"	$ 600
Officer of the Watch	PC Maritime Ltd	IBM & Comp. VGA colour	$ 5200
OOW Course Designer (Collision Avoidance)	"	Monitor	$ 4000
PC Navigator (electro. Navigation)	"	"	NA
PORTSIM C (Ship Manoeuvring)	SSPA Maritime	IBM & Comp. 486 20MB, VGA color Monitor	$31250
PORTSIM B (Ship Manoeuvring)	"	"	$ 8200
Principles of Radar (Radar)	Videotel International	IBM & Comp. EGA Monitor	$ 800
Safety Challenge Series (Marine Safety)	"	"	$ 400

[7] All courseware mentioned in appendix A use Dos or are dos compatible.

Ships' Lights, Shapes and Sounds	"	"	$ 600
SISRADAR Version 3 (Radar Navigation)	Sea Information Systems	IBM 386 16 MHz 20 MB HD, VGA Colour Monitor & Graphic adaptor	from $6000
SISRADAR Version 4 (Radar Navigation)	Sea Information System	IBM 486 SVGA Monitor	to $38500
TUTSIM (Automation)	Meerman Automation	IBM & Comp.	NA
Wayplanner (Route Planning)	PC Maritime Ltd	IBM	NA

♥ APPLICATION SOFTWARE

Denomination (Subject Area)	Producer or Marketing Co.	Computer Hardware	Price
ACT 2000 (Accounting)	Veson Computer Sytems	IBM & Comp.	NA
Marine Accounting & Management Information System (Accounting)	Computer Science Corporation	Any DOS & UNIX Compatible Machine	NA
Mariner (Stability)	Naval Architects & Marine Consultant	IBM	$ 700
Mathman (Ship Manoeuvring)	Burness, Corlett & Partners	Any MS-DOS Machine	NA
Ocean Navey System	Anchor Marine	IBM & Comp.	NA